The Asbestos Products Garlock Sold, the Applications and Manufacturing Process of Those Products, and the Development of Asbestos-Free Alternatives

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February 8, 2013

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I was employed by Garlock Sealing Technologies, LLC and its predecessor, Garlock Inc, for 38 years until my retirement from Garlock in 2010. For the last ten years of my career with Garlock, I also testified from time to time as its corporate representative in the asbestos personal injury litigation. I am now a consultant to Garlock and Garrison Litigation Management Group, Ltd.

During my employment with Garlock, I worked at least ten years each in manufacturing, sales, and marketing. Each assignment helped me to develop a broad understanding of how Garlock products were manufactured, distributed and sold. I dealt directly with internal and external customers and, as part of my responsibilities, reviewed and used Garlock catalogs, product masters, bills of material, quality requirements, and price lists. I had frequent interaction with Garlock suppliers and daily interaction with the Garlock manufacturing process. I worked closely with the Garlock sales force and customer base to understand their needs, how Garlock products addressed those needs, and how those products compared to competition. My education and experience with Garlock is summarized in my CV, attached as Exhibit A.

I submit this report to provide the Court with technical information about the different applications for Garlock's asbestos-containing sealing products, the manufacturing process and use of Garlock's asbestos-containing sealing products, and Garlock's development of asbestos-free alternatives.

Applications for Garlock's Sealing Products

Garlock's primary business has been the manufacture and sale of sealing products for processing industries. These products included gaskets, packing, and mechanical seals, among others. Garlock gasket materials were primarily used for static sealing of steam line flanges, cylinder heads of engines, compressors and refrigeration equipment, fluid conduits, etc. Garlock compression packing materials were primarily used for dynamic sealing of machinery. Different applications required products made with different materials. Some applications required sealing products made with asbestos. Garlock made gaskets, packing, and a limited line of expansion joints with asbestos. Garlock also sold a limited line of asbestos textile products (cloth and yarn) in limited quantities to manufacturers of packing products.

Selection of the right product for an application is a complex decision and depends on many factors. In static sealing applications like gasketing, these factors include fluid, temperature, media, pressure, and size. In dynamic applications speed is an additional factor. In all cases customer preference and experience is a significant factor in their decision as to what product to use. Garlock catalogues provide extensive technical information about the products and how to begin the process of selecting the right product for a particular application. I have attached a copy of Garlock's Gasketing Materials catalogue from 1975 as Exhibit B. On page 3, for example, there is a discussion on the beginning of selection of the right product for different applications. Similar information appeared in other historic catalogues that have been produced in this case. I used this and similar catalogues in making recommendations to customers. Of

course, the consequences of selecting the wrong product for a particular application can be severe, resulting in the loss of life or limb.

The catalogues also include charts on chemical resistance and chemical compatibility that are useful in determining the right product for a particular application. But, mechanical properties are also important. For example, compressed asbestos sheet gaskets, which accounted for the vast majority of the asbestos-containing gaskets Garlock sold, were typically used to seal steam lines in 150-300 lb. flanges. But compressed asbestos sheet gaskets were not suitable for the highest pressure and temperature steam lines.

The Manufacturing Process

The manufacturing process of Garlock's compressed asbestos sheet gaskets and asbestos compression packing resulted in the encapsulation of the asbestos in a binder material of various types. In the case of compressed asbestos gasketing, solvent, curatives, pigment, clay, and asbestos fiber were sequentially added to the dough mixer as mixing began. Mixing continued until the proper amount of time occurred and the particle size of the dough was correct. This solvated mixing process ensures that all the asbestos fiber has been thoroughly mixed into the matrix, after which the dough was dumped into a cart and transported to the sheeter. The dough was then shoveled into the gap (nip) between the two rotating rolls of the sheeter. Dough continued to be added to the sheeter nip until the proper thickness of sheet was achieved. Solvent was added as required to achieve a uniform thickness and consistency. Once a sheet was complete, it was a composite of all the added materials and was flat and smooth like linoleum. Garlock's anti-stick releasing agent was blended into the surface of compressed asbestos sheet to facilitate the removal of the gasket. Other gasket materials were made from woven, asbestos cloth impregnated and encased in a rubberized coating.

Garlock asbestos compression packing materials consisted of braided asbestos encapsulated in either elastomeric compounds or metal foils and/or impregnated with lubricants. Prior to braiding pump packing, asbestos yarn was bulk dipped in a vat of lubrication. The lubrication varied by style but included fish oil, tallow, oil, petrolatum, PTFE, and silicone, among others. This process created impregnation of the yarn. Additional impregnation could occur by adding a lubricant to the braiding pot, running the finished braid through a dip prior to calendaring, or soaking the finished braid into a lubrication tank. Valve packing was run through a lubrication tank, then received a coating of rubberized cement, after which a graphite and typically zinc coating was applied.

Asbestos cloth used to make Chevron packing and expansion joints was frictioned with a rubber compound, a process by which viscous rubber was driven into the cloth by a calendaring process forcing the rubber through the fabric. This left the cloth tacky. In the molding of the finished Chevron part, uncured rubber was combined with blanks formed from frictioned cloth and together they were compressed in a mold under temperature and pressure until a molded part was achieved. Other Chevron packing was produced using a similar process with Teflon – impregnated cloth.

To construct a cloth reinforced expansion joint, a homogenous rubber tube was first placed on a building form after which strips of frictioned cloth were added. This build up continued with rubberized cement added between layers of cloth until the proper thickness was achieved. A homogenous rubber cover was then applied and the entire structure was wrapped with Nylon fabric. This composite was then placed in a high temperature vulcanizer during which a solid mass was formed. After removing the Nylon fabric from the outside of the completed joint, the entire outside of the body was then painted with a rubberized paint that contains Hypalon resulting in a smooth rubber exterior.

Asbestos cloth was dipped in rubber cement one, two or three times until the proper amount of rubber build-up on the cloth was achieved. This process left the rubberized cloth 'tacky' which allowed it to be folded upon itself to make a gasket or packing. The process also left the cloth encapsulated by rubber.

Dust suppressed asbestos cloth was produced by first vacuuming the surface of the finished cloth and then impregnating the cloth with an acrylic surface finish by running the cloth through a bath containing an acrylic based solution. The process was completed by then drying the cloth.

These products would not function properly if these processes were not followed. For this reason, Garlock had strict quality control checks and procedures.

An example of the quality control procedures during manufacturing related to the manufacture of compressed asbestos sheet gaskets made with chrysotile and crocidolite asbestos. Almost all of the gaskets made were manufactured with chrysotile asbestos. Only about 1% by volume of the asbestos-containing gaskets manufactured were made with crocidolite asbestos.[1] Crocidolite gaskets were necessary when they were made for applications involving certain, but not all, hot and cold mineral acids. Though the same equipment may have been used to make the chrysotile gaskets and crocidolite gaskets, extensive steps were taken to ensure the equipment was clean before and after the crocidolite gaskets were made. Crocidolite fiber was too coarse to mix with chrysotile fiber and would not yield a properly functioning gasket.

Garlock made different styles of chrysotile asbestos-containing gaskets in different colors. The colors ranged from off-white to gray-black. Style 900 was off-white or yellow, for example, and Style 7021 was dark gray or gray-black. The sheets made with crocidolite were black or gray-black. While Garlock made chrysotile gaskets every day in the 1960s and 1970s, crocidolite gaskets were made every other month. Garlock made the different styles of gaskets by starting with the gaskets that were off-white in color and progressively making the darker-colored styles, finishing the cycle with the gray-black or black sheets. When Garlock made the

[1] Because crocidolite was more expensive to Garlock and its customers, crocidolite gaskets accounted for two to five percent of sales during the time period in which crocidolite gaskets were made. Exhibit C is a chart produced in this case summarizing Garlock asbestos purchases by fiber type and is based on historic records.

crocidolite asbestos sheets, they were made at the end of the cycle, just after the darkest of the chrysotile sheets and before the next run of the off-white chrysotile sheets.

The mixers and sheeters had to be thoroughly cleaned between runs of gasket styles with different pigments and different fiber types. Otherwise, either the different pigments would appear in the wrong style sheets or the asbestos, if a different fiber type, would not mix properly. If either happened, the sheet material would fail the quality control checks. The employees received financial incentives based on the quality of sheets produced.

Use of Garlock Gaskets

Garlock's customers typically specified specific performance criteria for the gaskets and packing. I have attached as Exhibit D examples of specifications from industrial customers and MIL-Specs for asbestos-containing gaskets and packing. The catalogues also identified the military and industry specifications Garlock's products met. See, e.g., Exhibit B, pp. 5-6.

The faces of the flanges in which compressed asbestos sheet gaskets were used typically had concentric circles with serrated edges. When the flange faces were bolted together, the gasket would compress and the serrated edges would grip the gasket.

Not all gaskets would be replaced, with some gaskets remaining in service for decades. But if a gasket were replaced, care would have to be taken not to damage the flange face. Otherwise, the new gasket would leak and the flange would be replaced, which is expensive and time consuming. When gaskets were replaced, they were often replaced on the line. Because it was difficult to separate the flanges in place on the line, only tools that could be inserted within the tight space would be used, such as a scraper, file, or wire brush. It would be unlikely power tools could be used (if electric or air power was available in the field) because of the inability to spread the flanges far enough apart. Moreover, plant safety rules in refineries and chemical plants often prohibited the use of power tools because of concern with fire or explosion.

Non-Asbestos Alternatives

During my career, I was involved with the development of numerous non-asbestos products in packing, hydraulics and gasketing, often coordinating their introduction to the market. Through this process, I learned first-hand the complexities of attempting to match the performance properties of asbestos-containing products with those offered as alternatives. These complexities extended not only to the changes in the Garlock manufacturing process required to produce an acceptable product, but also to the concerns and issues experienced by the end user, as they attempted to evaluate the impact these changes brought about to their plant operations, safety, efficiency, and maintenance practices.

Several major issues were quickly identified: 1) No one non-asbestos fiber could be successfully substituted for asbestos fiber. 2) No one non-asbestos product could be universally substituted for any one asbestos-containing product. 3) Before a non-asbestos product could be

recommended for an application where a compressed asbestos gasket was being used, a much greater understanding of the application as to temperature, pressure, application, media and size was required. 4) More precise methods of installation and adjustment were necessary for the non-asbestos alternatives to perform successfully.

In the search for potential fibers that could be used to produce packing and gasketing alternatives, Garlock worked with both traditional and non-traditional suppliers around the world. What Garlock found was that none of the existing fibers were suitable for use in their existing form. Kevlar was eventually able to be modified so that it could be processed in the high pressure sheet (HPS) manufacturing process and also yielded an acceptable finished product. However this evaluation was complicated by the fact that Kevlar produced static electricity and could cause a fire in the mixing process where Toluene, a flammable liquid, was used.

Even after potential substitutes were developed, Garlock ran into considerable resistance from customers in evaluating their use because the customers often had decades of experience with the asbestos-containing products. Some customers at times used asbestos-containing products in applications for which they were not recommended.

Consequently, both the end user and Garlock had to reevaluate the true capabilities of compressed asbestos, and clearly define their expectations for the alternatives. Generally, regardless of the results of performance testing conducted by Garlock, end users needed to conduct their own evaluations. This was especially true in critical applications.

One example of this was Garlock's efforts in the early 1980s to convince the US Navy to approve an asbestos-free alternative gasket for steam service. The Navy's initial response is attached as Exhibit E. Ultimately, Garlock obtained approval ten years later. See Exhibit F. This was the first time the Navy approved an asbestos-free alternative for steam service.

While the process used to produce non-asbestos gasketing is essentially the same as that used to produce compressed asbestos, more modern equipment was required to produce the non-asbestos product. This included both sheeters and mixers. This was because the non-asbestos substitutes needed to be produced in tighter tolerance and because the composition of the dough used in the HPS process changed significantly. While compressed asbestos sheet was made up of 75 – 85% asbestos fiber, the maximum amount of Kevlar fiber able to be added to the sheet was only about 30%. This meant the non-asbestos sheet needed to have filler materials added to it, and these new materials had to be found, evaluated, and successfully added to the manufacturing process. Only then could evaluations be conducted to determine that the finished product actually produced a sheet gasket that provided acceptable performance.

As mentioned above, I have testified as Garlock's corporate representative. A list of that testimony during the past four years is attached as Exhibit G. As I did in the two depositions I have given in this case, I may refer to the information in the attached catalogues and other catalogues and to Garlock documents produced in this case. I am compensated for my time on

this matter as part of my consulting agreement with Garlock and Garrison, under which I am paid $5,000/month and $125/hr for hours over 40 hours/month.

Respectfully,

James Heffron

Exhibit A

James E. Heffron

Educational Experience

1999	**Roberts Wesleyan College, Rochester, N.Y.** Bachelor of Science Degree in Organizational Management.
1971	**Finger Lakes Community College, Canandaigua, N.Y.** Applied Science Degree in Business Administration.
1969 – 1970	**SUNY, Geneseo, N.Y.** Course work towards a Bachelor of Science Degree in Liberal Arts.

Professional Experience

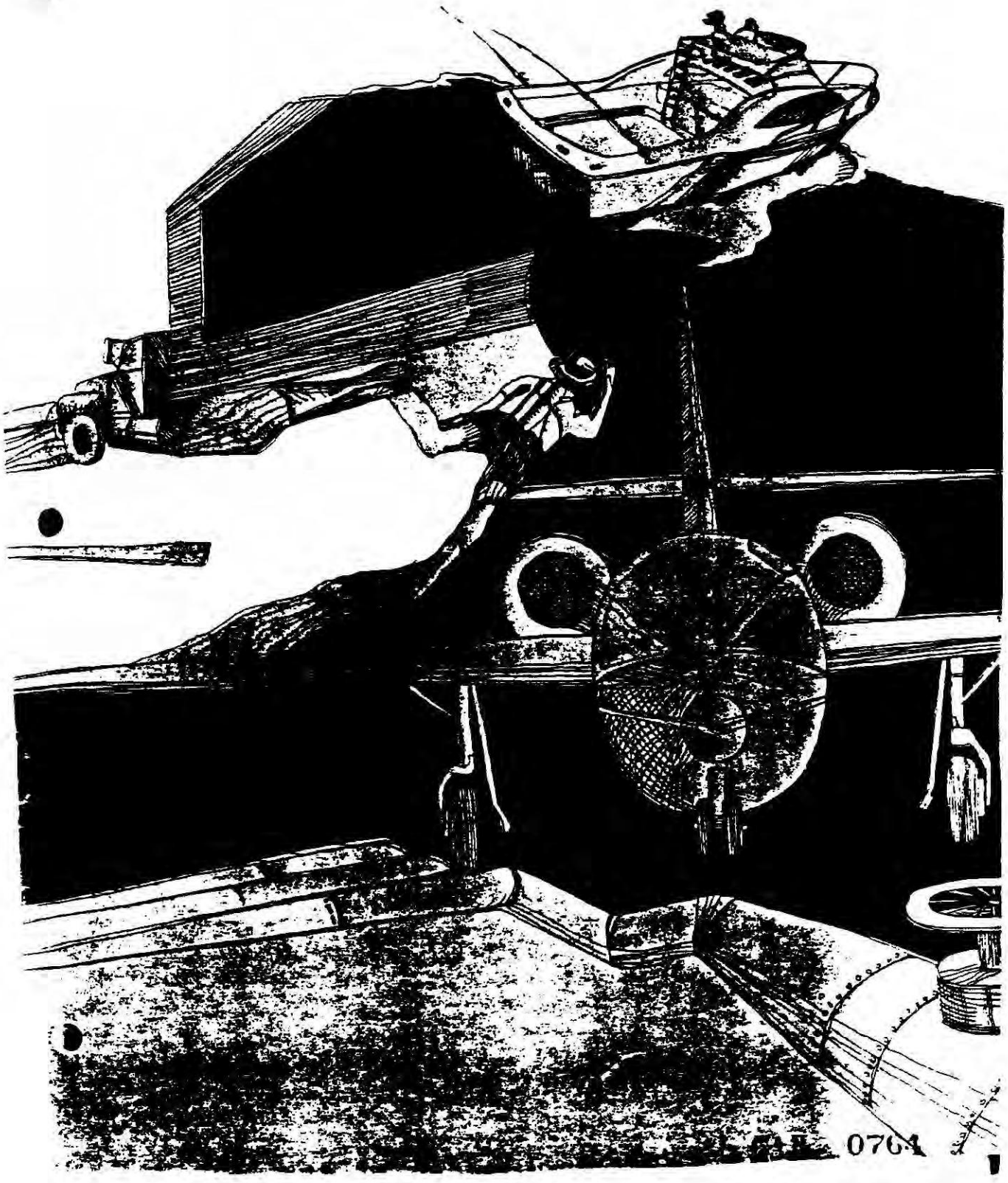
12/10 – present	**Consultant**
	Garlock Sealing Technologies, Palmyra, N.Y.
2/05 – 12/10 (ret)	**Senior Marketing Manager** Responsible for Voice of the Customer (VOC) activities, coordination of distributor training, and related product development support.
7/00 – 2/05	**Senior Marketing Manager, Industrial Gasketing** Responsible for the identification of customer needs, market trends and conditions, pricing, product training and new product development.
8/99 – 7/00	**Director of Training** Responsible for providing coordination and facilitation for the implementation of programs designed to improve plant-wide efficiencies and effectiveness. Examples are Six Sigma and Lean Manufacturing concepts.
10/97 – 8/99	**Vice President & General Manager, Hydraulic Components** Responsible for meeting and exceeding stakeholder needs, domestically and internationally, internally and externally. Responsible for product management, development, engineering and manufacturing.
2/96 – 10/97	**Vice President, Quality** Responsible for Quality, Training and Employee involvement departments.
8/90 – 2/96	**Vice President & General Manager, Compression Packing** Responsible for product sales and marketing, process and product engineering, production and inventory control.
1/89 – 8/90	**General Manager, Industrial Products** Responsible for product sales and marketing, process and product engineering, production and inventory control.
10/87 – 1/89	**Operations Manager, Hydraulic Components** Responsible for engineering, manufacturing and production control.

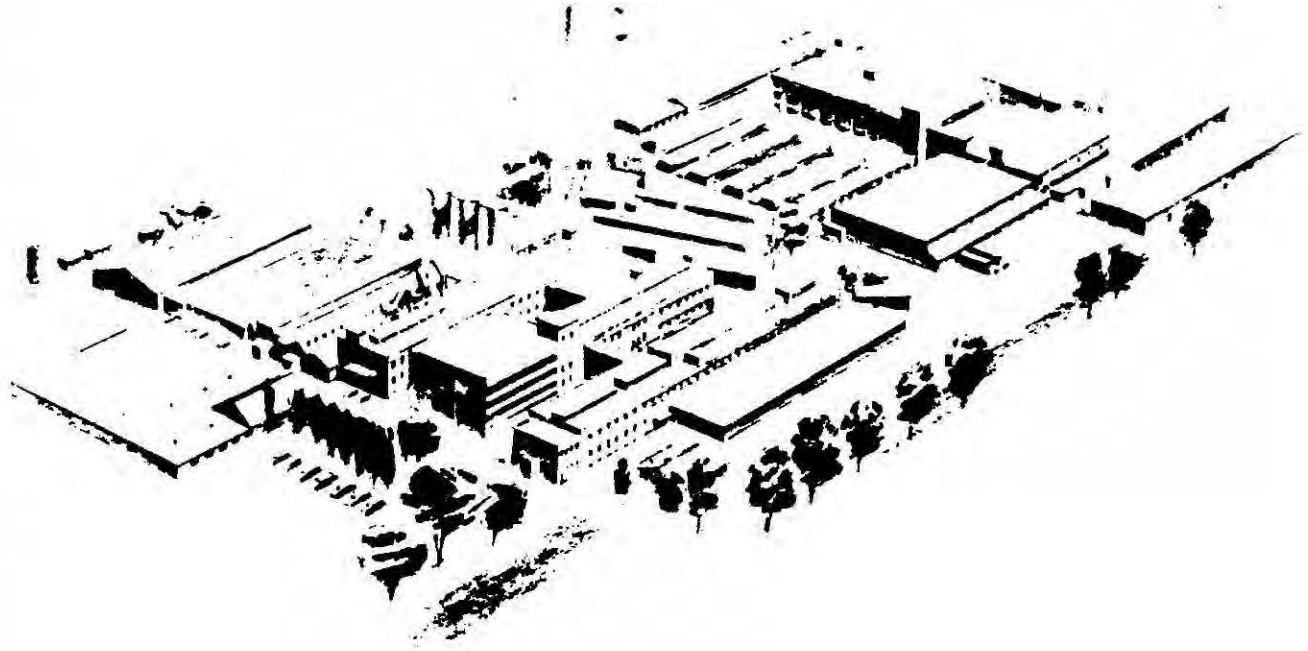
1/86 10/87	**Director, OEM Sales** Responsible for management of all product-line for sales to the Original Equipment Market (OEM). Duties included setting sales goals, expense budgets, contracts, assigning sales territories, calling on customers and hiring and firing employees and manufacturers representatives.
8/82 – 10/87	**Sales & Marketing Manager, Hydraulic Components** Responsible for coordinating the development and introduction of new products, literature, pricing policies and sales strategies.
4/81 – 8/82	**Southwest Regional Manager** Responsible for the management of a company sales force and a network of distributors. Established sales goals, larger accounts, managed distributor network, provided input as to market conditions and needs.
9/79 – 4/81	**Marketing Manager, Compression Packing** Responsible for the coordination and introduction of new products, developed literature, established pricing policies and sales strategies.
10/76 – 9/79	**MRO Salesman, Eastern Region** Provided account coverage on maintenance products in support of distributors. Introduced new products, made sales calls and trained distributor personnel. Provided feedback to factory on product performance, competitive situations, market conditions and sales and product projections.
8/75 – 10/76	**OEM Sales Correspondent, Compression Packing** Duties included handling inquiries, entering and expediting orders and providing technical support to equipment manufacturers.
	Metropolitan Life Insurance
10/74 – 8/75	**Insurance Salesman** Responsible for providing sales coverage and customer support for life and health insurance in self-developed sales territory.
	Garlock Packing
1/72 – 10/74	**MRO Sales Correspondent** Provided customer service on maintenance and repair products sold to distributors. Duties included handling inquiries, entering and expediting orders and providing technical support. Responsible for all product-lines.

Exhibit B

Garlock

GASKETING MATERIALS





The purpose of this manual is to provide you with the latest engineering information, to help you select the right gasketing material for your application, and to guide you in the proper design and installation of gaskets for years of trouble-free service. It is based on our more than 80 years of research and production experience as one of the world's largest manufacturers of gasketing materials.

Contents

Characteristics of an efficient gasket

A gasket has one basic function—to create a positive seal between two relatively stationary parts. The thinnest gasket that will create this seal is the most efficient and will last the longest. It is also the most economical.

To achieve a "tight joint" that will survive the rigors of the service these nine criteria must be met

1. The gasket must be impervious to the fluid handled in the system.

2. The gasket must have sufficient chemical resistance, both at its inner and outer areas in contact with the fluid, to prevent impairment of its physical properties.

3. The gasket must not contaminate the fluid being handled by the system.

4. The gasket must not promote corrosion of the flanges with which it comes in contact.

5. The gasket must be capable of withstanding the required bolt pressure without crushing or undergoing excessive plastic flow.

6. The gasket must be sufficiently deformable, without resorting to excessive thickness, to distribute the applied pressure evenly over the surfaces, compensating for normal irregularities.

7. Gasket material must be elastic enough to maintain an adequate portion of the applied load when joint movements are not fully eliminated by the joint design.

8. The gasket must develop sufficient friction in contact with the flange surface to resist excessive creep or extrusion.

9. The gasket must lend itself to easy installation and separation for ultimate removal.

Selecting the right gasket material

Every gasket material available to industry has certain inherent advantages that should be utilized to extend its range of applications. Limitations in a material can frequently be partly or wholly eliminated by using reinforcing inserts, combining with other materials, and varying construction or type of joint the material must seal.

Although mechanical factors are important to the design of the complete joint, primary selection of a gasket material is greatly influenced by two factors

TEMPERATURE AND NATURE
OF FLUID CONTAINED

Temperature

With very few exceptions, a material should never be used at temperatures higher than those recommended for its group.

Temperature ranges for rubber are Natural—up to 200°F SBR, Nitrile and Neoprene—up to 250°F VITON -up to 450°F. Silicone—up to 500°F.

Vegetable fiber sheet with glue-glycerine bond has a temperature range up to 250°F with synthetic rubber bond up to 300°F.

Woven asbestos cloth is effective up to 600°F compressed asbestos up to 700°F.

Rubber used in most cloth-inserted sheets usually determines the material's temperature range.

However you should never select or reject a gasket material solely on the preceding information as this is merely a general guide. To be sure, consult your nearest Garlock representative for more specific recommendations.

Fluid contained

Concentration of the corrosive agent can have a decided effect upon the gasket material selection. Full strength solutions are not necessarily more corrosive than those of dilute proportions. The reverse is often true.

Purity of corrosive agent or the absence of contaminating compounds is another factor involved. Example dissolved oxygen in otherwise chemically pure water may cause rapid oxidation of high temperature steam generating equipment.

Temperature of corrosive agent, in addition to temperature effect on mechanical properties, will also influence the rate of corrosive attack.

Location of gasket can often influence its chemical resistance. For example, a gasket either in a partially filled line or one at or above the solution level may be more subject to attack than those below the surface.

Construction of gasket material decidedly affects its chemical resistance. It is generally poor economy to use an inferior material that can cause frequent gasket replacements. This ultimately results in extremely high maintenance costs. However, if it is necessary that a joint be opened frequently, a less expensive, less resistant material may be quite satisfactory. Where a joint is seldom opened, the most resistant material, regardless of cost, is usually the most economical in the long run.

Also, if a slight swelling of the gasket occurs due to reaction to fluid, the overall effect may be a more positive seal. Conversely, materials that shrink and dry out usually cause early gasket failure.

Other factors that may influence material selection are internal pressures, operating cycle and vibration. A highly resilient material and proper design is essential where sudden variations in operating conditions occur frequently.

Bolt relaxation, caused by thermal expansion and creep, is sometimes an important consideration. Expansion and contraction of line or gasket and excessive bending movements on the flange may also limit selection of gasket material and construction.

To summarize... if these considerations are all taken into account and properly evaluated and a suitable gasket material is selected from the resistance chart the choice, in most cases, can be narrowed to a small number. Final choice, then, can usually be made on the basis of relative cost, availability or personal experience.

The first step in selecting the materials should be a survey of the conditions to be met by the gasket. Are there chemicals involved and, if so, what materials are available to withstand them? Table 1, on the following page, serves as an initial guide. Other factors to be considered are: 1) Are there solvents present which might swell and soften or extract components from the gasket? 2) Is there a gas present, necessitating permeability consideration? 3) What are the temperatures, pressures and other enivronmental parameters? The temperature/pressure relationship is shown for various materials in Table 2. With very few exceptions, a material should never be used at temperatures higher than those recommended for its group. It should be noted that Table 2 is merely a general guide and should not be the sole means of selecting or rejecting a material.

TABLE 2

Typical Temperature and Pressure Limitations

Gasketing Material	Maximum Temperature X Pressure	High-Temperature Limit
Compressed asbestos	300,000	750° F.
TFE	150,000	500° F.
GYLON filled TFE.....	150,000	500° F.
Woven asbestos cloth	125,000	600° F.
Reinforced rubber	125,000	225° F.
Beater-saturated cellulose .	50,000	300° F.
Vegetable fiber	40,000	212° F.
Natural rubber & SBR	20,000	225° F.
Neoprene and nitrile rubber	20,000	250° F.
VITON* Fluoroelastomer....	20,000	400° F.
Silicone rubber	20,000	500° F.

*Registered Trademark-du Pont Co.

TABLE 1

Basic Guide for Choice of Gasketing

● Preferred
○ Satisfactory

PRODUCT	BASIC COMPOSITION	STYLE	Hardness, Durometer	MEDIA: Acids – Mild	Acids – Corrosive	Alkalies – Mild	Alkalies – Corrosive	Gases – Air & Dry Inerts	Gases – Bromines, Chlorine	Gases – Oxygen	Oils – Petroleum	Oils – Synthetics, Blister	Solvents – Aromatic (Benz., etc.)	Solvents – Aliphatic (Gas., etc.)	Solvents – Chlorinated	Refrigerants, Halocarbons	Steam	Water & Salt Solution	Field Where Non-Contamination Required	COMMENTS
Compressed Asbestos	White Asbestos, SBR Binder	900/7735	NA	○		○	○	○	●	*							●	●		Prime General Service
Compressed Asbestos	White Asbestos, SBR Binder	7006/7819	NA	○		○	○	○	●								●	●		Commercial Grade
Compressed Asbestos	White Asbestos, SBR Binder	7021	NA	○		○	○	○	○		●						○	○		Hot Oil Resistant
Compressed Asbestos	White Asbestos, Neoprene Binder	7228	NA	○		○	○	●	○		●		○	●	○	○	○	○		Prime for Oils
Compressed Asbestos	White Asbestos, Neoprene Binder	9057	NA	○		○	○	○	○		○					●	○	○		Prime for Refrigerants
Compressed Asbestos	White Asbestos, Nitrile Binder	8748	NA	○		○	●	○	○		○	●	●	○	●		○	○		General Solvent Service
Compressed Asbestos	Blue Asbestos, SBR Binder	7705	NA	○	●	○	○	○	○		○						○	○		Acid Resistant
Homogeneous Rubber	Natural Rubber	6023	35	○		○		○										○	●	Soft Tan Gum Rubber
Homogeneous Rubber	SBR	152	50	○		○		○										●		
Homogeneous Rubber	SBR	91	60	○		○		○										●		
Homogeneous Rubber	SBR	22	80	○		○		○										●	●	Prime "Red Rubber"
Homogeneous Rubber	SBR	353	80	○		○		●										○		
Homogeneous Rubber	Neoprene	8312	50	○		○		○			○			●		○		○		
Homogeneous Rubber	Neoprene	7986	60	○		○		○						●		○		○		
Homogeneous Rubber	Neoprene	8639	70	●		○	○	○			●			●		○		○		
Homogeneous Rubber	Neoprene	7797	80	●		○	●	●			●			●		●		○		
Homogeneous Rubber	Nitrile	9122	60	○		○	○	○			○	○	●	○				○		
Homogeneous Rubber	Nitrile	8495	70	○		○	●	○			○	●	●	○				○		
Homogeneous Rubber	Nitrile	8459	80	○		○	●	●			○	●	●	○				○		
Reinforced Rubber	SBR Rubber, 12-oz. Cotton Chafer	19	80					○										●		⅛"; uses 5-oz. Cotton Sheeting
Diaphragm	SBR Rubber, 22-oz. Tire Duck	619	50					○										●		Heavy Cotton Reinforcement
Diaphragm	Neoprene, 22-oz. Tire Duck	7992	50					●										○		Heavy Cotton Reinforcement
Diaphragm	Neoprene, 13-oz. Nylon	8798	50					●			●							○		Prime General Duty
Diaphragm	Nitrile, 4.5-oz. Nylon	9205	50					○			●	○						○		Very Sensitive
Woven Asbestos	White Asbestos, White SBR Impreg.	605	NA	○		○		○									●	○		Soft and Conforming
Vegetable Fiber	Cellulose Fiber, Cork, Glue, Glyc.	660	NA					○			●	○	○	○	○					Soft, Resilient, Non-water
Vegetable Fiber	Cellulose Fiber, Glue, Glycerine	681	NA					○			●	○	○	○	○					Firm, Non-water
TFE	TFE plus Inert Filler	Gylon	NA	○	●		●		●	●			●	●	●	○				Low Cold Flow

* Style 900 Compressed Asbestos sheet has never been officially approved by any governmental or other independent laboratory for oxygen service. Despite the fact that we have many satisfied customers who have used this product for [illegible] oxygen service, we cannot guarantee its fitness for such use. †NA=not [illegible]

Anti-Stick Compressed Asbestos Gasketing

Garlock's anti-stick releasing agent, blended into the surface of all Garlock compressed asbestos gasketing, eliminates the need for graphited sheet. All styles are excellent for severe service applications involving high pressures or high temperatures. Garlock compressed asbestos gasketing materials are especially useful where heavy flanges and high bolt loads are commonly found, such as in steam line flanges, cylinder heads of engines, compressors and refrigeration equipment.

STYLE NO.	900 & 7739	7021	7228	7705	8748	7006 & 7819	[illegible]
Material	White chrysotile asbestos with SBR binder	White chrysotile asbestos with SBR binder	White chrysotile asbestos with neoprene binder —no sulphur	Blue crocidolite asbestos with acid-resisting SBR binder	White chrysotile asbestos with nitrile binder	White chrysotile asbestos with SBR binder	White chrysotile asbestos with neoprene binder —no sulphur
* Tensile strength: Across grain	3000 psi	3600 psi	3000 psi	2000 psi	4000 psi	2600 psi	4600 psi
Compressibility, under 5000 psi	7-17%	7-17%	7-17%	15-25%	7-17%	7-17%	7-17%
Recovery	(40% min.)	(40% min.)	(40% min.)	(40% min.)	(40% min.)	(40% min.)	(40% min.)
Oil resistance after 5 hrs. in: ASTM #3 oil @ 300° F. Thickness increase	30%	30%	20%		5%	30%	15%
Tensile loss	50%	50%	35%		7%	45%	25%
Fuel resistance, after 5 hrs. in: ASTM Ref. Fuel B @ R.T. Thickness increase	25%	20%	15%		7%	25%	15%
Weight increase	20%	25%	20%		15%	25%	15%
Flexibility	Bends 180° around rod (diameter 8X thicker than sheet) without cracking	Bends 180° around rod (diameter 8X thicker than sheet) without cracking	Bends 180° around rod (diameter 12X thicker than sheet) without cracking	Bends 180° around rod (diameter 8X thicker than sheet) without cracking	Bends 180° around rod (diameter 12X thicker than sheet) without cracking	Bends 180° around rod (diameter 12X thicker than sheet) without cracking	Bends 180° around rod (diameter 12X thicker than sheet) without cracking
Density (per cubic inch)	.93 oz.	.90 oz.	.91 oz.	.83 oz.	.85 oz.	.97 oz.	1.0 oz.
Thicknesses available (inches)	1/64 1/32 1/16 3/32 1/8 3/16 1/4	1/64 1/32 1/16 3/32 1/8 3/16 1/4	1/64 1/32 1/16 3/32 1/8	1/32 1/16 3/32 1/8	1/64 1/32 1/16 3/32 1/8	1/64 1/32 1/16 3/32 1/8	1/64 1/32 1/16 3/32 1/8
Sheet sizes (inches)	The following sizes are available in all style numbers: 40x42, 40x63	40x126	50x50, 50x75, 50x150	60x63, 60x126	75x150		120x126, 150x150
Tolerances on thicknesses (inches)	1/64 +.005 −.002; 1/64 CT ±.0015; 1/32 ±.005; 1/16 ±.006; 3/32 ±.008; 1/8 ±.010; 3/16 & 1/4 ±.015	1/64 +.005 −.002; 1/64 CT ±.0015; 1/32 ±.005; 1/16 ±.006; 3/32 ±.008; 1/8 ±.010; 3/16 & 1/4 ±.015	1/64 +.005 −.002; 1/64 CT ±.0015; 1/32 ±.005; 1/16 ±.006; 3/32 ±.008; 1/8 ±.010	1/32 ±.005; 1/16 ±.006; 3/32 ±.008; 1/8 ±.015	1/64 +.005 −.002; 1/32 ±.005; 1/16 ±.006; 3/32 ±.008; 1/8 ±.010	1/64 +.005 −.002; 1/64 CT ±.0015; 1/32 ±.005; 1/16 ±.006; 3/32 ±.008; 1/8 ±.010	1/64 +.005 −.002; 1/64 CT ±.0015; 1/32 ±.005; 1/16 ±.006; 3/32 ±.008; 1/8 ±.010
Meets specification	ASTM-D-1170-62T Grade P-1161A, MIL-G-12803A Grade P-1161A MIL-A-7021C Class 1	HH-P-46C ASTM-D-1170-62T Grade P-1161A MIL-G-12803A Grade P-1161A MIL-A-17472B UL Approval	MIL-A-7021C Cl. 1 ASTM-D-1170-62T P-1151-A AMS-3232H		ASTM-D-1170-62T Grade P-1141A MIL-G-12803A Grade 1141A AMS-3232H	ASTM-D-1170-62T Grade P-1161A	ASTM-D-1170-62T Grade P-1151A SAE J90A Grade P-1151A
How branded	Style numbers 900, 7021, 7228 and 7705 are branded with Garlock name and style number thru 60". Over 60" std. is unbranded unless otherwise specified.				Garlock name only thru 60". Over 60" std. is unbranded unless otherwise specified	Unbranded	Unbranded
Color	Light yellow	Grey-black	Black	Grey-black	Black	7006–Off white 7819–Grey-black	Black

*Typical physical values

Garlock Compressed Asbestos Styles versus Specification Numbers

SPECIFICATION NO.	900	7006	7021	7228	7735	7815	[illegible]	[illegible]
AMS-3232H				X			X	
ASTM-D-1170-62T, P-1161A	X	X	X		X	X		
ASTM-D-1170-62T, P-1161B								
ASTM-D-1170-62T, P-1151A				X				X
ASTM-D-1170-62T, P-1141A							X	
HH-P-46c			X		X			
MIL-A-7021C, Class I				X				
MIL-A-7021C, Class II					X			
MIL-A-17472B			X		X			
MIL-G-12803A, P-1161A	X		X		X			
MIL-G-12803A, P-1141A							X	
SAE J90A, P-1161A	X	X	X		X	X		
SAE J90A, P-1151A				X				X

Standard Commercial Tolerances of Compressed Asbestos Gasketing

Nominal Thickness	Variation	Tolerance
1/64" (.016")	.014"–.021"	– .005", – .002"
.020"	.018"–.025"	
1/32" (.031")	.026"–.036"	± .005"
3/64" (.047")	.042"–.052"	
1/16" (.062")	.056"–.068"	± .006"
5/64" (.078")	.071"–.085"	
3/32" (.094")	.086"–.102"	± .008"
7/64" (.109")	.100"–.118"	
1/8" (.125")	.115"–.135"	± .010"
9/64" (.141")	.126"–.156"	
5/32" (.156")	.141"–.171"	
3/16" (.188")	.173"–.203"	± .015"
7/32" (.219")	.204"–.234"	

Woven asbestos gasketing cloth style 605

Garlock 605 is woven from white asbestos yarn which has been reinforced with brass wire. It is impregnated with a high temperature-resistant natural rubber cement. Garlock 605 was specially designed for use against steam, gases and aqueous solutions other than strong mineral acids.

Woven Asbestos Cloth, Tape and Gaskets	605
	Asbestos Cloth with brass wire insertion, impregnated with a high temperature resistant rubber cement
Thicknesses available (inches)	1/64, 1/32, 1/16, 3/32, 1/8
Width available (inches)	48
Size of rolls	1/64" 100 lbs. 1/16" and up 200 lbs.
Also available in folded gasket form under style 604 and folded tape under style 612	

Premium-grade (ASTM) Rubber Gasketing

Garlock offers a wide range of natural and synthetic rubbers, all with the basic characteristics of rubber that allow infinite design possibilities.

Rubber is incompressible: it can be deformed, depending on durometer and cross section, but can never be reduced in volume.

Rubber is extensible: a rubber gasket can be assembled over a projection or shoulder and snap tight within a groove.

Rubber is highly impermeable: it can serve as a tight barrier against the passage of gases or liquids.

Rubber is elastic: it takes relatively little flange pressure to effect intimate contact with the face of the rubber gasket. This elasticity allows a rubber gasket to move with the flange surfaces, always maintaining a seal.

In addition to premium-grade rubber gasketing, Garlock offers commercial-grade rubber gasketing, silicone and VITON Fluoroelastomer.

Style No.	6023	152	91	22	8312	7986	8639	7797	9122	8495	8459	8752
Material and color	Natural Rubber—tan	SBR—black	SBR—black	SBR—red	Neoprene—black	Neoprene—black	Neoprene—black	Neoprene—black	Nitrile—black	Nitrile—black	Nitrile—black	CPE—black
Hardness (Shore A)	35 ± 5	50 ± 5	60 ± 5	80 ± 5	50 ± 5	60 ± 5	70 ± 5	80 ± 5	60 ± 5	70 ± 5	80 ± 5	70 ± 5
Tensile strength (min.)	3000 psi	1800 psi	2000 psi	1000 psi	1500 psi	2000 psi	1900 psi	1500 psi	2000 psi	2600 psi	2100 psi	1000 psi
Elongation (min.)	600%	450%	400%	250%	375%	300%	275%	125%	500%	450%	300%	225%
Compression set ASTM method B, 25% deflection	22 hrs./ 150° F. 25% max.	22 hrs./ 158° F. 25% max.	22 hrs./ 158° F. 25% max.	22 hrs./ 158° F. 60% max.	70 hrs./ 212° F. 35% max.	70 hrs./ 212° F. 35% max.	70 hrs./ 212° F. 65% max.	70 hrs./ 212° F. 75% max.	22 hrs./ 212° F. 20% max.	22 hrs./ 212° F. 40% max.	22 hrs. 212° F. 25% max.	22 hrs. 302° F 45% max.
Volume change after immersion in: ASTM #1 oil, 70 hrs/212°F.					—7 to 0%	—4 to —3%	0 to —10%	—7 to 0%	—10 to —5%	—10 to —5%	—5 to —5%	—4 to —3%
ASTM #3 oil, 70 hrs/212°F.					—60 to —90%	—50 to —80%	—40 to —70%	—45 to —60%	0 to +25%	0 to —35%	—16 to —35%	—60 to —85%
Thicknesses available (inches)	1/16 3/32 1/8 5/32 1/4 and greater	1/16 3/32 1/8 5/32 1/4 and greater	1/32 1/16 3/32 1/8 5/32 1/4 and greater	1/32 1/16 3/32 1/8 5/32 1/4 and greater	1/16 3/32 1/8 5/32 1/4 and greater	1/16 3/32 1/8 5/32 1/4 and greater	1/32 1/16 3/32 1/8 5/32 1/4 and greater	1/32 1/16 3/32 1/8 5/32 1/4 and greater	1/16 1/8 3/16 1/4 and greater	1/16 1/8 3/16 1/4 and greater	1/16 1/8 3/16 1/4 and greater	1/16 1/8 3/16 1/4 and greater
Meets specifications:	HH-G-156C Class A ASTM-D-2000 SAE J 200 4AA425A13 B33F17L14	ASTM-D-735-SAE J 14 Grade R-515 B, F1, F2 ASTM-D-2000-SAE J 200 5AA515A13 B13B33L14	ASTM-D-735-SAE J 14 Grade R-615 B, F1, F2 ASTM-D-2000-SAE J 200 5AA620A13 B13B33 F17 L14	HH-G-156-C Class C ASTM-D-2000-SAE J 200 ASTM-D-1330 Grades 1 & 2 2AA810A13 F17 L14	ASTM-D-735-SAE J 14 Grade SC515 B, E1, E3, F1 ASTM-D-2000-SAE J 200 6BC515A14 B14 C12E14 E34G21	ASTM-D-735-SAE J 14 Grade SC612 B, E1, E3, F1 ASTM-D-2000-SAE J 200 6BC620A14 B14 E14	ASTM-D-735-SAE J 14 Grade SC720 E1, E3 ASTM-D-2000-SAE J 200 6BC715A14 B14E14 E34G21	ASTM-D-735-SAE J 14 Grade SC815 E1, E3 ASTM-D-2000-SAE J 200 2BE815A14 E14E34	ASTM-D-735-SAE J 14 Grade SB620 ASTM-D-2000-SAE J 200 5BG620A14 B14B34 E14 E34	ASTM-D-735-SAE J 14 Grade SB720A ASTM-D-2000-SAE J 200 3BG725 B14 E14	ASTM-D-735-SAE J 14 Grade SB820 E1 ASTM-D-2000-SAE J 200 6BG82A14 B14E14E34	ASTM D-2000 SAE J 200 2CE710 A15B15

NOTE. All styles standard width 36". Other widths on inquiry.

Reinforced Rubber Gasketing and Diaphragm Material

By combining the elasticity and extensibility of rubber with the strong construction of a fabric insert, Garlock produces a very versatile diaphragm material and gasketing.

There are varying burst strengths, from low to high, dependent upon diaphragm service requirements. Each Garlock diaphragm gasketing style is specially compounded, using various combinations of rubbers and fabric inserts to meet a specific set of service conditions.

STYLE NO.	19	619	7992	8798	9205
Material	SBR rubber with 5-oz. cotton sheeting in 1/32" thickness as fabric insert. 12-oz. cotton chafer in all others	SBR rubber with 22-oz. tire duck fabric insert. Diaphragm gasketing	Neoprene with 22-oz. tire duck fabric insert. Diaphragm gasketing	Neoprene with 13-oz. nylon fabric insert. Diaphragm gasketing	Nitrile with 4.5-oz. nylon fabric insert. Diaphragm gasketing
Hardness (Shore A)	80	50	50	50	50
Burst test across 2" diameter opening	Not recommended for use as diaphragm material	270 psig (1/8"—1 ply)	270 psig (1/8"—1 ply)	1000 psig (1/8"—1 ply)	350 psi (1/32" or 1/16"—1 ply)
Number of plies	1/32, 1/16, 3/32—1 ply 1/8—2 ply 3/16—3 ply 1/4—4 ply	1/16, 3/32 & 1/8—1 ply 3/16—2 ply 1/4—3 ply	1/16, 3/32 & 1/8—1 ply 3/16—2 ply 1/4—3 ply	1/16, 3/32 & 1/8—1 ply 3/16—2 ply 1/4—3 ply	1/32 & 1/16—1 ply
Standard thicknesses (inch)	1/32, 1/16, 3/32, 1/8, 3/16, 1/4	1/16, 3/32, 1/8, 3/16, 1/4	1/16, 3/32, 1/8, 3/16, 1/4	1/16, 3/32, 1/8, 3/16, 1/4	1/32, 1/16
Width available (inches)	44	44	44	56	44

Standard Commercial Tolerances, Premium-Grade and Reinforced Rubber and Diaphragm Gasketing

Nominal Thickness	Decimals	Tolerances
under 1/32"	under .031"	±.010"
1/32" up to 1/16"	.031" up to .062"	±.012"
1/16" up to 1/8"	.062" up to .125"	±.016"
1/8" up to 3/16"	.125" up to .187"	±.020"
3/16" up to 3/8"	.187" up to .375"	±.031"
3/8" up to 9/16"	.375" up to .562"	±.047"
9/16" up to 3/4"	.562" up to .750"	±.063"
3/4" up to 1"	.750" up to 1.00"	±.093"
1" and up	1.00" and up	±10%

Vegetable-fiber Gasketing

Garlock high-quality vegetable-fiber gasketing is supplied in two styles. Style 660 with cork granules and Style 681 without cork granules.

STYLE NO.	660	681
Gasketing Material	Vegetable-fiber and cork granules with glue-glycerine binder	Vegetable-fiber with glue-glycerine binder
Tensile strength (minimum)	1000 psi	2000 psi
Compressibility under 1000 psi load	40%-55%	25%-40%
Recovery	40% (minimum)	40% (minimum)
Oil resistance after 22 hours in ASTM #3 oil at 70°-85° F.:		
Thickness increase	5% (maximum)	5% (maximum)
Weight increase	30% (maximum)	15% (maximum)
Fuel resistance after 22 hours in Fuel B at 70°-85° F.:		
Thickness increase	5% (maximum)	5% (maximum)
Weight increase	30% (maximum)	15% (maximum)
Water absorption after 22 hours in distilled water at 70°-85° F.:		
Thickness increase	30% (maximum)	30% (maximum
Weight increase	100% (maximum)	90% (maximum)
Standard thicknesses (inches)	.010, 1/64, .021, 1/32, 3/64, 1/16, 3/32, 1/8, 3/16, 1/4	.006, .010, 1/64, .021, 1/32, 3/64, 1/16, 3/32, 1/8, 3/16, 1/4
Tolerance on thicknesses (inches)	.010, 1/64 — ± .0035 .021, 1/32, 3/64 — ± .005 1/16 — ± .008 3/32 and greater — ± .016	.010, 1/64 — ± .0035 .021, 1/32, 3/64 — ± .005 1/16 — ± .008 3/32 and greater — ± .016
Meets specifications	ASTM-D-1170-62T Grade P-3415-A, SAE J90 Grade P-3415-A	ASTM-D-1170-62T Grade P-3313-B, SAE J90 Grade P-3313-B

GYLON® & TFE Gasketing

GYLON gasketing is made by a unique Garlock process that permits the restructuring of fluorocarbon particles to meet specific requirements of gasket applications.

GYLON gasketing has the chemical resistance of TFE and handles pressures to 500 psi and temperatures from cryogenic to 500°F. General chemical GYLON gasketing, color-coded fawn, meets FDA specifications. GYLON gasketing, color-coded black, is specifically designed for hydrofluoric acid service.

GYLON gasketing should be considered for chemical applications where stress relaxation is a problem. The low compression set characteristics and excellent recovery features of GYLON make it ideal for valves, pumps, tanks, pipe flanges, strainers, mixing equipment and all processing equipment requiring chemical resistant gaskets.

Garlock offers a complete line of TFE gasketing.

GYLON Service Recommendations:

Style	Color Code	Service
35102	Black	Hydrofluoric acid
35104	Fawn	General chemical

Technical Information

The gasket's function is to seal two imperfect 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 which has been stretched to develop a load by elongating it so many thousandths of an inch per inch of length. It must not be overelongated (overstrained), or the elastic limit of the steel will be exceeded. The bolt then deforms and with continued loading (stressing) will quickly rupture.

To avoid such problems with bolt tightening, the use of a torque wrench is recommended. Reference Table 5 shows the loadings achieved under various torques. The equipment designer normally specifies the torque required for his product. For example, the stud on an automotive cylinder head is typically torqued to 65 foot-pounds.

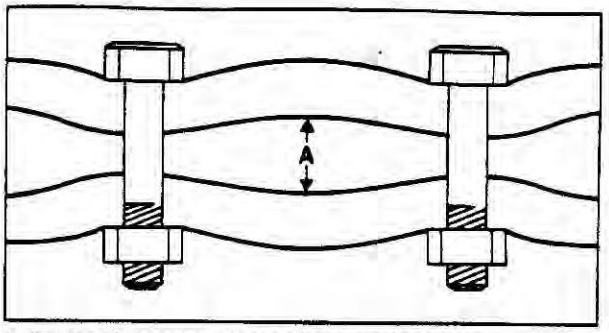
The inch-per-inch relationship demonstrates that the longer the bolt, the more it must be strained to yield a desired load; thus, the longer the bolt, the more follow-up or come-back there will be in actual linear inches. This is highly desirable, since most gasketing materials tend to remold, to relax, to take a permanent set. This is a creep-relaxation phenomenon. The more follow-up of spring provided by the bolt, the better the retention of stress on the gasket to maintain a leak-proof joint. In the same respect, a smaller-diameter bolt must be strained more to develop the same load. With the smaller-diameter bolt, there is a serious danger that it may be overstrained and stressed beyond the elastic limit, and finally broken. The smaller bolt, within its elastic limit, could give the same additional follow-up as the larger-diameter bolt of greater length.

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

1. ***ROUGHNESS***—Roughness is read in millionths of an inch 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 the 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.
3. ***WAVINESS***—Waviness is measured in thousandths or fractions of an inch. Basically, it is the departure from overall flatness.

Typical satisfactory rms or AA readings should be from 125 to 250. Finer finishes of 64 or even 32 rms are normally suitable but not necessary. Very fine finishes, such as polished surfaces, should be avoided, since adequate "tooth" 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—for example, concentric circles on a round flange or, next best, 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.

FIGURE 1



A—Bowing of flanges due to too high a bolt load for the flange design.

TABLE 5 Load on Machine Bolts and Cold-Rolled Steel Stud Bolts under Torque

Nominal Diameter of Stud (inches)	Number of Threads Per Inch	Diameter at Root of Thread (inches)	Area at Root of Thread (Sq. Inches)	STRESS 7,500 psi		15,000 psi		30,000 psi	
				Torque (Ft.-lbs.)	Compression (lbs.)	Torque (Ft.-lbs.)	Compression (lbs.)	Torque (Ft.-lbs.)	Compression (lbs.)
1/4	20	.185	.027	1	203	2	405	4	810
5/16	18	.240	.045	2	338	4	675	8	1,350
3/8	16	.294	.068	3	510	6	1,020	12	2,040
7/16	14	.345	.093	5	698	10	1,395	20	2,790
1/2	13	.400	.126	8	945	15	1,890	30	3,780
9/16	12	.454	.162	12	1,215	23	2,430	45	4,860
5/8	11	.507	.202	15	1,515	30	3,030	60	6,060
3/4	10	.620	.302	25	2,265	50	4,530	100	9,060
7/8	9	.731	.419	40	3,143	80	6,285	160	12,570
1	8	.838	.551	62	4,133	123	8,265	245	16,530
1 1/8	7	.939	.693	98	5,190	195	10,380	390	20,760
1 1/4	7	1.064	.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 at Root of Thread (Inches)	Area at Root of Thread (Sq. Inches)	STRESS 30,000 psi		45,000 psi		60,000 psi	
				Torque (Ft.-lbs.)	Compression (lbs.)	Torque (Ft.-lbs.)	Compression (lbs.)	Torque (Ft.-lbs.)	Compression (lbs.)
1/4	20	.185	.027	4	810	6	1,215	8	1,620
5/16	18	.240	.045	8	1,350	12	2,025	16	2,700
3/8	16	.294	.068	12	2,040	18	3,060	24	4,080
7/16	14	.345	.093	20	2,790	30	4,185	40	5,580
1/2	13	.400	.126	30	3,780	45	5,670	60	7,560
9/16	12	.454	.162	45	4,860	68	7,290	90	9,720
5/8	11	.507	.202	60	6,060	90	9,090	120	12,120
3/4	10	.620	.302	100	9,060	150	13,590	200	18,120
7/8	9	.731	.419	160	12,570	240	18,855	320	25,140
1	8	.838	.551	245	16,530	368	24,795	490	33,060
1 1/8	8	.963	.728	355	21,840	533	32,760	710	43,680
1 1/4	8	1.088	.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	8,880	236,655	11,840	315,540
3	8	2.838	6.324	7,720	189,720	11,580	284,580	15,440	379,440

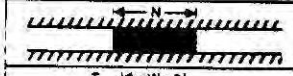
Waviness is seldom a problem under normal conditions. There are two areas however which must be watched since excessive waviness is very difficult to handle. The first area is in glass-lined equipment where the natural flow of the fused glass creates extreme waviness. Often the answer here is to use shims or wedges carefully shaped and inserted in the hollows. The second area of concern is warped flanges. If warpage is caused by heat or internal stresses, remachining is generally sufficient. However, warpage due to excessive bolt loads or, conversely, too light a flange design, results in what is generally called bowing. See Figure 1.

The solution is to redesign for greater flange rigidity. Sometimes pieces can be added between the bolts to beef up the design without having to replace the parts. Another step would be to add more bolts. When this is done, usually smaller diameters are possible, thus adding more spring-back and a much better joint.

TABLE 3
Recommended Seating Stresses

Gasket Material	"y" value (psi)	"m" factor
Compressed asbestos, 1/8" thick	1600	2.00
Compressed asbestos, 1/16" thick	3700	2.75
Compressed asbestos, 1/32" thick	6500	3.50
Woven asbestos, rubber filled, 3-ply	2200	2.25
Woven asbestos, rubber filled, 2-ply	2900	2.50
Woven asbestos, rubber filled, 1-ply	3700	2.75
Rubber, less than 75 Shore durometer	0	0.50
Rubber, 75 or higher Shore durometer	200	1.00
Rubber with cotton insert	400	1.25
Cork composition	450	1.25
Cork and rubber	200	1.00
Solid TFE, 1/8" thick	1600	2.00
Solid TFE, 1/32" thick	2000	2.50
Solid TFE, 1/16" thick	3700	2.75
Solid TFE, 1/32" thick	6500	3.50
GYLON, 1/8" thick	2300	1.50
GYLON, 1/16" thick	2800	1.75
GYLON, 1/32" thick	3200	2.00

TABLE 4
Effective Gasket Width—b

Facing Limits	Gasket Seating Width b
	$b_o = \frac{N}{2}$
	$b_o = \frac{W-T}{2}$, $\left(\frac{W+N}{4}\right.$ maximum$)$
	$b_o = \frac{7N}{16}$
	$b_o = \frac{3N}{8}$

b = effective gasket seating width in inches (see Table 3)
NOTE: $b = b_o$ when b_o is equal to or less than 1/4"
$b = \frac{\sqrt{b_o}}{2}$ when b_o is greater than 1/4"
2b = effective gasket pressure width in inches
m = gasket factor (see Table 3)
y = gasket seating load in psi (see Table 3)

Designing the Gasket

Practical application of theory

The gasket material is chosen for its chemical and physical ability to withstand temperatures pressures fluids, and perhaps to meet other criteria. Now comes the task of actually sealing the joint. A design engineer can generally control flange width thickness, finish the bolt load, size and spacing to suit the gasket material. However, many times the joint is designed according to some previous typical practice which may not give the desired joint performance. The necessary practical considerations for good design, including consideration of loads, thickness, bolt location contour and configuration, are as follows

Gasket factors—the "y" value

In order to effect a tight seal, the gasket material must be loaded sufficiently to flow into the imperfections of the contact faces, filling all voids between mating flanges. If this is not accomplished, a change in design, contour, area, thickness or possibly even in material or type is necessary.

The amount of load to cause this flow or yielding of the material is called the "y" value. The actual value has been established by the American Society of Mechanical Engineers (ASME) and is expressed in psi. The ASME Unfired Pressure Vessel Code, Section VIII contains a detailed list of various materials. Table 3 covers the most common and typical materials. It will be noted that there is a considerable spread from soft materials to hard.

In a given joint design, the available bolt load in psi on the effective area of the gasket may be found by the following equation, the force actually available to satisfy the "y" requirement:

$$y' = \frac{Wm_2}{3.14\,bG}$$

Where y' = psi available for "y" and which should be equal to or greater than "y", Table 3.

Wm_2 = gross bolt load: number of bolts times the load in each. See Table 5.

G = outside diameter of gasket less 2b.

b = see Table 4

. Gasket factors—the "m" value

The "y" value ignores the fluid pressure, which—since it relieves some of the bolt load from the gasket, and is the force trying to create leakage—must be recognized. The ASME has established multiplier values ("m" values) which define how many times the residual load, that is, the original load less the fluid relief or "Hydrostatic End Force," must exceed the fluid load in psi. See Figure 2. The available value for "m" can be obtained from the following equation.

$$m' = \frac{Wm_1 - 0.785\,G^2P}{6.28\,GPb}$$

where m' = available multiplying factor, it must be equal to or greater than "m" as defined by ASME, Table 3.

Wm_1 = gross bolt load available

P = fluid pressure in psi

GPb = as under y'

Failure to meet either the "y" or "m" value necessitates modification of the gasket. One of the easier steps is to increase the gasket thickness, as this will lower the requirements. See Table 3. However, the thinner the gasket, the more efficient it is; so rather than penalize the application by using a thicker gasket, we can consider reducing its area, thus raising the unit load (the psi) on the gasket. In simple ring gaskets, an increase in the ID or decrease in the OD may well suffice. In odd shapes a contoured gasket may result, such as in Figure 3.

These considerations are most important, but by no means all-inclusive. Where one can assist in a joint design, it is well to remember to keep all of the gasket possible within the bolting perimeter. See Figure 4. Generally, in an existing design which may not have followed this rule (see A & B, Figure 5), the best answer is contouring, such as thinning the width at A & B Figure 3.

Other very worthwhile points relative to the actual manufacture of the gasket are shown in Table 6. Observance of these will help to create the most economical product for both manufacture and installation.

FIGURE 2

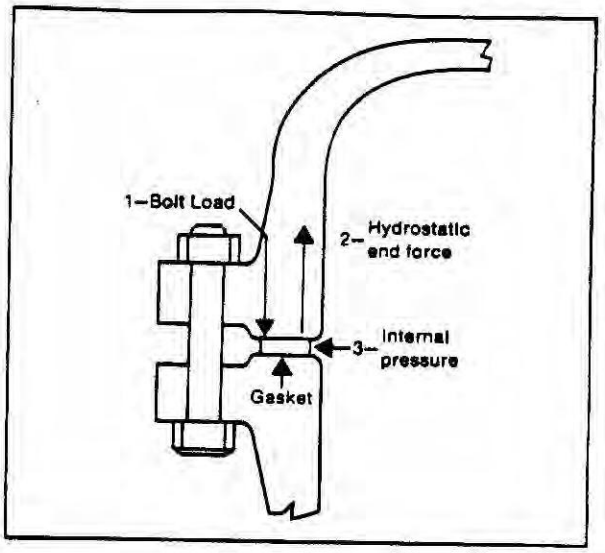
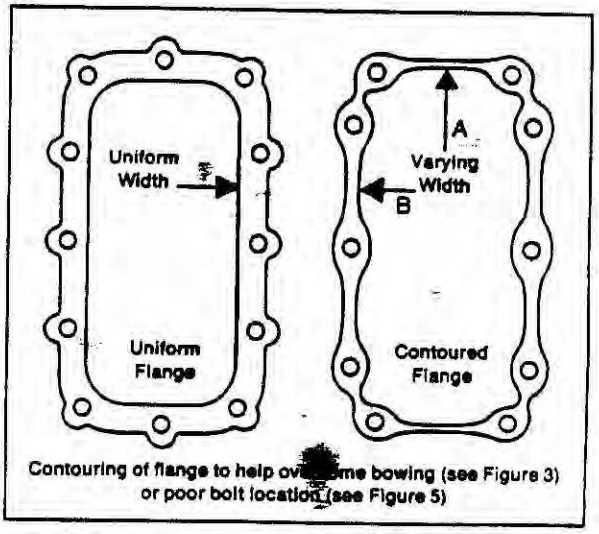
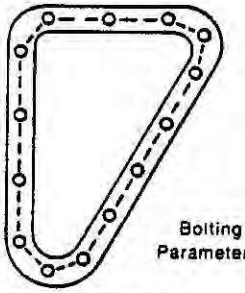


FIGURE 3



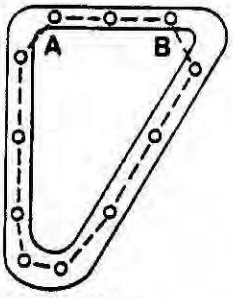
Contouring of flange to help overcome bowing (see Figure 3) or poor bolt location (see Figure 5)

FIGURE 4



GOOD DESIGN

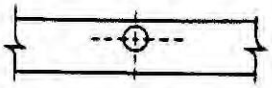
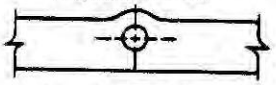
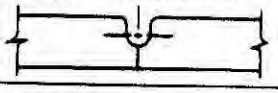
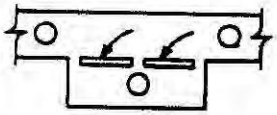
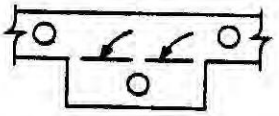
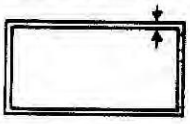
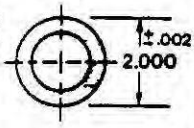
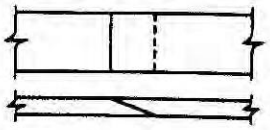
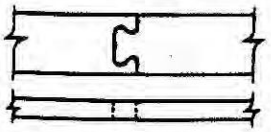
FIGURE 5



POOR DESIGN

TABLE 6

Common Faults in Gasket Design and Suggested Remedies

DETAIL	WHY FAULTY	SUGGESTED REMEDY
Bolt holes close to edge 	Causes breakage in stripping and assembling	Projection or "ear"  Notch instead of hole 
Very small bolt holes or noncircular openings 	Require hand picking . . easy to miss	Avoid hole sizes under $\frac{1}{32}$-inch diameter. If small hole is for locating or indexing, change to notch. 
Tear-away parts with open slots at attached edges 	Slots require hand picking, costly dies and die maintenance	Simple perforation 
Thin walls, delicate cross section in relation to overall size 	High scrap loss; stretching or distortion in shipment or use. Restricts choice to high tensile strength materials.	Have the gasket in mind during early design stages
Metalworking tolerances applied to gasket thickness, diameters, length, width, etc. 	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 deliveries.	Most gasket materials are compressible. Many are affected by humidity changes. Try standard or commercial tolerances before concluding that special accuracy is required.
Transference of fillets, radii, etc., from mating metal parts to gasket 	Unless part is molded, such features mean extra operations and higher cost.	Most gasket stocks will conform to mating parts without preshaping. Be sure radii, chamfers, etc., are functional, not merely copied from metal members.
Large gaskets made in sections with beveled joints 	Extra operations to skive. Extra operations to glue. Difficult to obtain smooth, even joints without steps or transverse grooves. 	Die-cut dovetail joint 

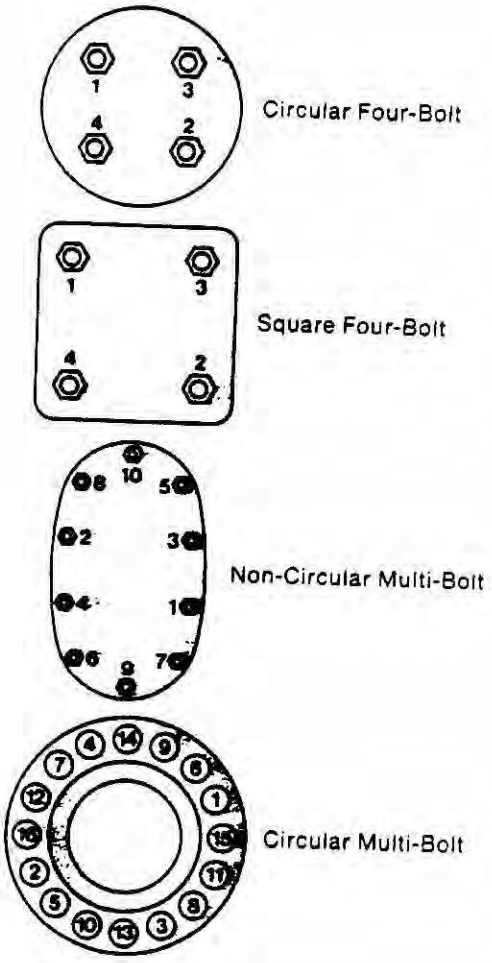
Installation:

A few simple precautionary measures must be observed in installation to insure the most satisfactory joint.

1. Center the gasket on the flange. This is extremely vital where raised faces are involved.
2. Be sure surface finish and flatness are satisfactory. If found otherwise, correct by remachining or shimming as on glass-faced flanges.
3. Tighten bolts to compress gasket uniformly. This means going from side to side around the joint. See Figure 6.
4. Use a torque wrench and well-lubricated fasteners to insure correct initial loading.
5. Retorque 12 to 24 hours after coming on stream, wherever possible. The joint should stand as long as possible before retorquing.

Correct Bolting Patterns

FIGURE 6



Additional product, as well as price and delivery, information on Garlock gasketing materials can be obtained from the Garlock Gasket Fabricator or Distributor serving your area or by getting in touch with Garlock Inc., Palmyra, N.Y. 14522

Garlock

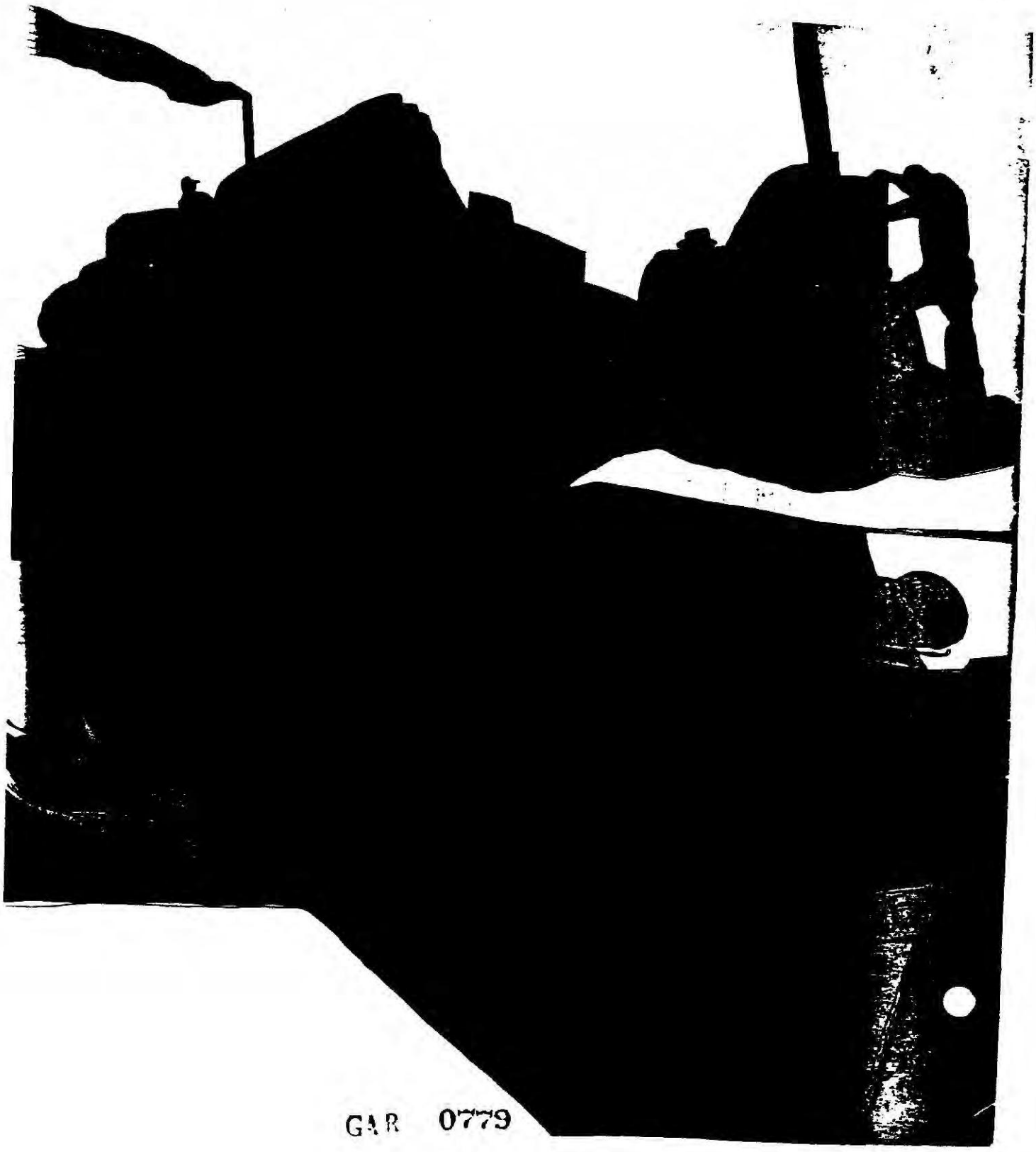


Exhibit C

Lake 1965 - 1979 - Dollars

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Asbestos Fibre M-7R															
H. K. Porter	-	-	-	-	-	-	-	-	-	-	-	7,534	20,341	-	-
Blue Fibre															
Mc. American Asbestos Corp.	3,432	7,658	4,706	4,092	5,712	3,983	7,380	5,595	9,233	13,197	14,424	13,715	26,301	35,395	-
Lake Asbestos of Quebec	-	-	-	-	-	-	-	-	-	1,767	-	-	-	-	-
Grade 3K															
Bell Asbestos Mines Ltd.	464	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	-	-	-	981	15,030	52,214	28,025	43,031	47,274	19,991	12,471	-	-	-	9,658
Grade 3R															
Bell Asbestos Mines Ltd.	60,715	50,244	7,974	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos Corp. Ltd.	-	450	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	-	34,431	49,031	24,402	113,393	74,160	95,269	78,471	100,011	104,930	79,751	-	-	-	-
National Gypsum Co.	-	-	-	676	7,518	-	-	-	-	-	-	-	-	-	-
Grade 3T															
Bell Asbestos Mines Ltd.	65,651	39,285	63,292	13,540	-	-	-	-	-	-	-	-	-	-	-
Asbestos Corp. Ltd.	-	414	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	-	11,291	22,532	43,635	31,058	3,399	44,711	70,835	45,614	80,605	78,778	-	-	-	-
National Gypsum Co.	-	-	-	86,256	60,689	65,182	46,228	-	41,349	-	-	-	-	5,891	-
Jaquay Mining Corp.	-	-	-	-	-	-	-	-	-	-	47,314	-	-	-	-
Coastar AC-45															
Bell Asbestos Mines Ltd.	139,417	113,342	67,455	58,489	107,183	32,130	-	-	-	-	80,694	-	-	-	-
Grade 4T															
The Ruberoid Co.	25,442	58,511	14,186	26,036	44,877	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	-	-	7,932	3,836	-	1,184	25,608	20,762	20,618	15,072	-	-	-	-	127,946
Johns-Manville Sales Corp.	-	-	-	238	4,961	2,116	-	462	1,159	-	-	-	-	-	-
Westwood Chemical Co. Inc.	-	-	-	-	23,670	45,010	30,038	50,505	54,996	43,420	65,501	3,086	-	-	-
National Gypsum Co.	-	-	-	-	163	3,761	-	-	-	-	-	-	-	-	-
Jaquay Mining Corp.	-	-	-	-	-	-	-	-	-	-	31,460	730	-	-	-
Grade 4J until 1974-then 5R															
Asbestos Corp. Ltd.	3,901	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	91,134	125,269	112,417	146,316	178,356	133,012	197,245	155,860	176,276	156,915	205,516	581,190	623,048	509,824	581,977
Westwood Chemical Co. Inc.	-	-	-	-	-	-	-	-	-	-	47,103	-	-	-	-
Carey Canadian Mines Ltd.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	601
Grade 4P															
Lake Asbestos of Quebec	6,886	14,012	3,959	20,413	84,512	26,793	31,071	31,434	69,810	110,098	17,965	-	-	-	-
Bell Asbestos Mines Ltd.	-	-	422	-	-	-	-	-	-	-	-	-	-	-	-
Grade 4X															
Lake Asbestos of Quebec	360,813	359,347	132,903	122,222	103,327	36,647	5,195	-	-	-	-	-	-	-	-
Carney Canadian	-	98	-	-	-	-	-	-	-	-	-	-	-	-	-
Bell Asbestos Mines Ltd.	-	-	-	4,229	-	-	-	-	-	-	-	-	-	-	-
Grade 5D															
Lake Asbestos of Quebec	10,934	12,562	10,281	15,510	42,168	37,074	92,172	60,077	123,464	141,566	4,041	-	-	4,230	-
Bell Asbestos Mines Ltd.	-	-	1,090	-	-	-	-	-	-	-	-	-	-	-	-
The Ruberoid Co.	-	-	-	-	165	-	-	-	-	-	-	-	-	-	-
National Gypsum Co.	-	-	-	-	134	7,630	-	-	-	-	-	-	-	-	-
Johns-Manville Sales Corp.	-	-	-	-	-	-	-	-	-	159	-	-	-	-	-

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	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
AC-Grade 7D															
Lake Asbestos of Quebec	3,999	7,459	1,136	1,432	1,776	3,630	84,237	45,362	51,120	43,554	13,236	13,440	9,169	37,107	39,536
AH-Fleetfibre 20															
Lake Asbestos of Quebec	6,271	-	6,136	-	-	-	-	-	-	-	-	31,404	-	-	-
Canadian Johns-Manville	9,107	15,985	-	-	-	-	-	-	-	-	-	-	-	-	-
Johns-Manville Sales Corp.	-	-	12,398	11,345	19,642	15,685	8,931	18,161	9,240	11,118	101,681	89,091	78,014	39,847	-
AH-Fleetfibre 20 Pressure Packed															
Lake Asbestos of Quebec	-	-	-	-	-	-	-	-	744	-	-	7,743	16,305	47,965	60,949
AO-Grade 7R															
Lake Asbestos of Quebec	-	-	-	58	66	71	143	776	79	1,112	99	-	-	-	-
Westwood Chemical Co, Inc.	-	-	-	-	-	-	-	-	-	5,541	231	-	-	-	-
AZ-Cassiar A															
Bell Asbestos Mines Ltd.	-	-	-	-	-	-	-	-	-	-	29,789	462	-	-	-
AR-Grade 7M															
Lake Asbestos of Quebec	-	-	-	-	-	-	-	-	1,318	660	-	-	25,054	72,354	26,279
Miscellaneous & Experimental															
Bell Asbestos Mines Ltd.	7,134	62	42	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	-	4,655	94	-	65	-	-	-	4,827	1,741	-	-	-	-	-
Canadian Johns-Manville	-	42	-	-	-	-	-	-	-	-	-	-	-	-	-
Johns-Manville Sales Corp.	-	-	-	-	-	-	181	-	127	-	-	-	-	-	-
The Ruberoid Co.	-	-	-	-	45	-	-	-	-	-	-	-	-	-	-

	1980-1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1/1/98-3/12/98
AX-Asbestos Fibre RL-TR															
H. K. Porter	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-Blue Fibre															
No. American Asbestos Corp.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AC-Grade 3K															
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AD-Grade 3R															
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos Corp. Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
National Gypsum Co.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AE-Grade 3T															
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos Corp. Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
National Gypsum Co.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jaquay Mining Corp.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AF-Cassiar AC-45															
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AG-Grade 4T															
The Ruberoid Co.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	NA	69,889.44	65,032.17	-	-	-	-	-	-	-	-	-	-	-	-
Johns-Manville Sales Corp.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Westwood Chemical Co. Inc.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
National Gypsum Co.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jaquay Mining Corp.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Chrysotile Inc.	NA	-	-	36,919.54	49,349.82	78,275.33	53,895.99	40,062.97	26,048.80	12,607.87	25,557.32	41,862.91	17,799.70	6,256.61	-
AH-Grade 4A until 1974-then 5R															
Asbestos Corp. Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	NA	193,003.39	215,162.12	-	-	-	-	-	-	-	-	-	-	-	-
Westwood Chemical Co. Inc.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carey Canadian Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Chrysotile Inc.	NA	-	-	194,553.27	198,298.72	177,782.88	145,341.00	115,112.01	89,084.51	48,309.96	37,268.44	69,898.95	49,000.40	139,401.68	23118.25
J.M. Asbestos	NA	-	-	-	-	4,564.24	11,161.62	-	-	-	-	-	-		
AI-Grade 4D															
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AJ-Grade 4K															
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carney Canadian	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AK-Grade 5D															
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
The Ruberoid Co.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
National Gypsum Co.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Johns-Manville Sales Corp.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL-Grade 7D															
Lake Asbestos of Quebec	NA	89,674.39	109,907.43	-	-	-	-	-	-	-	-	-	-	-	-
Lab Chrysotile Inc.	NA	-	-	69,868.23	93,503.98	3,470.99	-	-	-	-	-	-	-	-	-

AM-Plastibest 20															
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canadian Johns-Manville	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Johns-Manville Sales Corp.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AN-Plastibest 20 Pressure Packed															
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AO-Grade 7R															
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Westwood Chemical Co. Inc.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AP-Cassiar A															
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AR-Grade 7M															
Lake Asbestos of Quebec	NA	69,889.44	65,032.17	-	-	-	-	-	-	-	-	-	-	-	-
Lab Chrysotile Inc.	NA	-	-	36,919.54	49,349.82	78,275.33	53,895.99	40,062.97	26,048.60	12,807.87	25,557.32	41,862.91	17,799.70	58,251.95	7,705.97
J.M. Asbestos	NA	-	-	-	-	1,310.52	3,966.30	-	-	-	-	-	-	-	-
09981-0001															
Lab Chrysotile Inc.	NA	-	-	-	-	-	9,147.63	16,633.19	11,852.73	9,661.89	-	-	-	-	-
09981-0002															
Lab Chrysotile Inc.	NA	-	-	-	-	-	27,049.89	40,095.93	44,987.01	36,426.21	-	-	-	-	-
09981-0003															
Lab Chrysotile Inc.	NA	-	-	-	-	-	-	-	4,598.38	9,417.75	-	-	-	-	-
Miscellaneous & Experimental															
Bell Asbestos Mines Ltd.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Asbestos of Quebec	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canadian Johns-Manville	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Johns-Manville Sales Corp.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
The Ruberoid Co.	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Chrysotile Inc.	NA	-	-	-	3,380.07	-	-	-	-	-	-	-	-	-	-

NOTES: NA = No Accounts Payable Records Found

Exhibit D

MIL-P-17577(NAVY)
10 JULY 1953
SUPERSEDING
NAVY 33P26b
2 OCTOBER 1944

MILITARY SPECIFICATION

PACKING MATERIAL, ASBESTOS, ROD, BRAIDED

All interested Bureaus of the Navy Department have concurred in the use of this specification.

1. SCOPE

1.1 Scope.- This specification covers braided asbestos rod packing material without wire insertion (symbol 1103) for rotary rod and valve stem service and braided asbestos rod packing material with wire insertion (symbol 1104) for valve stem service.

1.2 Classification.- Braided asbestos rod packing material shall be of the following types, as specified (see 6.1):

Type I - Without wire insertion, symbol 1103.
Type II - With wire insertion, symbol 1104.

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS, AND PUBLICATIONS

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL
NN-B-591 - Boxes, Fiberboard, Wood-Cleated (for Domestic Shipment).
NN-B-601 - Boxes, Wood-Cleated-Plywood, for Domestic Shipment.
NN-B-621 - Boxes, Wood, Nailed and Lock-Corner.
QQ-S-781 - Strapping, Flat; Steel.
ZZ-R-601 - Rubber Goods; General Specifications (Methods of Physical Tests and Chemical Analyses).
LLL-B-631 - Boxes; Fiber Corrugated (for Domestic Shipment).
LLL-B-636 - Boxes, Fiber, Solid (for Domestic Shipment).

GPO—O—NAV—L-1

MIL-P-17577(NAVY)

MILITARY
JAN-P-103 - Packaging and Packing for Overseas Shipment - Boxes; Wood Cleated; Solid Fiberboard.
JAN-P-105 - Packaging and Packing for Overseas Shipment - Boxes, Wood, Cleated, Plywood.
JAN-P-106 - Packaging and Packing for Overseas Shipment - Boxes; Wood, Nailed.
JAN-P-108 - Packaging and Packing for Overseas Shipment - Boxes, Fiberboard (V-Board and W-Board), Exterior and Interior.
JAN-P-120 - Packaging and Packing for Overseas Shipment - Cartons, Folding, Paperboard.
JAN-B-121 - Barrier-Material, Greaseproof.
JAN-P-133 - Packaging and Packing for Overseas Shipment - Boxes, Set-Up, Paperboard.
JAN-P-139 - Packaging and Packing for Overseas Shipment - Plywood, Container-Grade.
MIL-L-10547 - Liners, Case, Waterproof.

NAVY DEPARTMENT
General Specifications for Inspection of Material.

STANDARDS

MILITARY
MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking of Shipments.

(Copies of specifications, standards, and drawings required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

2.2 Other publications.- The following publications, of the issue in effect on date of invitation for bids, unless otherwise stated, form a part of this specification:

POST OFFICE DEPARTMENT
Postal Regulations.

(Application for copies should be addressed to the Post Office Department, Washington 25, D.C.)

CONSOLIDATED CLASSIFICATION COMMITTEE
Consolidated Freight Classification Rules.

(Application for copies should be addressed to the Consolidated Classification Committee, 202 Chicago Union Station, Chicago 6, Ill.)

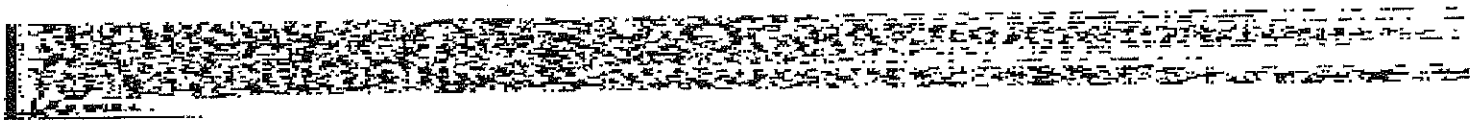
AMERICAN TRUCKING ASSOCIATION, INC.
Motor Freight Classification Rules.

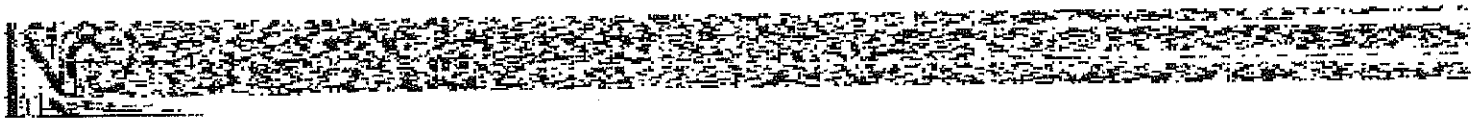
(Application for copies should be addressed to the Issuing Officer, American Trucking Association, Inc., 1424 16th St., N.W., Washington 6, D.C.)

3. REQUIREMENTS

3.1 Qualification.- Type II packing material furnished under this specification shall be a product which has been tested and has passed the qualification tests specified in section 4 (see 6.2).

3.2 Material.- Packing material shall be composed of asbestos yarn rovings, with or without wire insertion, and a high temperature lubricating compound.





3.3 Lubricant. - Each asbestos yarn or strand shall be treated with a suitable high temperature lubricating compound. The finished packing material shall be coated with lubricating graphite. The finished packing material shall contain not more than 30 percent, by weight, of lubricant, which shall include the lubricating compound and the graphite (see 4.4.1.2).

3.4 Type I, without wire insertion, symbol 1103. -

3.4.1 Asbestos yarn. - The yarn shall be composed of roving containing not less than 75 percent, by weight, of asbestos fiber of not less than 12 percent chemically combined water (see 4.4.1.3).

3.4.2 Construction. - Packing material shall be either "braid over braid" or "square braided". A core will be permitted in all sizes. When "square braided", corner strands shall not be included in sizes below five-eights of an inch, but they will be permitted in all sizes five-eights of an inch and over. The finished packing material shall be approximately square in cross section.

3.4.3 Weight. - The weight per linear yard of the packing material shall be in accordance with table I.

Table I - Weight per linear yard.

Nominal size	Weight per linear yard	
	Minimum	Maximum
Inch	Pounds	Pounds
1/8	0.015	0.12
3/16	.034	.20
1/4	.10	.28
5/16	.16	.36
3/8	.23	.44
7/16	.30	.55
1/2	.42	.66
9/16	.54	.80
5/8	.66	.92
3/4	.91	1.26
7/8	1.30	1.66
1	1.70	2.10

3.5 Type II, with wire insertion, symbol 1104. -

3.5.1 Asbestos yarn. - The yarn shall contain not less than 85 percent, by weight, of asbestos fiber of not less than 12 percent chemically combined water (see 4.4.1.3).

3.5.2 Rovings. - The rovings shall be composed of strands of asbestos yarn and brass or copper wire. Each strand shall contain two asbestos yarns and not more than two brass or copper wires. The wires shall not be more than 0.01 inch in diameter.

3.5.3 Construction. - Packing material one-eight of an inch and three-sixteenths of an inch may be "braid over braid". All other sizes shall be "square braided". A core will be permitted in all sizes. Corner strands shall not be included in sizes below five-eights of an inch, but they will be permitted in all sizes five-eights of an inch and over. The finished packing material shall be approximately square in cross section.

3.5.4 The composition and construction of the packing material shall conform to that of the sample submitted for qualification (see 4.3.2.2).

MIL-P-17577(NAVY)

3.5.5 Weight. - The weight per linear yard of the packing material shall be in accordance with table II.

Table II - Weight per linear yard.

Nominal size	Weight per linear yard	
	Minimum	Maximum
Inch	Pounds	Pounds
1/8	0.025	0.18
3/16	.06	.24
1/4	.12	.30
5/16	.20	.40
3/8	.28	.50
7/16	.39	.64
1/2	.50	.78
9/16	.65	.95
5/8	.78	1.12
11/16	.90	1.35
3/4	1.00	1.54
7/8	1.45	2.02
1	1.80	2.60

3.5.6 Simulative service. - Type II packing material shall pass the simulative service test as specified in 4.4.2. The valve stem shall not be scored or pitted.

3.6 Sizes. - The packing material shall be furnished in the sizes specified (see 6.1).

3.7 Workmanship. - The workmanship shall be first class in every respect.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 Qualification tests at a Government laboratory. - Qualification tests of type II, symbol 1104 packing material shall be conducted at a Government laboratory designated by the Bureau of Ships. These tests shall consist of the tests specified in 4.4.

4.2 Sampling. -

4.2.1 Inspection lot. - For purposes of sampling, a lot shall consist of all finished packing material of one type and size, produced under essentially the same conditions, and offered for delivery at one time.

4.2.2 Sampling for lot acceptance inspection and weight determination. - A random sample of lengths of packing material shall be selected in accordance with table III from each inspection lot of material offered for Government inspection of visual and dimensional characteristics and weight determinations with lot acceptance based on single sampling inspection requirements in accordance with the procedures of Standard MIL-STD-105.

Table III - Sampling for visual and dimensional inspection and weight determination
AQL (approx.) = 2.5 percent defective.

Number of lengths of packing material in inspection lot	Number of lenghts of packing material in sample for dimensional and visual inspection	Number of lengths of packing material in sample for weight determination	Dimensional and visual inspection acceptance number (defectives)	Weight determinations acceptance number (defectives)
15 and under	7	5	0	0
16 to 40	10	7	0	0
41 to 110	15	10	0	0
111 to 300	25	15	1	0
301 to 500	35	25	2	1
501 to 800	50	35	3	1
801 to 1300	75	50	4	2
1301 and over	110	75	6	3

4.2.3 Sampling for production check tests at a Government laboratory. - From the first lot of packing material of each size offered for delivery under a contract or order, the Government inspector shall select two lengths of packing material at random. From each sample length, a 24-inch specimen shall be cut off for the purpose of the production check tests specified in 4.3.2. Thenceforth, two such sample pieces of packing material shall be selected from one of every ten lots which have passed inspection at the place of manufacture.

4.3 Inspection and tests. -

4.3.1 Visual and dimensional inspection. - Each of the sample specimens selected in accordance with 4.2.2 shall be visually and dimensionally inspected and weighed by the Government inspector to verify compliance with this specification. Minor surface defects not affecting the serviceability of the packing material shall not be cause for rejection. Any length of packing material in the sample containing one or more visual, dimensional, or weight defects shall be rejected, and if the number of defective lengths of packing material in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected. Rejected lots may be offered again for Government inspection provided the contractor has removed all nonconforming lengths of packing material. The Government inspector shall again select and examine samples from such resubmitted lots to verify compliance with this specification.

4.3.2 Production check tests at a Government laboratory. -

4.3.2.1 Type I packing material. - The sample specimens selected in accordance with 4.2.3 shall be subjected to the tests specified in 4.4.1.

4.3.2.2 Type II packing material. - The sample specimens selected in accordance with 4.2.3 shall be subjected to those tests which will establish the identity of the inspection samples with that given qualification and to the tests specified in 4.4.1.

4.3.2.3 Place of test. - Unless otherwise specified in the contract or order, these tests shall be conducted at the U.S. Naval Engineering Experiment Station, Annapolis, Md.

4.3.2.4 Action in case of failure. - Acceptance of the first lot offered for delivery under a contract or order shall be withheld until a satisfactory report is received on the production check test sample. Thenceforth, except as hereinafter specified, acceptance and rejection of lots shall normally be on the basis of the lot acceptance inspection specified in 4.2.2. Lot acceptance shall then not be withheld pending receipt of a test report on the subsequent production samples. However, upon receipt of an unsatisfactory test report on a production check test sample, the Government inspector shall select additional samples from every subsequent lot offered for delivery. The sample so selected shall be submitted to the U.S. Naval Engineering Experiment Station, Annapolis, Md., and shall there be subjected to the production check tests specified in 4.3.2. Lots shall then be accepted only upon receipt of a satisfactory test report on the samples so selected. Additional testing shall be discontinued and lot acceptance returned to the normal basis when four successive lots have been accepted.

4.4 Test procedures. -

4.4.1 Lubricant and asbestos yarn roving. -

4.4.1.1 Preparation for analysis. - Small strips or cross sections shall be cut from various parts of the sample so as to be representative of the sample.

4.4.1.2 Lubricant. - The lubricant shall be determined as specified in Specification ZZ-R-601. A five-gram sample shall be used.

4.4.1.3 Cotton, asbestos, and chemically combined water. - After removal of the lubricant, any wire or metal parts in the sample, shall be removed with the aid of forceps. The asbestos content of the fibrous material remaining after removal of the lubricant, and the percent of chemically combined water of the asbestos shall be determined by the following combustion procedure. If material insoluble in the paranitrotoluene - orthodichlorobenzene mixture remains on the fibers, the combustion method will not give reliable results, and in such cases the results obtained shall be considered to be approximations.

4.4.1.3.1 A specimen weighing approximately 1 gram shall be taken from the fibrous material. It shall be placed in a porcelain or platinum combustion boat, dried for 1 hour at a temperature of 105° to 110°C., cooled in a desiccator, and weighed. The dried specimen in the boat shall be inserted in the combustion tube of an electric organic combustion furnace. The specimen shall be maintained at a temperature of 900° plus or minus 50°C. for approximately 30 minutes or until combustion of the cotton is complete. During the combustion period a current of oxygen (carbon-dioxide free) shall be passed through the combustion tube at a rate of approximately 200 milliliters per minute. The combustion gases shall be passed through either two U-tubes containing calcium chloride or through a drying tube containing anhydrous magnesium perchlorate or calcium sulphate to remove the moisture; and finally the gases shall be passed into either a weighed Vanier or similar absorption bulb containing a strong solution of caustic potash, or in a weighed carbon dioxide absorption bulb containing a sodium hydroxide impregnated base (the absorbent having the trade name "Ascarite" is of this type) to absorb the carbon dioxide. Three-elevenths of the increase in weight of the Vanier or other carbon dioxide absorption bulb shall represent the weight of the carbon in the cloth or yarn. This shall be 44.40 percent of the cotton. These factors may be combined to

give a constant of 0.614. When the combustion has been completed, the absorption tube shall be weighed, and the combustion boat containing the ignited residue shall be removed from the furnace, cooled in a desiccator and weighed.

Calculation.

$$\text{Cotton, percent, } A = \frac{61.4 \times C}{S}$$

Asbestos, percent, D = 100 - percent cotton

$$\text{Ignited asbestos, percent } B = \frac{R}{S} \times 100$$

$$\text{Chemically combined water of asbestos, percent} = \frac{D - B}{D} \times 100$$

Where S = weight of specimen of fibers
C = weight of carbon-dioxide absorbed
R = weight of residue after ignition
A = percent cotton
B = percent ignited asbestos
D = percent asbestos

4.4.1.3.2 Two specimens shall be tested. The average of the results obtained from the two specimens shall be the asbestos content of the sample.

4.4.2 Simulative service test. - The simulative service test shall be made under simulated operating conditions in a machine designed for the purpose. The following test conditions shall apply:

Valve stem service with superheated steam at 600 pounds per square inch and 750°F. temperature. The test shall be concluded after 3,500 hours of operation.

4.5 Inspection procedures. - For Naval purchases, the general inspection procedures shall be in accordance with General Specifications for Inspection of Material.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. -

5.1.1 For domestic shipment - immediate known use. - Preservation and packaging shall be in accordance with manufacturer's commercial practice.

5.1.2 For domestic shipment and storage or overseas shipment. - Lengths of braided asbestos rod packing, as specified in the contract or order (see 6.1), shall be wrapped in greaseproof barrier material conforming to type II, grade A of Specification JAN-B-121. The braided asbestos rod packing shall then be placed in snug fitting unit and intermediate containers complying with Specification JAN-P-120, JAN-P-133, LLL-B-631 or LLL-B-636. The gross weight of folding cartons or set-up boxes shall not exceed 10 pounds and fiberboard boxes shall not exceed 45 pounds. Closure and sealing of the boxes shall conform to the applicable container specification.

5.2 Packing. -

5.2.1 For domestic shipment - immediate known use. - The braided asbestos rod packing, packaged as specified in 5.1.1, shall be packed in accordance with the latest edition of the Consolidated Freight Classification Rules, Motor Freight Classification Rules or Postal Regulations, whichever may be applicable. When fiberboard is used for container construction, the Mullen test shall be no less than 200 pounds. The gross weight of wood boxes shall not exceed 200 pounds.

5.2.2 For domestic shipment and storage. - Unless otherwise specified in the contract or order, the braided asbestos rod packing, packaged as specified in 5.1.2, shall be packed in one or more intermediate containers in snug fitting wood cleated fiberboard, cleated plywood, nailed wood, corrugated or solid fiberboard boxes conforming to Specification NN-B-591, NN-B-601, NN-B-621, LLL-B-631 or LLL-B-636, respectively. Fiberboard boxes shall conform to the special requirements of the applicable box specification. Closure of the shipping container shall conform to the applicable container specification. The gross weight of wood boxes shall not exceed 150 pounds, and fiberboard boxes shall not exceed 70 pounds.

5.2.3 For overseas shipment. - The braided asbestos rod packing, packaged as specified in 5.1.2 shall be packed by placing one or more intermediate containers in snug fitting wood cleated fiberboard, wood cleated plywood, nailed wood or fiberboard boxes conforming to Specifications JAN-P-103, JAN-P-105, style 2, 2-1/2 or 3 of Specification JAN-P-106, or symbol V3c or V3s of Specification JAN-P-108, respectively. Plywood shall conform to type A or B, condition I of Specification JAN-P-139. Boxes shall be lined with a sealed waterproof case liner conforming to type I, grade B, class 2 of Specification MIL-L-10547. Seams and closures shall conform to the appendix of the liner specification. Shipping containers shall be closed and strapped in accordance with the appendix of the applicable container specification. Flat steel strapping shall conform to class A or B of Specification QQ-S-781. The gross weight of wood boxes shall not exceed 150 pounds, and fiberboard boxes shall not exceed 70 pounds.

5.3 Marking. - In addition to any special marking required by the contract or order, unit packages, intermediate and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129, and in addition, shall be marked with the date of manufacture.

6. NOTES

6.1 Ordering data. - Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Type and size required (see 1.2, 3.4.2 and 3.5.3).
(c) Whether packing for domestic or overseas shipment is required; if domestic, the type required (see 5.1 and 5.2).

6.2 In the procurement of products requiring qualification, the right is reserved to reject bids on products that have not been subjected to the required tests and found satisfactory for inclusion on the Military Qualified Products List. The attention of suppliers is called to this requirement, and manufacturers are urged to communicate with the Bureau of Ships, Navy Department, Washington 25, D.C., and arrange to have the products that they propose to offer to the Army, the Navy, or the Air Force, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products covered by this specification may be obtained from the Chief of the Bureau of Ships, Navy Department, Washington 25, D.C.

6.3 The packaging, packing, and marking specified herein apply only to direct shipment to the Government and are not intended to apply to contracts or orders between the manufacturer and the prime contractor.

Notice. - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodian:
Bureau of Ships
Other interest:
Navy - OrSY

HH-P-46c
May 26, 1966
SUPERSEDING
Fed. Spec. HH-P-46b
February 6, 1952

FEDERAL SPECIFICATION

PACKING; ASBESTOS, SHEET, COMPRESSED

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers one type of compressed asbestos sheet packing of various thicknesses and weights for such uses as material for making gaskets for joints in piping and valves (see 6.1).

1.2 Classification (for weights and thicknesses see 3.6).

2. APPLICABLE DOCUMENTS

2.1 Specifications and standards. The following specifications and standards, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

Federal Specifications:

UU-P-271—Paper, Wrapping, Waterproofed Kraft.
PPP-B-576—Box, Wood, Cleated, Veneer, Paper Overlaid.
PPP-B-585—Boxes, Wood, Wirebound.
PPP-B-591—Boxes, Fiberboard, Wood-Cleated.
PPP-B-601—Boxes, Wood, Cleated-Plywood.
PPP-B-621—Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636—Box, Fiberboard.
PPP-B-640—Boxes, Fiberboard, Corrugated, Triple-Wall.

Federal Standard:

Fed. Std. No. 123—Marking for Domestic Shipment (Civilian Agencies).

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Washington, D. C., Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, and Seattle, Wash.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Specification:

MIL-L-10547—Liners, Case, and Sheet, Overwrap, Water-Vaporproof or Waterproof, Flexible.

Military Standards:

MIL-STD-105—Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129—Marking for Shipment and Storage.
MIL-STD-147—Palletized Unit Loads (40 in. x 48 in. 4-way Partial and 4-way Pallets).

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

FSC 5330

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Publications:

F 36—Method of Test for Compressibility and Recovery of Gasket Materials (Tentative).

F 39—Methods of Testing Compressed Asbestos Sheet Packing.

(Copies may be obtained from the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa., 19103.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Preproduction sample. Unless otherwise specified (see 6.2), a preproduction sample shall be prepared using the same methods proposed for the preparation of subsequent lots of asbestos packing and shall meet all the requirements of this specification (see 4.3.1). Approval of the preproduction sample by the procuring agency shall not relieve the contractor of his obligation to supply packing that shall conform to all the requirements of this specification. Any change or deviation from the preproduction sample shall be subject to the approval of the procuring agency.

3.2 Material. The packing shall be made of asbestos fiber combined with rubber (see 3.4) and suitable mineral fillers.

3.3 Graphite. Unless otherwise specified (see 6.2), the finished sheets of packing shall not be lubricated or graphited. When a lubricant or graphite is required, it shall be tested as specified in 4.6.1.1.1.

3.4 Asbestos fiber and rubber content. The packing shall contain not less than 70 percent by weight of asbestos fiber and not less than 10 percent by weight of natural or synthetic rubber when tested as specified in 4.6.1.1.2.

3.4.1 *Chemically combined water.* The asbestos fiber shall be chrysotile and the dry asbestos fiber shall contain not less than 12 percent by weight of chemically combined water (water of chrystallization), when tested as specified in 4.6.1.2.

3.5 Construction. The packing shall be thoroughly and evenly mixed to the desired consistency (see 3.4), and compressed into a sheet of compact and uniform texture either cross-laminated or single-ply.

3.6 Weight and thickness. The weight and thickness of the finished compressed asbestos sheet shall be as specified (see 6.2), and in accordance with table I.

TABLE I *Weight and thickness*

Weight (pounds per square yard[1])	Thickness[2]	
Minimum	Required (inch)	Tolerance (inch)
0.8	0.0156	+0.005 −0.002
2.0	.0313	±0.005
4.0	.0625	±0.0063
6.0	.0938	±0.0094
8.0	.1250	±0.0125
12.0	.1875	±0.0188
16.0	.250	±0.0250

[1] Weight. The weight of the packing shall be determined as specified in 4.5.1.

[2] Thickness. The thickness of the packing shall be determined as specified in 4.6.3.

3.7 Length and width. Unless otherwise specified (see 6.2), asbestos packing sheets shall be furnished in widths not less than 36 inches, and in lengths not greater than 153 inches when examined as specified in 4.5.1.

3.8 Loss of weight on heating. The loss of weight of the packing on heating at 900° to 925°C. (1652° to 1697°F.) shall be not more than 35 percent when tested as specified in 4.6.2.

3.9 Compressibility and recovery. The compressibility of the sheet shall be not less

than 7 percent nor more than 17 percent. The recovery shall be not less than 40 percent. Tests shall be as specified in 4.6.4.

3.10 Tensile strength. Tests for tensile strength shall be made as specified in 4.6.5.

(a) Sheets 1/32 inch and thicker shall have an average tensile strength of not less than 3,500 pounds per square inch.

(b) Single-ply sheets 1/64 inch thick shall have a minimum average tensile strength of 1,200 pounds per square inch in the weakest direction and an average tensile strength in both the longitudinal and transverse directions of not less than 2,000 pounds per square inch.

3.11 Identification of product. Unless otherwise specified (see 6.2), sheets shall be legibly marked with a fuel-oil resistant lacquer, ink, or dye to show information as follows:

(a) Specification number.
(b) Manufacturer's name.
(c) Product identification.

The markings shall be not less than 3/8 inch in height on one side only and shall be on every square foot, or less, of the packing.

3.12 Limitation on age. The packing shall be not older than 4 quarters from date of manufacture, when offered for delivery to the Government (see 5.3).

3.13 Workmanship. Workmanship shall be first class in every respect. The packing shall be uniform in quality and condition and shall be clean, sound, smooth, free from foreign material and from defects detrimental to fabrication, appearance, or performance of parts. The finished sheet shall be free of gasoline or other solvents used in the process of manufacture.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Lot. A lot shall consist of all packing of the same thickness, weight, and width produced from the same raw materials, manufactured under the same conditions, and offered for delivery at one time.

4.3 Classification of inspection. The inspection and testing of the packing shall be classified as follows:

(a) Preproduction sample inspection (see 4.3.1).
(b) Acceptance inspection (see 4.3.2).

4.3.1 *Preproduction sample inspection.* The preproduction sample of approximately 2 square yards shall be subjected to examination and all tests specified herein. Unless otherwise specified, the Government will perform the examination and tests for preproduction sample acceptance at the contractor's plant (see 6.2).

4.3.2 *Acceptance inspection.* Acceptance inspection shall consist of examination (see 4.5), and all tests of this specification except those of 4.6.1 (chemical analysis), provided a comparison can be made with the chemical analysis and loss of weight on heating with a previous approved lot (see 6.3).

4.4 Sampling.

4.4.1 *Sampling for examination of asbestos packing.* A representative sample of sheets of packing shall be selected at random from each lot for examination. Unless otherwise specified, the sample size shall be in accordance with MIL-STD-105 at inspection level I. The unit-of-product shall be one square yard.

4.4.2 *Sampling for examination of packaging, packing, and marking for shipment.* A random sample of exterior containers

TABLE II. *Classification of defects*

Category	Item	AQL percent	Defect	Method of inspection
Critical			None defined	
Major:				
101	Packing; asbestos sheet compressed (see 4.5.1).	2.5	Packing not thoroughly and evenly mixed (see 3.5).	Visual
102			Not compact and of uniform texture (see 3.5).	Visual
103			Weight of sheet not as specified (see 3.6).	Approved scale[1]
104			Length and width not as specified (see 3.7).	Measure
105			Lack of or improper marking (see 3.11).	Visual
106			Overage (see 3.12).	Visual
107			Not clean or free from foreign material (see 3.13).	Visual
108			Not free of imperfections (see 3.18).	Visual
109			Not free of solvents (see 3.18).	Olfactory
110	Asbestos sheets up to and including 1/16 inch in thickness (see 4.4.2 and 5.1.1.1).	2.5	Rolls not restrained from unwinding.	Visual
111			Rolls not wrapped properly.	Visual
112			Wrong type wrapping paper.	Visual
113			Rolls not sealed properly.	Visual
114			Overlap not 2″ minimum.	Visual
115	Asbestos sheets exceeding 1/16 inch in thickness (see 4.4.2 and 5.2.1.1).	1.0	No case liners or provisions made for omitting case liners in accordance with applicable box specification.	Visual
116	Box open (see 4.4.2 and 5.2.1.2, 5.2.2, or 5.2.3).	1.5	Wrong type.	Visual
117			Improper size.	Visual
118			Not suitably packed.	Visual
119	Box closed (see 4.4.2, (5.2.1.2.1, 5.2.2.1, or 5.2.3), 5.3 and 5.4).	1.5	Lack of or improper strapping.	Visual
120			Weight excessive.	Approved scale[1]
121			Improperly closed.	Visual
122			Improper marking.	Visual
123			Not palletized (if required see 6.2).	Visual

[1]Approved by procuring activity.

shall be selected from each lot in accordance with MIL-STD-105 at inspection level S-1.

4.4.3 *Sampling for tests.* Two samples of asbestos packing from each 2000 pounds in the lot shall be selected at random for tests. Each sample piece shall be 12 by 12 inches.

4.5 Examination.

4.5.1 *Examination of asbestos sheet.* Sample units of asbestos sheets, selected in accordance with 4.4.1, shall be examined for the defects and at the acceptable quality level (AQL) shown in table II.

4.5.2 *Examination of packaging, packing, and marking for shipment.* Sample units of exterior containers, selected in accordance with 4.4.2, shall be examined for the defects and at the AQL shown in table II.

4.6 Tests.

4.6.1 *Chemical analysis.*

4.6.1.1 *Preparation of specimen for analysis.* From the samples selected in accordance with 4.4.3, small strips or cross-sections shall be cut from various parts so that the specimen shall be representative of all the samples. The specimen shall be split with

the aid of a knife to produce relatively thin layers of material.

4.6.1.1.1 *Graphite (or lubricant) content (when specified).* A 1 to 3 gram (g.) specimen, prepared as specified in 4.6.1.1, shall be weighed accurately and placed in a siphon cup without a filter thimble. If graphite is present, a few milliliters (ml.) of chloroform shall be added to the cup and agitated gently to dislodge the bulk of the graphite, which shall be removed by decanting into the extraction flask. This is done to prevent the siphon cup from becoming plugged. Two or 3 treatments are usually sufficient to remove most of the graphite which shall be collected in the extraction flask along with the chloroform soluble material. The siphon cup shall then be assembled in the extraction flask, sufficient chloroform added to bring the volume up to about 50 ml., and the extraction shall be continued in the usual manner for a period of 2 hours. The extracted material shall then be transferred to a watchglass and permitted to air dry. When dry, the fibers shall be carefully separated, and the remaining graphite carefully brushed off and collected on the watchglass, then added to the extraction flask. The residue shall be reserved for subsequent determinations.

The chloroform shall be distilled from the extraction flask on a steam bath, using a gentle stream of filtered air to prevent boiling. The flask shall then be dried for 1 hour at 105°C. (221°F.), cooled in a desiccator, and weighed.

Calculation.

$$\text{Lubricant, percent} = \frac{L}{S} \times 100$$

Where:

L = weight of graphite and soluble material.
S = weight of specimen.

4.6.1.1.2 *Asbestos fiber and rubber content.* A specimen of approximately 2 g. and prepared as specified in 4.6.1.1, shall be placed in a 125 ml. lipped assay flask or a 250 ml. Erlenmeyer flask fitted with a standard taper and an air condenser. Ten g. of paranitrotoluene and 25 ml. of orthodichlorobenzene shall be added, and the mixture heated to 180° to 190°C. (356° to 374°F.) on a hotplate under a hood with occasional stirring until the rubber dissolves. From 4 to 10 hours are usually sufficient to effect solution.

The flask and contents shall then be cooled, 10 ml. of chloroform added, and the mixture decanted through a 100 mesh screen. The residue shall be washed with chloroform until the insoluble fillers are removed as indicated by a clear filtrate. If undissolved rubber remains, the fibers shall be returned to the digestion flask and the treatment with paranitrotoluene and orthodichlorobenzene repeated.

The filtrates and wash solutions shall be combined and poured through a portion of the sieve that is free of fibers, in order to collect any fibers that may have passed through previously. The fibers shall then be transferred to a siphon cup and extracted for 1 hour with chloroform, dried at 105°C. (221°F.), for 1 hour, cooled, and weighed.

Calculation.

$$\text{Asbestos fibers percent} = \frac{F}{S} \times 100$$

Rubber content, percent = 100-A-B.

Where:

F = weight of fibers.
S = weight of specimen.
A = percent fibers.
B = percent lubricant.

4.6.1.2 *Chemically combined water.* Two specimens of approximately 1 g. each shall be taken from the fibrous material which has been treated as required in 4.6.1.1.2. They shall be dried for 1 hour in platinum crucibles at a temperature of 105° to 110°C. (221° to 230°F.), cooled in a desiccator, and again weighed. The specimens and crucibles shall be ignited in an electric furnace at a temperature of 800° to 825°C. (1472° to 1517°F.), or over a blast lamp, to a constant weight.

Calculation.

Chemically combined water,

$$\text{percent} = \frac{S-R}{S} \times 100$$

Where:

R = weight of specimen after ignition.
S = weight of specimen before ignition.

The average of the results obtained from the two specimens shall be the chemically combined water of the sample.

4.6.1.2.1 *Cotton, asbestos, and chemically combined water.* If the fibrous material contains cotton or other organic materials as indicated by nonconformance to 3.4.1, it may be determined as follows: The asbestos content of the fibrous material which has been treated as specified in 4.6.2.2, shall be determined by the combustion procedure for cotton and asbestos. If graphite, carbon black, or other material insoluble in the paranitrotoluene—orthodichlorobenzene mixture remains on the fibers, the combustion method will not give reliable results, and in such cases the results obtained shall be considered to be approximations.

A specimen weighing approximately 1 g. shall be taken from the fibrous material of 4.6.1.1.2. It shall be placed in a porcelain or platinum combustion boat, dried for 1 hour at a temperature of 105° to 110°C. (221° to 230°F.), cooled in a desiccator, and weighed. The dried specimen in the boat shall be inserted in the combustion tube of an electric organic combustion furnace. The specimen shall be maintained at a temperature of 900° ± 50°C. (1652° ± 90°F.) for approximately 30 minutes or until combustion of the cotton is complete. During the combustion period, a current of oxygen (carbon dioxide free) shall be passed through the combustion tube at a rate of approximately 200 ml. per minute. The combustion gases shall be passed through either two U-tubes containing calcium chloride or through a drying tube containing anhydrous magnesium perchlorate or calcium sulphate to remove the moisture; and finally the gases shall be passed into either a weighed Vanier or similar absorption bulb containing a strong solution of caustic potash, or in a weighed carbon dioxide absorption bulb containing a sodium hydroxide impregnated base (the absorbent having the trade name "ascarite" is of this type), to absorb the carbon dioxide. Three-elevenths of the increase in weight of the Vanier or other carbon dioxide absorption bulb shall represent the weight of the carbon in the fibrous material. This shall be 44.40 percent of the cotton. These factors may be combined to give a constant of 0.614. When the combustion has been completed, the absorption tube shall be weighed, and the combustion boat containing the ignited residue shall be removed from the furnace, cooled in a desiccator, and weighed.

Calculation. The percentage of cotton shall be calculated as follows:

$$A = \frac{61.4 \times C}{E}$$

Where:

A = Percentage of cotton.
C = Weight of carbon dioxide, grams.
E = Weight of fiber specimen, grams.

4.6.2 *Loss in weight on heating.*

4.6.2.1 *Preparation of sample.* Small strips or cross-sections shall be cut from various parts of the sample so as to be representative of the sample. The specimen shall be split with the aid of a knife to produce relatively thin layers of material.

4.6.2.2 *Procedure.* Specimens of approximately 5 g. each, prepared as in 4.6.2.1, shall be dried for 1 hour in a porcelain crucible at a temperature at 105° to 110°C. (221° to 230°F.), cooled in a desiccator, and again weighed. The specimen and crucible shall be ignited in an electric furnace at a temperature of 900° to 925°C. (1652° to 1697°F.) or over a blast lamp, to a constant weight. The loss in weight shall be calculated as follows:

$$\text{Loss in weight (percent ash)} = \frac{R}{S} \times 100$$

Where:

R = weight of specimen after ignition.
S = weight of specimen before ignition.

4.6.3 *Thickness.* The thickness of the asbestos packing shall be determined as specified in ASTM F 39.

4.6.4 *Compressibility and recovery.* Compressibility and recovery shall be determined as specified in ASTM F 36, procedure A.

4.6.5 *Tensile strength.* Tensile strength shall be determined as specified in ASTM F 39.

5. PREPARATION FOR DELIVERY

5.1 Packaging. Packaging shall be level A or C as specified (see 6.2).

5.1.1 *Level A.* Compressed asbestos packing in thicknesses up to and including 1/16 inch shall be furnished in rolls (see 5.1.1.1); and compressed asbestos packing exceeding 1/16 inch in thickness shall be furnished in flat sheets.

5.1.1.1 *Rolls.* Asbestos packing shall be rolled and restrained from unwinding. The rolls shall be wrapped with class 2 kraft paper conforming to UU-P-271 with ends enclosed. All seams, joints, and closures shall be sealed with adhesives or other suitable materials to afford waterproofness equal to that of the wrap material itself. A minimum of 2-inch overlap shall be provided at all overlapping edges.

5.1.1.2 *Sheets.* No overpackaging required.

5.1.2 *Level C.* The asbestos packing shall be packaged in accordance with supplier's commercial practices. Protection shall be such as to prevent deterioration during shipment and ensure safe delivery at destination.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.2).

5.2.1 *Level A.*

5.2.1.1 *Case liners for flat sheets (see 5.1.1).* Shipping containers for flat sheets shall have case liners conforming to MIL-L-10547. Case liners shall be closed and sealed in accordance with the appendix to MIL-L-10547. Case liners for fiberboard boxes, PPP-B-636 and PPP-B-640, may be omitted provided all center and edge seams and manufacturer's joints are sealed and waterproofed with pressure sensitive tape in accordance with the applicable fiberboard box specification.

5.2.1.2 *Rolls and sheets.* Rolls and sheets shall be packed in containers conforming to any of the following specifications at the option of the contractor:

Specification	Classification
PPP-B-576	Class 2
PPP-B-585	Class 3 use
PPP-B-591	Overseas type
PPP-B-601	Overseas type
PPP-B-621	Class 2
PPP-B-636	Weather-resistant
PPP-B-640	Class 2

5.2.1.2.1 Shipping containers shall be closed and strapped or banded in accordance with the applicable box specification or appendix thereto. The gross weight of wood or wood-cleated boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable fiberboard box specification.

5.2.2 *Level B.* Asbestos packing shall be furnished in rolls or sheets as specified in 5.1.1.

(a) Rolls packaged as specified in 5.1.1.1 will need no overpacking.

(b) Sheets shall be packed in containers conforming to any of the following specifications at the option of the contractor.

Specification	Classification
PPP-B-576	Class 1
PPP-B-585	Class 1 or 2 use
PPP-B-591	Domestic type
PPP-B-601	Domestic type
PPP-B-621	Class 1
PPP-B-636	Class domestic
PPP-B-640	Class 1

5.2.2.1 Shipping containers shall be closed in accordance with the applicable box specification or appendix thereto. The gross weight of wood or wood-cleated boxes shall not exceed 200-pounds; fiberboard boxes shall not exceed the weight limitations of the applicable fiberboard box specification.

5.2.3 *Level C.* The asbestos sheet shall be packed for shipment in compliance with common carrier regulations applicable to that mode of transportation to insure safe delivery at destination at lowest transportation costs without assessment of penalty charges for improper packing.

5.3 Marking. Containers shall be marked in accordance with 5.3.1 or 5.3.2, as applicable, and shall include any special marking specified in the contract or order (see 6.2). In addition, the date of manufacture (see 3.12), expressed by quarter and year (for example sheets manufactured in January, February, or March 1966 would be marked 1-66), shall be marked on the outside of each shipping container. The size of letters and material for the marking for date-of-manufacture shall conform to Fed. Std. No. 123 or MIL-STD-129, as applicable.

5.3.1 *Civil agencies.* In addition to the marking specified in 5.3, all containers for civil agencies shall be marked in accordance with Fed. Std. No. 123.

5.3.2 *Military agencies.* In addition to the marking specified in 5.3, all containers for military agencies shall be marked in accordance with MIL-STD-129.

5.4 Palletization. When specified (see 6.2), shipping containers shall be palletized in accordance with MIL-STD-147.

6. NOTES

6.1 Intended use. The packing is intended for use in pipe joints under the following conditions:

(*a*) Steam to 300 pounds pressure and 700°F. temperature.
(*b*) Hot or cold water or brine to 300 pounds pressure.
(*c*) Air to 3,000 pounds pressure.
(*d*) Gases of combustion to 500 pounds pressure and 700°F. temperature.
(*e*) Fuel oil to 500 pounds pressure and 250°F. temperature.

6.2 Ordering data. Purchasers should select the preferred options offered herein and include the following information in procurement documents:

(*a*) Title, number, and date of this specification.
(*b*) Whether a preproduction sample is required (see 3.1).
(*c*) When required, whether the Government will perform examination and tests on preproduction sample at contractor's plant (see 4.3.1).
(*d*) Whether the finished sheet shall be lubricated or graphited (see 3.3).
(*e*) Weight and thickness required (see 3.6).
(*f*) Length and width of sheet required (see 3.7).
(*g*) Whether identification of product shall be other than that specified (see 3.11).
(*h*) Selection of applicable levels of packaging and packing required (see 5.1 and 5.2).
(*i*) Whether special marking is required (see 5.3.1 or 5.3.2).
(*j*) Whether shipping containers shall be palletized (see 5.4).

6.3 Chemical analysis. Present known methods of chemical analysis of this type of material do not have a high degree of accuracy. It is necessary to make assumptions and, unless one has run this type of test many times, it is difficult to arrive at the correct answer on what is in the sheet and have other laboratories be able to duplicate the findings. At the same time the importance of accurately determining what is in the sheet is considered important. It has been found, however, that once the material has been approved and is satisfactory,

G-150RC303A Issued, Revised.
GASKET; GASKET; RING; SHEET TYPE; STYRENE-BUTADIENE RUBBER (SBR); COMPRESSED ASBESTOS FIBER; THICKNESS: 1/16 INCH; ASME B16.21 (B16.5 & B16.47-A); CLASS 150;
GASKET TO BE PURCHASED FROM DURABLA.
PROPER HANDLING PROCEDURES FOR THE ASBESTOS GASKETS WILL FOLLOW APPROVED PLANT HANDLING PROCEDURES.
CAUTION: THIS GASKET IS TO BE USED ONLY IN UNIQUE PROCESSES THAT HAVE PROVEN NOT TO WORK WITH NON-ASBESTOS GASKETS ALTERNATIVES.
THE NOTE ITEM NGSK-005 MUST ACCOMPANY THIS GASKET ITEM WHEN IT IS USED IN A CPPS.
MOC 0001-041,
MOC 0000-173.

DURABLA	BLACK		1/2	-60	-
Item Temperature	Range:	-350 -	1100	DEGREE F	

G-150RD301A Issued, Revised.
GASKET; GASKET; RING; SHEET TYPE; VITON A; THICKNESS: 1/8 INCH; ASME B16.21 (B16.5 & B16.47-A); CLASS 150;
DUROMETER SHORE A HARDNESS 50-70+/-5.
MOC 0000-305.
REVISED MOC 1918 3/99

GARLOCK	9518		1/2	-36	-
Item Temperature	Range:	-50 -	400	DEGREE F	

G-150RD302A Issued, Revised.
GASKET; GASKET; RING; SHEET TYPE; VITON A; THICKNESS: 1/8 INCH; ASME B16.21 (B16.5 & B16.47-A); CLASS 150;
LITHARGIC CURED; 60 DUROMETER OR LESS HARDNESS.
SEE MOC 1918; DO NOT PLACE IN SPECS, DO NOT PURCHASE
MOC 0000-305.

MOSITES	10125		1/2	-60	-
Item Temperature	Range:	-50 -	400	DEGREE F	

Piping Network

U2A
Gasket Codes

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Document revised July 1999 / Document reaffirmed July 1999
Contact Valerie.S.Lamison@usa.dupont.com on E-mail for more information.

1. Scope

This standard describes DuPont coded gaskets in **Tables 1** and **2**. **Figure 1** explains the spiral-wound gasket code numbering system. **Figure 2** explains the laminate gasket code numbering system. Acceptable materials and vendors for DuPont codes are listed in DuPont Standard Engineering Specification SU2A. Refer to DuPont Engineering Standards U1A and U5A for gasket application and selection.

2. General

The prefix or initial letter of the code designates the general classification (e.g., "G" for cut gaskets and "S" for gasket material in sheet form). The second part of the code is an arbitrary designation for identification.

The following ASTM rubber designations are used in **Table 1**:

CR	Neoprene
EPDM	Ethylene propylene terpolymer elastomer (Nordel®)
FKM	Fluoroelastomer (Viton®)
NBR	Nitrile butadiene rubber
NR	Natural rubber
SBR	Styrene butadiene rubber
TFE	Fluorocarbon resin

Important! On drawings specifying DuPont code numbers, reference should be made to DuPont Standard Engineering Specification SU2A. This specification can be sent to DuPont contractors to show acceptable materials and vendors for each code number.

®Nordel is a registered trademark of the DuPont Company.

®Viton is a registered trademark of the DuPont Company.

3. References

ASME B16.1–1989	American Society of Mechanical Engineers Publication—Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ASME B16.5–1996	American Society of Mechanical Engineers Publication—Pipe Flanges and Flanged Fittings
ASME B16.20–1993	American Society of Mechanical Engineers Publication—Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral Wounds and Jacketed
ASME B16.21–1992	American Society of Mechanical Engineers Publication—Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.24–1991	American Society of Mechanical Engineers Publication—Cast Copper Alloy Pipe Flanges and Flanged Fittings
ASTM D 1415	American Society for Testing and Materials Publication—Test Methods for Rubber Properties International Hardness
SU2A	DuPont Standard Engineering Specification—Gasket Codes, Manufacturers
U1A	DuPont Engineering Standard—Gasket Application
U5A	DuPont Engineering Standard—Code Gasket Selection
U10A	DuPont Engineering Standard—Gasket Dimensions, Special
U16A	DuPont Engineering Standard—Teflon® Envelope Gasket Dimensions

®Teflon is a registered trademark of the DuPont Company.

Table 1. Sheet and cut gasket codes (nonmetallic)[a]

DuPont code		Description	Max. temp.[b]	
			°C	°F
S1	G1	Gray, SBR bonded compressed white asbestos	399	750
S2	G2	Black, SBR bonded compressed white asbestos	399	750
S3	G3	Brown, 30 IRHD[c], NR gum rubber	99	210
S4	G4	Red, 75 IRHD, NR or SBR rubber	99	210
S6	G6	Black, 60 IRHD, acid-resistant filler, NR or SBR rubber	99	210
S7	G7	White, SBR coated, wire inserted, woven-asbestos cloth	321	610
—	G8	Folded and formed S7	321	610
S10	G10	Black, 35 IRHD, CR neoprene	99	210
S11	G11	Black, 60 IRHD, CR neoprene	99	210
S12	G12	Black, 75 IRHD, CR neoprene	99	210
S13	G13	Flexible graphite	454[d]	850
S13F	G13F	S13 with Type 316 stainless foil insert	454[d]	850
S13G	G13G	S13 with glass fiber insert	454[d]	850
S13K	G13K	G13 with Kevlar® and NBR bonding	260	500
S13S	G13S	S13 with Type 316 stainless perforated sheet insert	454[d]	850
S13T	—	S13 corrugated tape with adhesive backing	454[d]	850
S13V	G13V	S13 with 0.015″ 316 stainless steel insert	454[d]	850
S13W	G13W	S13 with Type 316 stainless wire screen insert	454[d]	850
S14	G14	Compressed plant fiber	99	200
S16	G16	Cloth inserted SBR rubber sheet	121	250
—	G18	Special EPDM ribbed gasket, PTFE encapsulated	149	300
S19	G19	Black, 60 IRHD, EPDM, Peroxide cure	177	350
S20	G20	Black, 70 IRHD, EPDM, Peroxide cure	177	350
S21	G21	General-purpose, black, 60 IRHD, FKM, 100% virgin DuPont Dow Viton®, Dipolymer, A Family, Bisphenol cure	204	400
S22	G22	General-purpose, black, 75 IRHD, FKM, 100% virgin DuPont Dow Viton®, Dipolymer, A Family, Bisphenol cure	204	400
S23	G23	General-purpose, black, 60 IRHD, FKM, 100% virgin DuPont Dow Viton®, Terpolymer, B Family, Bisphenol cure	204	400
S24	G24	General-purpose, black, 75 IRHD, FKM, 100% virgin DuPont Dow Viton®, Terpolymer, B Family, Bisphenol cure	204	400
S25	G25	High-performance, black, 60 IRHD, FKM, 100% virgin DuPont Dow Viton®, Specialty Polymer Family, Peroxide cure. For use in steam, hot water, acid, etc.	204	400
S26	G26	High-performance, black, 75 IRHD, FKM, 100% virgin DuPont Dow Viton®, Specialty Polymer Family, Peroxide cure. For use in steam, hot water, acid, etc.	204	400
S27	G27	Low-temperature service, black, 60 IRHD, FKM, 100% virgin DuPont Dow Viton®, Specialty Polymer Family, Peroxide cure	204	400
S28	G28	Low-temperature service, black, 75 IRHD, FKM, 100% virgin DuPont Dow Viton®, Specialty Polymer Family, Peroxide cure	204	400
S30	G30	Black, 75 IRHD, DuPont Dow Kalrez® 4079	316	600
S31	G31	Black, 82 IRHD, DuPont Dow Kalrez® 1050 LF	316	600
S32	G32	Black, 91 IRHD, DuPont Dow Kalrez® 3018	316	600

(continued)

See notes at end of table.

Table 1. Sheet and cut gasket codes (nonmetallic)[a] *(continued)*

DuPont code		Description	Max. temp.[b]	
			°C	°F
S34	G34	Non-black 79 IRHD, DuPont Dow Kalrez® 2037	316	600
S35	G35	White 55 IRHD, CR neoprene	99	210
S40	G40	Black NBR bonded compressed white asbestos	399	750
S45	G45	Black 60 IRHD, NBR rubber	127	260
—	G46	Teflon® TFE with Type 304 stainless insert	190	375
S47	G47	Brown Teflon® fiber felt, TFE impregnated	221	430
S47W	G47W	White Teflon® fiber felt, TFE impregnated	220	430
S48	—	Teflon® TFE, multifilament braided tape	177	350
S49A	G49A	Teflon® TFE, glass fiber filler	204 to 260[e]	400 to 500[e]
S49B	G49B	Teflon® TFE, glass sphere filler	204 to 260	400 to 500
S49H	G49H	Teflon® TFE, barium sulfate filler	204 to 260	400 to 500
S49J	G49J	Teflon® TFE, graphite filled	204 to 260	400 to 500
S50	G50	White virgin Teflon® TFE	177 to 260[f]	350 to 500[f]
S50B	G50B	Expanded Teflon® sheet	204 to 260	400 to 500
—	G50C	Expanded Teflon® tape	204 to 260	400 to 500
—	G50D	Expanded Teflon® insertable gasket	204 to 260	400 to 500
—	G51	Expanded Teflon® joint sealant	260	500
S80	G80	SBR bonded Kevlar®	204[g]	400[g]
S81	G81	NBR bonded Kevlar®	204[g]	400[g]
S82	G82	CR bonded Kevlar®	204[g]	400[g]
S83	G83	EPDM bonded Kevlar®	204[g]	400[g]
S84	G84	NBR bonded graphite	371[h]	700[h]

[a] Purchase orders for pipe flange gaskets shall specify the following:

- Style—full-face flat ring, male and female (small, large), tongue and groove (small, large).
- Flange dimensional specification in accordance with ASME B16.5–1996, ASME B16.24–1991, and ASME B16.1–1989.
- Flange class (e.g., 150, 300).
- Refer to ASME B16.21–1992 unless it is required to avoid a crevice at the gasket i.d., in which case refer to DuPont Engineering Standard U10A.

[b] Maximum temperature may be lower for some services.

[c] IRHD (International Rubber Hardness Degrees) as described in ASTM D 1415, approximately equal to Durometer A hardness.

[d] Maximum temperature in air, but if nonoxidizing, temperature may go to 1,100°C (2,012°F) or higher.

[e] 204°C (400°F) recommended, but under proper conditions 260°C (500°F) may be used.

[f] 177°C (350°F) recommended, but under proper conditions 260°C (500°F) may be used.

[g] Recommended, but after proper consultation and under proper conditions 260°C (500°F) is acceptable.

[h] May be useful to 540°C (1,000°F) under some conditions.

Shading indicates an asbestos product.

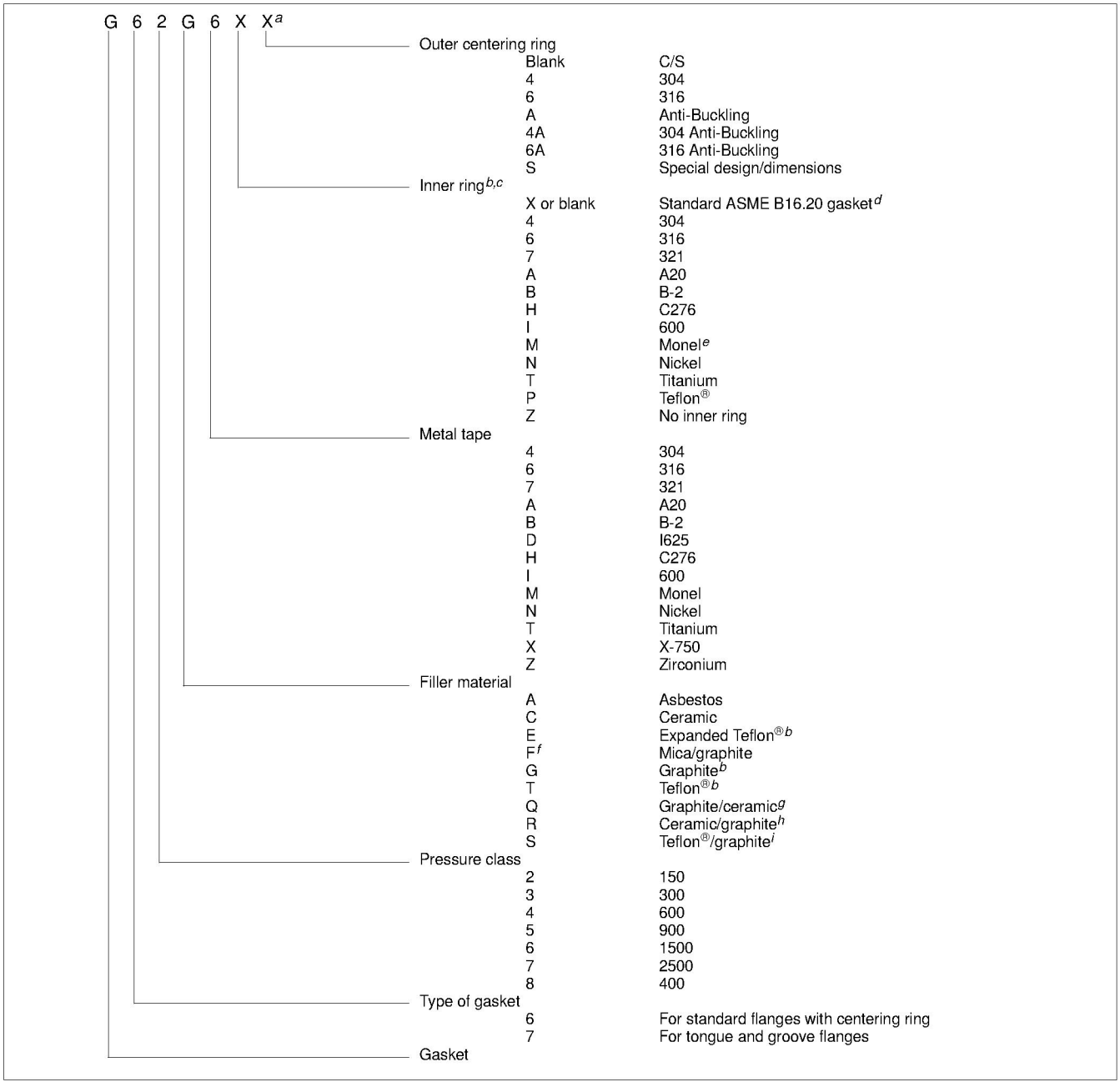
Table 2. Teflon® envelope gasket codes[a]

	Type	Center insert	Outer insert	Use	Max. temp. °C	Max. temp. °F
G52	Square (milled)	Reinforced Neoprene[b]	None	Pipe flanges	100	212
G53	V (slit)					
G54	Square (milled)					
G55	V (slit)					
G58	Square (milled)	Aramid fiber sheet G81 or equivalent			177	350
G59	V (slit)					
G60A	V (slit)	Corrugated stainless steel	Nonasbestos Aramid felt		232	450
	Square (milled)					
G61A	V (slit)			Glass-lined vessels		
	V (rolled)					
G61B	Square (milled)					
G61C	V (slit)		Graphite			
	V (rolled)					
G61D	Square (milled)					

[a] For component thicknesses, see DuPont Engineering Standard U16A.

[b] To have EPDM as the center insert, add "EPDM" to the code (e.g., G52EPDM). Max temp. 163°C (325°F).

Figure 1. Spiral-wound gasket code numbering system



Notes:

[a] Note the following example requirements in specifications:
G62T6 or G62T6XX = standard gasket
G62T6X4 = G62T6 with 304 SS outer ring
G62T64 or G62T64X = G62T6 with 304 SS inner ring
G62T664 = G62T6 with 316 inner ring and 304 outer ring
G62T6Z6A = G62T6 w/o inner ring, 316 anti-buckling outer ring
G72G6ZS = G72G6 w/o inner ring, special design and/or dimensions

[b] A metallic inner ring is standard on all ASME B16.20 gaskets with Teflon® filler. A metallic inner ring is required on all NPS 8 and above gaskets with flexible graphite filler. Exception: anti-buckling gaskets do not require inner rings.

[c] Inner ring has standard API dimensions.

[d] In accordance with ASME B16.20–1993

[e] Monel, a nickel alloy, is a registered trademark of Inco Alloys International, Inc.

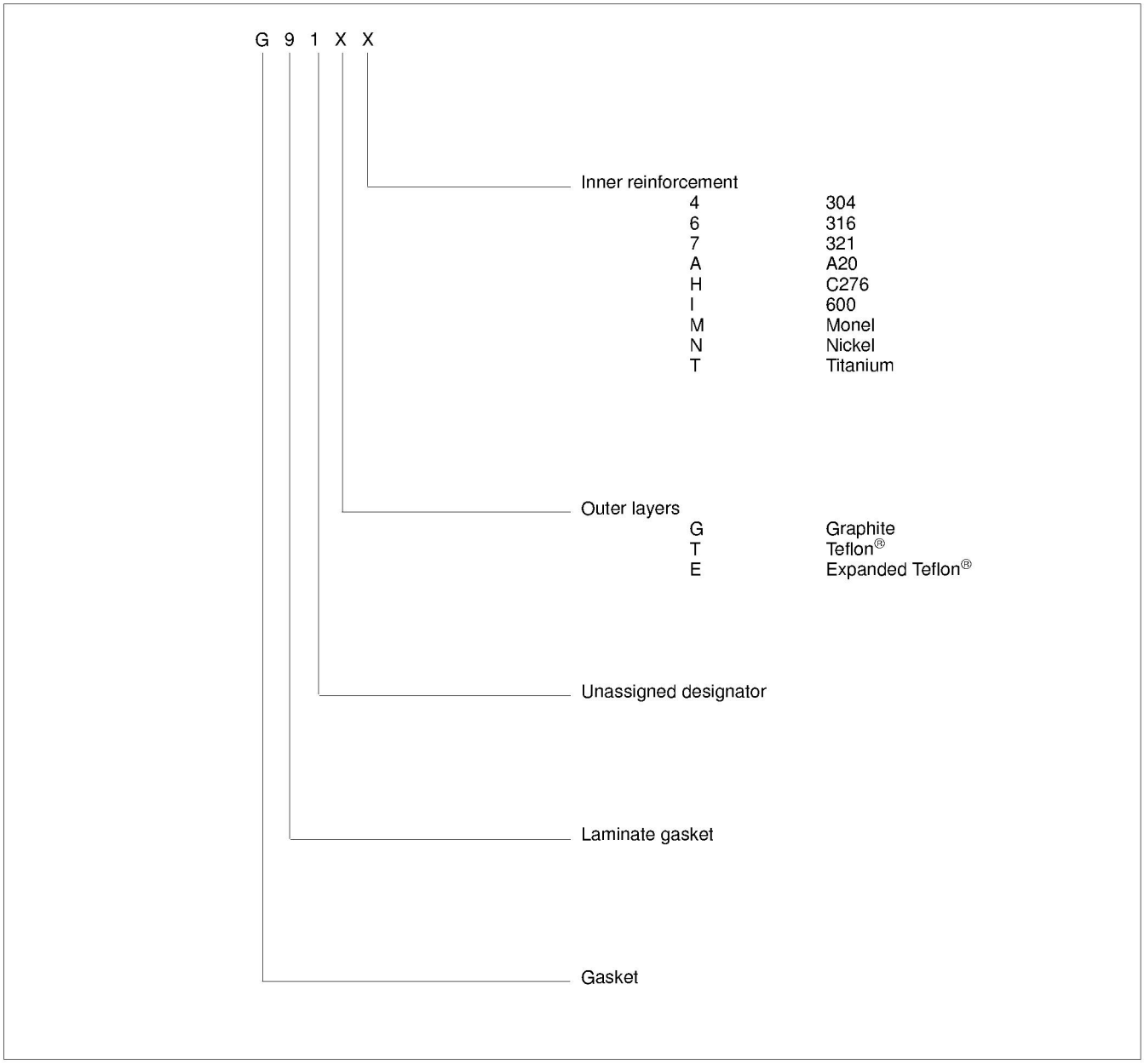
[f] Not for new design; use "G."

[g] This gasket has flexible graphite inner filler and ceramic outer filler.

[h] This gasket has a ceramic inner filler and flexible graphite outer filler.

[i] This gasket has a Teflon® inner filler and flexible graphite outer filler.

Figure 2. Laminate gasket code numbering system



Piping Network

SU2A
Gasket Codes—Manufacturers

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List of Tables

Document reaffirmed June 1999 / Document revised June 1999
Contact Valerie.S.Lamison@usa.dupont.com on E-mail for more information.

1. Scope

This specification designates manufacturer style numbers that meet DuPont gasket code requirements and applies only to products manufactured in the United States. Similar styles and names of foreign affiliates are not necessarily equal. Manufacturers are listed below in Section 2. On DuPont drawings and purchase requisitions, use the DuPont Gasket Code number only; do not use manufacturer style numbers. DuPont Engineering Standard U2A, "Gasket Codes," should also be considered a part of any purchase order.

2. List of manufacturers

The following manufacturers are used throughout **Tables 1–4**:

- A. W. Chesterton Company
- John Crane Belfab
- J M Clipper
- Coltec Specialty Products
- Donit
- Dowty Palmer-Chenard, Inc.
- DuPont Dow Elastomers
- Durabla Manufacturing Company
- Eagle Elastomer, Inc.
- EGC Enterprise
- Elkhart Rubber
- Flexitallic Gasket Company
- Frenzelit
- Garlock, Inc.
- W. L. Gore & Associates
- Inertex
- IPM—Industrial Plastics & Machine
- Kirkhill Rubber Co.
- Lamons Gasket Co.
- Lydall, Inc., Composite Materials Division
- Mosites Rubber Co.
- Nichlas
- Passaic Rubber Co.

- Pfaudler
- Polycarbon, Inc.
- Pureflex Inc.
- Reinz
- SEPCO—Sealing Equipment Products Co.
- Thermodyn Corp.
- Thermoseal Inc.
- UCAR Carbon Company Inc.
- West American Rubber

3. References

ASME B16.5–1996	American Society of Mechanical Engineers Publication—Pipe Flanges and Flanged Fittings
ASME B16.20–1993	American Society of Mechanical Engineers Publication—Metallic Gaskets for Pipe Flanges—Ring Joint, Spiral Wounds and Jacketed
U2A	DuPont Engineering Standard—Gasket Codes
U9A	DuPont Engineering Standard—Gasket Dimensions, Standard
U10A	DuPont Engineering Standard—Gasket Dimensions, Special
U16A	DuPont Engineering Standard—Teflon® Envelope Gasket Dimensions

®Teflon is a registered trademark of the DuPont Company.

Table 1. Manufacturers' style numbers

Manufacturers	DuPont sheet and cut gasket codes (use G for cut gaskets and S for gasket material in sheet form)															
	S1	S2	S3	S4	S6	S7	—	S10	S11	S12	S13	S13F	S13G	S13K	S13S	S13T
	G1	G2	G3	G4	G6	G7	G8	G10	G11	G12	G13	G13F	G13G	G13K	G13S	—
	Style number															
Chesterton											198	199				
Clipper											Quadra-Graph					
Coltec											G	GSS			GT	
Crane																
Dowty Palmer-Chenard, Inc.																
DuPont Dow Elastomers[a]																
Durabla	Pen-pak	Durabla Black									FGS95	FGL316			FGT316	
Eagle Elastomer Inc.																
EGC Enterprise											GTB	GHR			GHE	G6350 G6360
Elkhart Rubber			2526	2642	B-293			D-2548	D-2612	D-2604						
Flexitallic											HS/LS	SR			ST	GT
Frenzelit														825F 925F Premium Special		
Garlock, Inc.	9532	9533	6023	22	91				7986	7797	3123	3125SS			3125TC	Graphlock
Gore																
Inertex																
IPM																
Kirkhill Rubber Co.[a]																
Lydall																
Mosites Rubber Co.[a]																
Passaic Rubber Co.																
Polycarbon											B	BSSC			BTCSS	PSA
Pureflex																
SEPCO											SG36	500			SG373	SG6350/ SG6360
Thermodyn Corp.[a]																
Thermoseal											HL	SLS			PSM	
UCAR											GTB	GHR	GHW		GHE	GTH-K
West American Rubber[a]																

(continued)

Shading indicates asbestos product.

[a] Identifies Certified Viton® Licensees, preferred suppliers of sheet and gasket products made of Certified DuPont Dow Elastomers' Viton®. The other manufacturers listed (S21/G21 through S28/G28) will also certify in writing that their style numbers are made of 100% virgin DuPont Dow Elastomers Viton®.

Note: Manufacturers' and merchandise designations are given to describe materials and may not include all acceptable products. Substitutions by suppliers are to be made only on approval by the local authority initiating the use of this specification.

Table 1. Manufacturers' style numbers *(continued)*

Manufacturers	DuPont sheet and cut gasket codes (use G for cut gaskets and S for gasket material in sheet form)												
	S13V	S13W	S14	S16		S19	S20	S21	S22	S23	S24	S25	S26
	G13V	G13W	G14	G16	G18	G19	G20	G21	G22	G23	G24	G25	G26
	Style number												
Chesterton													
Coltec													
Crane													
Dowty Palmer-Chenard, Inc.								DE-6Z-0660	X-6102	X-6103	X-6104	X-6105	X-6106
DuPont Dow Elastomers[a]													
Durabla													
Eagle Elastomer Inc.								EE-50060	EE-60075	EE-6050	EE-7550		EE-75GFLT
EGC Enterprise													
Elkhart Rubber						Q2600	Q2609	V-2532	V-2546	V-2533	V-2558	V-2500	V-2559
Flexitallic		WR											
Garlock, Inc.		3124	681	159			317	9523	9524	9525	9527	9529	9531
Gore													
Inertex													
IPM													
Kirkhill Rubber Co.[a]								CD 60-163	CD 75-151	CD 60-196	CD 70-191		CD 75-188
Lydall													
Mosites Rubber Co.[a]								1046	10116-A	10125B	10307	10310	10212
Passaic Rubber Co.								MFE 1570	MFE 170GC	MFE 1571	MFE 1707		
Polycarbon		BSC											
Pureflex													
SEPCO			440										
Thermodyn Corp.[a]								TD-6014A175	TD-7514A175	TD-6014B175	TD-7514B175	TD-6020GF175	TD-7520GF175
Thermoseal													
UCAR	GT-V												
West American Rubber[a]								60-F-96	75-F-97				

(continued)

Shading indicates asbestos product.

[a] Identifies Certified Viton® Licensees, preferred suppliers of sheet and gasket products made of Certified DuPont Dow Elastomers' Viton®. The other manufacturers listed (S21/G21 through S28/G28) will also certify in writing that their style numbers are made of 100% virgin DuPont Dow Elastomers Viton®.

Table 1. Manufacturers' style numbers *(continued)*

Manufacturers	DuPont sheet and cut gasket codes (use G for cut gaskets and S for gasket material in sheet form)													
	S27	S28	S30	S31	S32	S33	S34	S35	S40	S45	—	S47	S47W	S48
	G27	G28	G30	G31	G32	G33	G34	G35	G40	G45	G46	G47	G47W	—
	Style number													
Chesterton														382
Coltec											Tex-O-Lon			
Crane														C–1050G
Dowty Palmer-Chenard, Inc.	DE-60360	X-6107												
DuPont Dow Elastomers[a]			4079	1050FL	3018	2035	2037							
Durabla									Black Nitrile					
Eagle Elastomer Inc.		EE-75GFLT												
EGC Enterprise														
Elkhart Rubber	V-2507	V-2508						D-2564		R-2286				
Flexitallic														
Garlock, Inc.	9535	9537							8748	9122				620
Gore														
Inertex														
IPM														
Kirkhill Rubber Co.[a]		CD 75-212												
Lydall														
Mosites Rubber Co.[a]	10311	10282												
Passaic Rubber Co.														
Polycarbon														
Pureflex											Task-Line			
SEPCO														2210
Thermodyn Corp.[a]	TD-6020GLT150	TD-7520GLT150												
Thermoseal														
UCAR														
West American Rubber[a]														

(continued)

Shading indicates asbestos product.

[a] Identifies Certified Viton® Licensees, preferred suppliers of sheet and gasket products made of Certified DuPont Dow Elastomers' Viton®. The other manufacturers listed (S21/G21 through S28/G28) will also certify in writing that their style numbers are made of 100% virgin DuPont Dow Elastomers Viton®.

Table 1. Manufacturers' style numbers *(continued)*

Manufacturers	DuPont sheet and cut gasket codes (use G for cut gaskets and S for gasket material in sheet form)													
	S49A	S49B	S49H	S49J	S50	S50B	S50C	—	—	S80	S81	S82	S83	S84
	G49A	G49B	G49H	G49J	G50	G50B	—	G50D	G51	G80	G81	G82	G83	G84
	Style number													
Chesterton											195		192	
Clipper		Tuff 2000				QuadraLon				961	NA60 978C	976	986	
Coltec	500FG				600A									
Crane					68–B					4160	2160	3160		
Donit											Teenit BA-Unit			
Dowty Palmer-Chenard, Inc.														
DuPont Dow Elastomers[a]														
Durabla		9000	9200W	9400						Durlon 8600	Durlon 8500, 8400			
Eagle Elastomer Inc.														
EGC Enterprise														
Elkhart Rubber														
Flexitallic		Sigma 500	Sigma 533							SF2420	SF2400	SF2440	SF2500	SF5000
Garlock, Inc.	9405	3504	3510 3511[b]	3530	8764	3540				3200 3400	3001	3300	3700	G9900
Gore						Gore-Tex GR	Gore-Tex Tape	Gore-Tex Insertable	Gore-Tex Joint Sealant					
Inertex						SQ–S			UHF					
IPM	4250	4810			4000									
Kirkhill Rubber Co.[a]														
Lydall										7301	7201	7101		
Mosites Rubber Co.[a]														
Nichlas											1993			
Passaic Rubber Co.														
Pureflex														
Reinz											34			
SEPCO					5000									
Thermodyn Corp.[a]														
Thermoseal									Sealex	C-6401	C-4401[c]	C-5401		
UCAR														
West American Rubber[a]														

Shading indicates asbestos product.

[a] Identifies Certified Viton® Licensees, preferred suppliers of sheet and gasket products made of Certified DuPont Dow Elastomers' Viton®. The other manufacturers listed (S21/G21 through S28/G28) will also certify in writing that their style numbers are made of 100% virgin DuPont Dow Elastomers Viton®.

[b] 3511 available in yellow.

[c] C-4401 available in white.

Table 2. Teflon® envelope gasket codes manufacturers' styles

Manufacturers	G52	G53	G54	G55	G58	G59	G60AS	G60AM	G61AS	G61AR	G61B	G61CV	G61CR	G61D
	Style number													
Type					Square (milled)	V (slit)	V (slit)	Square (milled)	V (slit)	V (rolled)	Square (milled)	V (slit)	V (rolled)	Square (milled)
Pfaudler[a]							NS (1–12)	CH (1-1/2–12)	NS (1–20)	NS (24–84)	CH (1-1/2–84)	ES (1–20)	ES (24–96)	PS (1-1/2–48)
Garlock[b]	63213	63113	63213	63113	63225 (1/2–12)	63125 (1/2–12)	63127 (1/2–12)	63227 (1/2–12)	63127 (1/2–12)	63439 (14–84)				
Coltec[c]	G52	G53	G54	G55	G58	G59	G60AS	G60AM						

[a] Pfaudler uses proprietary i.d. and o.d. dimensions.

[b] Garlock uses old ASA dimensions that match DuPont Engineering Standard U10A for some pipe sizes.

[c] Coltec uses dimensions from DuPont Engineering Standard U16A.

Table 3. Spiral-wound gasket codes manufacturers' styles[a,b,c,e]

Manufacturers	G6XXX[d]	G7XXX[d]	G6XXXX (inner ring)	G6XXXZA (anti-buckling)
Flexitallic[e]	CG	R-1, R-3, R-4	CGI	
Lamons	WR	W	WRI	
Garlock	RW	SW	RWI	Edge
J M Clipper	LG-13	LG-11	LG-13-IR	

[a] DuPont code numbers must be used to order gaskets for which code gaskets are specified. Include DuPont Engineering Standard U2A when specifying spiral-wound gaskets. G6XXX gasket dimensions are in accordance with ASME B16.20–1993. G7XXX gasket dimensions are in accordance with ASME B16.5–1996 and manufacturing tolerances.

[b] Gaskets will be furnished color-coded in accordance with ASME B16.20–1993 unless otherwise specified.

[c] Flexible graphite gaskets 8-in. pipe size and larger will be furnished with inner rings 1/8-in. thick i.d. (as specified in DuPont Engineering Standard U9A) and in the same metal as tapes unless otherwise specified on order. Refer to DuPont Engineering Standard U2A, Figure 1. All gaskets with Teflon® will have an inner ring. Exception: Garlock Edge™ anti-buckling gaskets do not require inner rings.

[d] All filler and winding materials per DuPont Engineering Standard U2A, Figure 1.

[e] The metal tapes in all common alloys are color-coded. The color code is visible on the i.d. of the gasket.

Table 4. Laminate gasket code manufacturers' styles

Manufacturer	G91G6[b]	Max. temp.[a]	
		°C	°F
J M Clipper	Elastograph	454	850
Coltec	Graphonic	454	850
Lamons	CMG	454	850

[a] Higher temperature may be possible in nonoxidizing conditions.

[b] Refer to DuPont Engineering Standard U2A, Figure 2 for other gasket combinations.

Flanged Joints, Gaskets, and Bolting

GP 03-16-01

Version 1

February 2002

Scope

[I] This Global Practice (GP) covers the design of flanged joints for piping, and the selection of flanges, flange facings, gaskets and bolting for piping, and equipment flanged nozzles and manways.

[I] Orifice flanges and valve bonnets are outside the Scope of this Practice.

[I] An asterisk (*) indicates that additional information is required. If a job is contracted, this information is to be furnished in the Job Specification.

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Table of Tables

1. Required References

[I] This Section lists Practices and Standards that are generically referenced and assumed to be a part of this document. Unless otherwise specified herein, use the latest edition.

[I] Where specific references to ASME, ANSI or ASTM requirements are made in this Practice, the Owner's Engineer may authorize the use of equivalent or more stringent provisions of other applicable recognized codes or standards.

1.1. Global Practices–ExxonMobil Engineering Practices

GP 03-10-01	Piping Selection and Design Criteria
GP 03-12-01	Valve Selection
GP 03-16-03	Heat/Weather Shields for Flanges and Flangeless Valves
GP 18-10-01	Additional Requirements for Materials

1.2. API–American Petroleum Institute

API STD 590	(Withdrawn) Steel Line Blanks

1.3. ASME–American Society of Mechanical Engineers

Unless specific references to the ASME Code are listed, an IHS link to the Introduction is provided to facilitate access to relevant parts of the Code.

ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.20	Metallic Gaskets for Pipe Flanges Ring-Joint, Spiral-Wound, and Jacketed
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.47	Large Diameter Steel Flanges NPS 26 Through NPS 60
ASME B16.5	Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24
ASME B31.3	Process Piping
ASME SEC VIII D1	BPVC Section VIII - Rules for Construction of Pressure Vessels - Division 1

1.4. ASTM–American Society for Testing and Materials

ASTM A 193/A 193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A 320/A 320M	Standard Specification for Alloy/Steel Bolting Materials for Low-Temperature Service

	Temperature Service
ASTM F 436	Standard Specification for Hardened Steel Washers

2. Definitions

1) [I] Hydrogen Service, as used herein, is any fluid service when the hydrogen partial pressure exceeds 90 psi (620 kPa) with a design temperature of 450°F (230°C) or greater.

2) [I] Combustible liquids—High flash liquids [flash points 100°F (38°C) or higher] when handled at temperatures more than 15°F (8°C) below their flash point.

3) [I] Flammable liquids—Low flash liquids [flash point below 100°F (38°C)]; and high flash liquids [flash point 100°F (38°C) or higher] when handled at temperatures above or within 15°F (8°C) of their flash point.

4) [I] Flammable materials—Flammable liquids; hydrocarbon vapors; and other vapors, (i.e., hydrogen and carbon disulfide) that are readily ignitable when released to atmosphere.

3. Flanged Joints

1) [R] The selection of flanged facings and gaskets shall be per Table 3, or per Table 4 if asbestos based gaskets are used.

2) * [S], [R] Electrically insulated flanged joints require approval of the Owner's Engineer. Insulating flanged joints are required for:
   a) Isolation of all lines heated by electric impedance heating systems.
   b) Protection of marine terminal loading stations to electrically isolate on-board (tanker or barge) piping from the pier piping under any of the following circumstances:
      i) At cathodically protected marine terminals
      ii) Where loading arms or electrically bonded oil cargo hoses are used
      iii) For loading and unloading products classified as flammable liquids

3) [R] For flanged joints with fluid operating temperatures below −50°F (−45°C), the flanged joint design must compensate for the differential contraction of the flanges and bolts so that change in gasket seating pressure will not result in leakage.

4) * [R] When specified, hot service thermal insulation of flanges is permitted where all of the following conditions are met:

Maximum Fluid Operating Temperature	550°F (290°C) (1)(2)
Maximum Design Pressure	600 psig (4140 kPa) (2)
Flange Material	Carbon Steel, or Low Alloy Steel (to 5% Cr) (3)
Bolting Material	Grade B7 or B16 per Section 6, Item 1
Service Restrictions	Not for hydrogen service, highly corrosive fluids such as concentrated acids, or toxic materials such as phenol

or hydrogen sulfide

Notes:

(1) For temperatures below 300°F, consideration shall be given to the possibility of corrosion under the insulation.

(2) Steam service flanges may be insulated to a maximum fluid operating temperature of 750°F (400°C) and a maximum design pressure of 650 psig (4480 kPa).

(3) For hydrocarbon services, the flange periphery shall, in addition, be fitted with a leak band.

5) * [S], [R] For any flammable material or combustible liquid service where the piping system is lined with plastic or low melting point [below 700°F (370°C)] material, flanged joints shall be designed to prevent leakage when exposed to heat sufficient to destroy or melt the lining material (lapped over flange faces). External insulation of the flanges may be considered for this purpose subject to the Owner's Engineer approval and the requirements of Section 3, Item 4 above.

6) [S], [R] For wafer or lug type valve installations in piping systems with a design temperature greater than 400°F (200°C), flanges and bolting material shall be selected to have the same nominal coefficient of thermal expansion as the body material of the valve.

7) [R] Steel flanges mating to flat-faced cast iron flanges shall be flat faced. Full-faced gaskets shall be used.

8) * [R] Proprietary flanged piping connectors, quick opening closures, or clamps shall not be used without prior approval of the Owner's Engineer.

4. Flanges

1) * [R] Flanges shall be in accordance with the Standards given in Table 1 and the additional requirements of this Practice. Flanges of materials other than those listed or flanges with special dimensions for mating to equipment shall be per ASME B31.3 and shall be approved by the Owner's Engineer.

Table 1: Flange Standards

Flange Material	NPS Size Range		Applicable Standard
	in.	mm	
Carbon Steel Ferritic Alloy Steel Austenitic Cr-Ni Steel 3 1/2 percent Ni Steel	1/2 through 24	15 through 600	ASME B16.5
	26 through 60	650 through 1500	ASME B16.47 Series B (1)
Cast Iron	1 through 48	25 through 1200	ASME B16.1
Nickel; Nickel Copper (Monel) Nickel-Chromium-Iron (Inconel) Hastelloy B-2 and C-276	1/2 through 24	15 through 600	ASME B16.5

Flange Material	NPS Size Range		Applicable Standard
	in.	mm	
Hastelloy B-2 and C-276	26 through 60	650 through 1500	ASME B31.3
Aluminum Bronze	1/2 through 24	15 through 600	ASME B31.3 (2)
Aluminum Alloy	1/2 through 24		ASME B31.3, Appendix L (2)

Notes:

(1) Except where ASME B16.47 Series A flanges may be required to accommodate flangeless or lug type valves or other similar flangeless components, or to mate with existing equipment flanges.

(2) Dimensions including flange face finish per ASME B16.5.

2) [R] For ring joint Class 900 or higher flanges, the ring groove corner radius ("R" dimension of ASME B16.5) shall be 1/8 ±0.03 in. (3 ±0.8 mm) when all of the following apply:
   a) Size exceeds NPS 3
   b) Design Temperature exceeds 500°F (260°C)
   c) Flange material is either solid austenitic stainless, or low alloy with austenitic stainless weld overlay

3) [C] The use of dual certified stainless steel flanges is permitted for the specified grade within the ASME B16.5 pressure-temperature limits as follows:
   a) Up to 1000°F (540°C), the straight grade pressure-temperature limits may be used per ASME B31.3 Code Cases 8–18 and 8–34.
   b) Above 1000°F (540°C), the pressure-temperature limits shall be calculated in accordance with the requirements of ASME B16.5, Annex D, using the L grade allowable stresses per ASME B31.3.
   c) Dual certified flanges shall be marked per ASME B16.5 but showing both grades (e.g., 304/304L).

4) * [R] The use of lap joint flanges requires approval by the Owner's Engineer and is subject to the following limitations:
   a) They shall not be used where the combined longitudinal stress in the pipe where attached to the lap-joint stub-end, resulting from pressure, weight, and thermal expansion, exceeds the ASME B31.3 basic allowable stress at the pipe design temperature.
   b) The flange may be of a material different from that of the pipe provided the flanged joint will not be subject to galvanic corrosion (e.g., carbon steel flanges may be used on lap-joint stub-ended 18Cr 8 Ni pipe in aboveground services).
   c) Stub-ends for lap-joint flanges, if fabricated by welding, shall be made with full penetration welds.

5) * [R] The use of slip-on flanges is subject to the following limitations:
   a) They shall not be used for Class 400 or higher flanges unless approved by the Owner's Engineer.
   b) They shall not be used at design temperatures above 750°F (400°C) or where the specified corrosion allowance exceeds 0.125 in. (3 mm).

c) They shall not be welded directly to welding fittings unless approved by the Owner's Engineer.

d) Aluminum alloy slip-on flanges shall not be used.

6) [C] Cast iron flanges are permitted only if furnished as integral flanges on cast iron piping or equipment.

7) [R] Threaded flanges on cast iron or ductile iron pipe shall be of steel.

8) [R] Aluminum alloy flanges shall be either wrought or forged forms. Castings shall not be used.

5. Gaskets

1) * [R] Gasket selection shall be per Table 3 for fluid services compatible with flexible graphite. Gaskets for other services shall be approved by the Owner's Engineer.

Where permitted by local authorities, asbestos-based gaskets may be used with the Owner's Engineer approval per Table 4 and other limits specified locally.

2) [R] Gasket designs shall be per the following Standards and the additional requirements of this Practice.

Gasket Type	Standards
Compressed Asbestos Fiber (CAF) sheet	ASME B16.21
Metal Reinforced Flexible Graphite (RFG) sheet	Dimensions per ASME B16.21
Corrugated Metal flexible Graphite Covered (CMGC)	Dimensions per ASME B16.21
Grooved Metal profile flexible Graphite Covered (GMGC)	Manufacturer's Standards
Corrugated Double Jacketed (DJ)	ASME B16.20 with Corrugated Jacket
Spiral Wound (SW)	ASME B16.20
Ring Joint (RJ)	ASME B16.20 for Oval Shape

3) * [R] The asbestos content for Compressed Asbestos Fiber (CAF) gaskets shall be a minimum of 70 percent (by weight). The binder shall be NBR polymer (ASTM D2000 Type B Class F) unless specified otherwise. The grade of asbestos and binders or impregnants used shall be suitable for the service fluids and temperature. Gasket shall contain an anti-stick release agent or be graphited on both sides, and shall have a minimum tensile strength across the grain of 4000 psi (27.6 MPa).

4) [R] The design of Reinforced Flexible Graphite (RFG) and Corrugated Metal flexible Graphite Covered (CMGC) gaskets shall be in accordance with Manufacturer standards subject to Owner's Engineer approval and the dimensions of ASME B16.21. The flexible graphite covering for these gaskets shall contain a minimum of 95 percent pure carbon and have a nominal density of 70 lb/ft^3 (1120 kg/m^3).

5) * [R] The design of Grooved Metal Graphite Covered (GMGC) gaskets shall be in accordance with Manufacturer standards, subject to Owner's Engineer approval. The flexible graphite covering for

this gasket type shall contain a minimum of 95 percent pure carbon with a nominal density of 45–70 lb/ft³ (700–1120 kg/ m³). All GMGC gaskets shall be supplied with an outer centering ring, loosely attached to the core gasket ring, unless specified otherwise.

6) * [R] The metal insert reinforcement for Reinforced Flexible Graphite (RFG) and Corrugated Metal Graphite Covered (CMGC) gaskets and the grooved profile metal for Grooved Metal Graphite Covered (GMGC) gaskets shall be Series 300 austenitic stainless steel unless other materials are specified for the process service.

7) * [R] An inner retaining ring, or other means to prevent inward buckling of the spiral windings as approved by the Owner's Engineer, shall be provided for spiral wound (SW) flexible graphite filled gaskets under any of the following conditions:

   a) Gasket size is NPS 6 or larger.

   b) Gasket design temperature exceeds 800°F (427°C).

   c) Flange rating is Class 900 or higher.

   For Class 900 and higher SW gaskets, the inside diameter of the inner ring shall be equivalent to the inside diameter of Schedule 80 pipe for the NPS size involved, and the inner ring shall be the same nominal thickness as the outer centering ring of the gasket.

8) * [R] The use of alternative spiral wound gasket designs to prevent inward buckling of the spiral windings shall be approved by the Owner's Engineer.

9) * [R] The metal windings (and inner retaining ring where required) of spiral wound (SW) gaskets shall be 300 series stainless steel unless other materials are specified for the process service. For operating temperatures below −50°F (−45°C), the outer centering ring shall also be 300 series stainless steel.

10) [R] Double jacketed (DJ) gaskets of materials other than carbon steel shall be used if the corrosion allowance is greater than $^{1}/_{16}$ in. (1.5 mm) or if the piping is other than carbon steel. The jacket material selected shall be based on a corrosion rate of less than 0.01 in./yr (0.25 mm/a) in service.

11) [C] Soft iron or low carbon content steel oval ring-joint (RJ) gaskets, with hardness limits per ASME B16.20, are satisfactory for carbon steel piping with a maximum corrosion allowance of $^{1}/_{16}$ in. (1.5 mm).

12) [R] Oval ring-joint (RJ) gaskets of materials other than soft iron or low carbon content steel shall be used if the corrosion allowance is greater than $^{1}/_{16}$ in. (1.5 mm), or if the piping is other than carbon steel. The ring material selected shall be based on a corrosion rate of less than 0.01 in./yr (0.25 mm/a).

    The hardness of the ring shall be lower than that of the flange. Where it may not be possible to obtain this feature, as in the case of some alloys, the material selection shall be resolved with the Owner's Engineer.

6. Bolting

1) [R] Bolting shall be selected per Table 2.

Table 2: Bolting Requirements

Design Metal Temperature		Flange Rating	Bolts			Nuts	
Deg F	Deg C	Class	Type	ASTM Std.	Grade	ASTM Std.	Grade
−20 to 800	−29 to 427	Any	Stud	ASTM A 193/A 193M	B7	ASTM A 194/A 194M	2H (1)
800 to 1100	427 to 593	Any	Stud	ASTM A 193/A 193M	B16	ASTM A 194/A 194M	2H(1)
1100 to 1200	593 to 650	Any	Stud	ASTM A 193/A 193M	B5	ASTM A 194/A 194M	3(1)
1100 to 1500	593 to 815	≤ 300	Stud	ASTM A 193/A 193M	B8M Class 1 (2)	ASTM A 194/A 194M	8M
−150 to −20	−101 to −29	Any	Stud	ASTM A 320/A 320M	L7 (3)	ASTM A 194/A 194M	4(1)(4)
−325 to −20	−198 to −29	Any	Stud	ASTM A 320/A 320M (5)	B8 Class 2 (6)	ASTM A 194/A 194M	8

Notes:

(1) Nuts larger than $^1/_2$ in. (12 mm) shall not be machined from bar stock.

(2) Class 1 (low yield) bolts shall not be used for Class 400 or higher flanges nor for flanged joints using metallic gaskets unless supported by appropriate design calculations per ASME B31.3, Par. 309.2.1.

(3) Test temperature for impact testing of all L7 bolts and Grade 4 nuts, per ASTM A 320/A 320M, shall be −150°F (−101°C).

(4) Nuts $^1/_2$ in. (12 mm) and smaller shall not be machined from cold finished bar stock.

(5) ASTM A 193/A193M Grade B8 Class 2 bolts with ASTM A194/A194M Grade 8 nuts may be used as an alternate.

(6) Grade B8 bolts shall be strain hardened (i.e., Class 2 of designated ASTM material standard).

2) * [R] Ferritic bolting shall be used for all ferritic flanges per the design temperature limits specified by Section 6, Item 1, unless otherwise approved by the Owner's Engineer.

3) * [R] For austenitic stainless steel flanges, the bolting material selection shall be limited to the following:

Bolting Material	Flange Design Temperature
Ferritic Steel (Grade B7 or B16)	−20°F to 1100°F (−29°C to 593°C)
Austenitic Stainless (Grade B8 Class 2)	Below −20°F (−29°C)

Bolting material and design for temperatures higher than these limits shall be approved by the Owner's Engineer.

4) [R] Bolting, including the use of protective coatings, for highly corrosive services such as concentrated acids shall be approved by the Owner's Engineer.

5) [R] Stud bolts shall be threaded full length with continuous threads.

6) [R] Bolts $1^1/_2$ in. (38 mm) and larger shall be fitted with hardened washers conforming to ASTM F436 under each nut. Washers fabricated from AISI 4140 material are acceptable. Surface finish shall be 125 microinch (3.2 micrometers) Ra or smoother on both sides.

7) * [R] For bolt diameters $1^1/_2$ in. (38 mm) and larger, or when specified, bolt lengths shall be one nut thickness larger than normally required to accommodate the use of bolt-on type stud tensioners.

Table 3: Flange Facings and Gaskets

Service Fluid	Flange Design Conditions		Flange Facing	Gasket Type
	ASME Rating Class	Temperature Range, Deg F (1)		
Hydrocarbon (3)	150 (2) and 300	−50 to 750	RF	RFG, CMGC, GMGC, or SW (9)
		Above 750 to 975	RF	SW or DJ
	400 and 600	−50 to 975	RF	SW
		Above 975	RJ	Oval RJ
	900	−50 to 750	RF	SW
		Above 750	RJ	Oval RJ
	1500 and 2500	Any	RJ	Oval RJ (10)
Hydrogen (4) and Helium	150 (2) and 300	−50 to 750	RF	RFG, CMGC, GMGC, or SW (1)
		Above 750 to 900	RF	SW or DJ
	400 and 600	−50 to 900	RF	SW
		Above 900	RJ	Oval RJ
	900	−50 to 750	RF	SW
		Above 750	RJ	Oval RJ
	1500 and 2500	Any	RJ	Oval RJ (10)
Steam and Steam Condensate	150 and 300	750 and below	RF	RFG (11), CMGC, GMGC, or SW (9)
		Above 750 to 975	RF	SW or DJ
	400, 600, and 900	975 and below	RF	SW
		Above 975	RJ	Oval RJ
	1500	Any	RJ	Oval RJ (10)

Service Fluid	Flange Design Conditions		Flange Facing	Gasket Type
	ASME Rating Class	Temperature Range, Deg F (1)		
Air or other Oxidizing Media	150 and 300	600 and below	RF	RFG, CMGC, GMGC, or SW (9)
		Above 600 to 750	RF	CMGC, GMGC or SW
		Above 750 to 875	RF	SW or DJ
Water (5) including Boiler Feed	150 or lower	Any	FF	RFG
	150 and 300	Any	RF	RFG, CMGC, GMGC, or SW (9)
	400, 600, 900	Any	RF	SW
	1500	Any	RJ	Oval RJ (10)
Fluid Catalyst (6)	150 and 300	750 and below	RF	RFG, CMGC or GMGC
		Above 750 to 875	RF	SW or DJ
Toxic Materials (7)	150 and 300	750 and below	RF	RFG, CMGC, GMGC, or SW (9)
Refrigerant (8) and Refrigerated Hydrocarbons	150 and 300	−250 and above	RF	RFG, CMGC or GMGC
	900 and below	−400 and above	RF	SW (9) (12)

Legend for Gasket Types:

RFG-Nominal $^1/_{16}$ in. (1.5 mm) thick Reinforced Flexible Graphite Sheet gasket

CMGC-Nominal $^1/_{16}$ in. (1.5 mm) thick Corrugated Metal Graphite Covered gasket

GMGC-Grooved Metal Graphite Covered gasket

SW-Spiral Wound (flexible graphite filled) gasket

DJ-Corrugated Double Jacketed (flexible graphite filled) gasket

RJ-Oval Ring Joint gasket

*** Notes to Table 2:**

(1) Gasket design temperature shall be the same as the flange design temperature. The Owner's Engineer shall be consulted for temperatures beyond the range specified.

(2) Includes Vacuum.

(3) Liquid, vapor, or gas, except when in refrigerant service.

(4) Ring joint materials in hydrogen service will be specified.

(5) Excludes seawater or other aqueous solution salts where possible electrochemical reactions between the graphite and metallic flange (or gasket) components can lead to galvanic corrosion.

(6) In suspension in any medium, unless medium is toxic.

*** Notes to Table 2:**

(7) Includes materials such as acids, caustics, phenol, chorine, hydrogen sulfide contained in solutions or mixtures. Mineral acids, such as sulfuric and nitric acids, not compatible with graphite are excluded.

(8) Includes propane, ethylene, ammonia, freon, Nitrogen, LNG.

(9) Use of SW gaskets for Class 150 flanges requires review of applied bolt loads for proper seating of the gasket. A review of applied bolt load is not required where acceptable flange sealing performance has been demonstrated by past experience or test.

(10) Raised face flanges (RF) and spiral wound (SW) flexible graphite filled gaskets with inner and outer rings are acceptable up to 750°F (400°C) where the design pressure is below 2700 psig (18600 kPa).

(11) Use of RFG gaskets for steam services limited to Class 150.

(12) Use of spiral wound (SW) gaskets for aluminum alloy flanges requires approval of Owner's Engineer.

General Note (for both Tables 3 and 4):
Acceptable Metric Equivalents For Temperatures

°F	°C
1200	650
1000	540
975	525
900	480
875	470
750	400
600	315
−50	−45
−250	−160
−400	−240

Table 4: Asbestos Based Gaskets where Permitted

Service Fluid	Flange Design Conditions		Flange Facing	Gasket Type
	ANSI Rating Class	Temperature Range, °F [1]		
Hydrocarbon [2] and Hydrogen [4]	150 [3] and 300	−50 to 750	RF	CAF or SW Asbestos Filled [7][8]
		Above 750 to 1000	RF	SW [8] or DJ Asbestos Filled
	400 and 600	−50 to 1000	RF	SW Asbestos Filled [8]
	900	−50 to 750	RF	SW Asbestos Filled [8][9]
Steam and Steam Condensate	150	750 and below	RF	CAF [8] or SW Asbestos Filled [7][8]
	and 300	Above 750 to 1000	RF	SW [10] or DJ Asbestos Filled
	400, 600, 900	1000 and below	RF	SW Asbestos Filled [8][9]
Air	150	750 and below	RF	CAF or SW Asbestos Filled [7][8]
	and 300	Above 750 to 1000	RF	SW[8] or DJ Asbestos Filled
		Above 1000 to 1200	RF	SW Asbestos Filled [8]
Water including Boiler Feed	150 and 300	Any	RF or FF	CAF
	400, 600, 900	Any	RF	SW Asbestos Filled [8][9]
Fluid Catalyst [5]	150 and 300	750 and below	RF	CAF or SW Asbestos Filled [7][8]
		Above 750 to 1000	RF	SW[8] or DJ Asbestos Filled
Toxic Materials [6]	150 and 300	750 and below	RF	CAF or SW Asbestos Filled [7][8]
Refrigerant and Refrigerated Hydrocarbons	150 and 300	−50 and above	RF	CAF or SW Asbestos Filled [7][8]
	Above 300	−50 and above	RF	SW Asbestos Filled [8][9][11]

Legend for Gasket Types:

CAF-Nominal $^{1}/_{16}$ in. (1.5 mm) thick

Compressed Asbestos Fiber Sheet gasket

SW-Spiral Wound (asbestos filled) gasket

DJ-Corrugated Double Jacketed (asbestos filled) gasket

*** Notes to Table 4:**

(1) Gasket design temperature shall be the same as the flange design temperature. The Owner's Engineer shall be consulted for temperatures beyond the range specified.

(2) Liquid, vapor, or gas, except when in refrigerant service.

(3) Includes Vacuum.

(4) Metallic components of composite gaskets in Hydrogen Service shall be Series 300 stainless steel unless specified otherwise.

(5) In suspension in any medium, unless medium is toxic.

(6) Includes materials such as acids, caustics, phenol, chorine, hydrogen sulfide contained in solutions or mixtures.

(7) Use of SW gaskets for Class 150 flanges requires review of applied bolt loads for proper seating of the gasket. A review of applied bolt load is not required where acceptable flange sealing performance has been demonstrated by past experience or test.

(8) Both inner and outer retaining rings shall be provided for spiral wound (SW) asbestos filled gaskets under any of the following conditions:

(a) Gasket size exceeds NPS 24.

(b) Gasket design temperature exceeds 800°F (427°C).

(c) Flange rating is Class 900 or higher.

For Class 900 and higher SW gaskets, the inside diameter of the inner ring shall be equivalent to the inside diameter of Schedule 80 pipe for the NPS size involved, and the inner ring shall be the same nominal thickness as the outer centering ring of the gasket.

(9) Raised face flanges (RF) and spiral wound (SW) asbestos filled gaskets with inner and outer rings are acceptable for Class 900 and above ANSI Ratings up to 750°F (400°C) where the design pressure is below 2700 psig (18600 kPa).

(10) Use of CAF gaskets for steam services limited to Class 150.

(11) Use of spiral wound (SW) gaskets for aluminum alloy flanges requires approval of Owner's Engineer.

Record of Change

Common

Version 1			Date: 02/02
Location	**Action**	**Description**	
N/A	N/A	No changes	

Attachment: Purpose Codes Definitions

Code	Description
C	Assigned to paragraphs containing specifications whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include Life-Cycle cost considerations. Life-Cycle cost considerations are captured under reliability, maintainability, or operability purpose codes.
E	Assigned to paragraphs containing specifications whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy.
I	Assigned to paragraphs that provide only clarifying information such as Scope statements, definitions of terms, etc.
M	Assigned to paragraphs containing specifications whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during on-stream operations.
O	Assigned to paragraphs containing specifications whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design, such as during startups, process swings, subcomponent malfunction, etc.
R	Assigned to paragraphs containing specifications whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions.
S	Assigned to paragraphs containing specifications whose primary purpose is avoidance of personnel or operational safety incidents. Any deviation from the specifications contained in such designated paragraphs requires formal review and approval according to local safety policy. Personnel Safety: Refers to the avoidance of recordable personnel injuries; i.e., burns, cuts, abrasions, inhalation, or exposure to dangerous substances, etc., that could result in medical treatment, restricted work, lost-time incidents, or fatalities. Operational Safety: Refers to the prevention and control of process releases, fires, explosions, etc.

N/A - Re-issued as A50T4004

Specification A50AF004
Issue No. S03
19 December 1988

GE - TURBINE BUSINESS OPERATIONS
NAVAL AND DRIVE TURBINE SYSTEMS DEPARTMENT
NONMETALLIC MATERIALS SPECIFICATION

SHEET GASKETS AND GASKET MATERIAL

1.0 SCOPE

1.1 SCOPE. GE Company Material Specification A50AF004 identifies compressed gaskets and gasket material as follows:

A50AF004A - Asbestos, Nitrile Gaskets and Sheet Gasket Material
A50AF004B - Non-Asbetos, Nitrile Gaskets and Sheet Gasket Material

2.0 COMPOSITION REQUIREMENTS

2.1 A50AF004A MATERIAL. Gaskets and sheet material shall be made from GE material A16C4A as follows:

	A50AF004A
Chrysotile Asbestos, Long Fiber	65 to 85%
Acrylonitrile-Butadiene Copolymer	15 to 35%

Material shall be made of long fiber chrysotile asbestos and an oil resistant nitrile rubber compound bonded under pressure and vulcanized into a homogeneous sheet.

2.2 A50AF004B MATERIAL. Gaskets and sheet gasket material shall be made from ASTM-F104 Class 992111 material as follows:

	A50AF004B
Aramid Fiber	65 to 85%
Acrylonitrile-Butadiene Copolymer	15 to 35%

3000
F-92
10-20 B

Material shall be made of aramid fiber and an oil resistant nitrile rubber compound bonded under pressure and vulcanized into a homogeneous sheet.

Parlock does not have a product of this formulation.

Supersedes Issue A50AF004-S2
dated 7/20/78

DOCUMENT NO A16C5
ISSUE NO. S2

Orders and Correspondence Must Specify Complete Material Number

GENERAL ELECTRIC

SPECIFICATION

COMPRESSED ASBESTOS-NEOPRENE GASKET MATERIAL

Supersedes A16C5-S1

GE Material A16C5 identifies compressed asbestos-neoprene gasket material, as follows:

A16C5A - 65-85% asbestos

CHEMICAL COMPOSITION: %

Chrysotile asbestos fiber	65-85
Neoprene and fillers	15-35

PROPERTIES:

Initial: (1)	
Compressibility, 5000 psi load, %	12 ±5
Recovery, 5000 psi load, %, min	40
Tensile strength, psi, min	2000
Aged five hours at 300 F in ASTM Oil No. 3:	
Compressibility, 5000 psi load, %, max	30
Thickness increase, %	15-30
Loss in tensile strength, %, max	50
Aged five hours at 70 to 85 F in ASTM Reference Fuel B:	
Thickness increase, %	10-25
Weight increase, %, max	30

Material - Gasket material shall be made of long fiber chrysotile asbestos and an oil resisting neoprene compound bonded under pressure and vulcanized into a homogeneous sheet.

Defects - The packing shall show no evidence of poor workmanship and shall have smooth surfaces and shall be free from imperfections.

Impurities - The finished sheets shall be free from solvents used in the process of manufacture and unless otherwise specified shall contain no graphite.

Identification - At least each square foot of packing shall be legibly marked with the manufacturer's name or brand name.

(1) Conditioned dry at 212 F for one hour and cooled to room temperature in a dessicator.

REFEREE METHODS:

Chemical composition	ASTM F39
All other tests	ASTM F104

DIMENSIONS AND TOLERANCES:

Cut parts - Shall be furnished in accordance with the drawings accompanying the purchase order.

Sheets - Shall be furnished in commercial sizes as follows:

Thickness, inch	Tolerance, inch
1/64 and under	+.005, -.002
Over 1/64 and under 1/16	±.005
1/16 and over	±.008

CERTIFICATE OF TEST:

When requested, the supplier shall submit promptly to the purchaser at the point of delivery a certificate of test in triplicate showing the results of tests for chemical analysis and properties required by this specification. This certificate shall be addressed to the section, unit or person specified on the purchase order, and shall contain the GE designation, the purchase order number, and the quantity shipped so that the certificate may be identified with the shipment.

PACKING AND MARKING:

All material shall be adequately packed in accordance with the best commercial practice.

Each container shall be legibly marked with the purchase order number, the supplier's name, and the GE designation.

DAC 25-2019 (REV. 9-94) ATTN: SARA

DOUGLAS MATERIAL SPECIFICATION QUALIFIED PRODUCT LIST

MCDONNELL DOUGLAS CORPORATION

DMS QPL 2334
ISSUE NO. 2

PAGE 1 OF 1
DATE: 8-9-89
SUPERSEDES ISSUE NO. 1

GASKET, ELASTOMER AND FIBER, COMPRESSED SHEET

THE PRODUCTS OR SOURCES LISTED BELOW HAVE BEEN QUALIFIED UNDER THE REQUIREMENTS OF THIS DMS. THE LISTING OF A PRODUCT OR SOURCE DOES NOT RELEASE THE MANUFACTURER FROM COMPLIANCE WITH THE SPECIFICATION REQUIREMENTS.

DMS CLASS.	DAC CODE	MANUFACTURER'S DESIGNATION	MANUFACTURER'S NAME & ADDRESS	REMARKS
Type 1	2334-1	Blue-Gard Sty. 3300 F712400A9B4E34K5M9 1/64, 1/32, 3/64, 1/16, 3/32, and 1/8 inch thick in 60x60, 60x120, and 60x180 inch sheets	Garlock Mechanical Packing Div. 1666 Division St. Palmyra, NY 14522	The local Garlock Mechanical Packing Div. is in Huntington Beach, CA (800) 422-4451
Type 2	2334-2	Blue-Gard Sty. 3000 F712100A9B4E22K5M6 1/64, 1/32, 3/64, 1/16, 3/32, and 1/8 inch thick in 60x60, 60x120, and 60x180 inch sheets	Garlock	

Issue No. 2 issued unrevised with Revision "A"

NOTE: Deleted Sealco, Klingersil C-5401. Material no longer meets specification.

Added qualified source and material.

KC:md

DAC 25-1710 (REV. 1-86)

PROCESS ENGINEERING ORDER DOUGLAS AIRCRAFT COMPANY LONG BEACH, CA	SHEET 1 OF 2	DMS 2334	
	DATE 10-18-89	1 COMPLETE REVISION	A
	DATE	2 ADVANCE CHANGE	
TITLE GASKET, ELASTOMER AND FIBER, COMPRESSED SHEET	DATE	3 SERIALIZED CHANGE	
	DATE	4 NEW	
	DATE	5 REISSUE TO REVISE	

HANDLING INSTRUCTIONS (HI):

2. COMPLY AT SPECIFIED EFFECTIVITY.
3. COMPLY WHEN INVOKED BY DRAWING OR OTHER AUTHORITY.
4. COMPLIANCE OPTIONAL; NO ENGRG. REQUIREMENT.
5. NOTED.

RELEASE APPROVALS

PARA.	MODEL	HI. NO.	EFFECTIVITY
All	Coml &	5	Future Procurement
	Mil		

PEO MADE BY:	DER COML - M&P
K. Cutler	
CUSTODIAN COML - M&P	BACK-UP COML - M&P
GOVERNMENT - M&P	GOVERNMENT - IPT

DISTRIBUTION	SPECIALTY MANUAL NUMBERS	PRODUCT CONFIGURATION CONTROL		M&P QCB NO.
[X] STANDARD [ ] LIMITED		[ ] CLASS I	[X] CLASS II	
		CCN FD807EDG	EWO N/A	WRO N/A

ACTION COPIES

NAME	DEPT	M/C	NAME	DEPT	M/C
D. L. Clarke	C1-E32	36-14	L. G. Maduro	C1-E57	76-26

This PEO is authority to release DMS 2334, Revision "A". This revision replaces and includes issue of 9-8-88.

Summary of Changes & Reasons:

Changes are so numerous in this revision that margin bars were not used. Technical changes are as follows:

1. - Changed wording.
   Reason: Clarity.

1.2 - Changed to add Type 2 and delete Class 1 and 2.
   Reason: Added nitrile rubber gaskets and deleted classes as they did not differentiate materials.

2.1 - Changed specification descriptions and deleted MIL-A-7021.
   Reason: MIL-A-7021 no longer referenced in text.

3.3.1.4 & 3.3.1.5 - Changed to add a more complete description of test and to make the requirement more stringent.
   Reason: For clarification and to correlate the requirement with AMS 3232.

3.3.2 - Changed requirements to be more stringent.
   Reason: To correlate with MIL-A-7021 and AMS 3232 asbestos materials, where applicable, this DMS is intended to supersede.

3.3.4 - Changed Type 1 requirements to be more stringent and added Type 2 requirements.
   Reason: To correlate requirements with MIL-A-7021 and AMS 3232.

3.3.7	- Changed to add Type 2. Reason: To include the added Type 2 material.
4.7.1.4. & 4.7.1.5	- Changed to delete class distinction. Reason: Class distinction did not differentiate material.
4.7.3, 4.7.3.1, 4.7.3.2 & 4.7.4.1	- Changed the material fiber direction definition. Reason: To correspond to the definition in AMS 2332, which is superseded by this DMS, and to better define the material.
4.7.4.2	- Changed to delete Class 1 and 2. Reason: Added nitrile rubber gaskets and deleted classes as they did not differentiate materials.
5.2	- Changed to delete class marking. Reason: Class distinction has been deleted.
6.	- Changed to add asbestos material specifications this DMS was intended to supersede. Reason: Identify asbestos materials this DMS is intended to supersede.

KC:ww

DMS 2334
GASKET, ELASTOMER AND FIBER, COMPRESSED SHEET

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

DAC 37-102 (REV. 2-97)

DOUGLAS MATERIAL SPECIFICATION	DMS 2334A
MCDONNELL DOUGLAS CORPORATION	ISSUE OF 10-18-89 REPLACES REVISION "NEW" PAGE 1 OF 8

GASKET, ELASTOMER AND FIBER, COMPRESSED SHEET

1. SCOPE

1.1 Scope - This specification states the minimum requirements for a compressed sheet material composed of an elastomer and high temperature resistant fibers.

1.2 Classification - The material shall be furnished in the following types:

Type 1 - Polychloroprene (Neoprene) Elastomer

Type 2 - Nitrile Elastomer

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards (and subsidiaries thereof), drawings, and publications of issue in effect on date of invitation for bid, form a part of this specification to the extent specified herein.

STANDARDS

Federal

Federal Test Method Standard No. 601	Flat Foot Micrometer Thickness
Federal Test Method Standard No. 601	Rubber: Sampling and Testing

Douglas Process Standard

DPS 3.301	Supplier Packaging
DPS 8.86	Sandwich Corrosion Test

OTHER PUBLICATIONS

American Society for Testing and Materials

ASTM F 36	Compressibility and Recovery of Gasket Materials
ASTM F 152	Tension Testing of Nonmetallic Gasket Materials

3. REQUIREMENTS

3.1 Preproduction Approval - The material furnished under this specification shall be a product that has been tested and has passed the preproduction tests specified herein. After preproduction approval, the properties, and methods of manufacture shall not be changed without written approval from the procuring activity.

3.2 Preproduction Sample - The supplier shall provide sufficient material to perform all preproduction tests specified herein.

3.3 Physical and Mechanical Properties

3.3.1 Size

3.3.1.1 Width - Unless otherwise specified, the material shall be supplied within ± 0.25 inch of the width specified in the purchase contract, when measured per paragraph 4.7.1.1.

3.3.1.2 Length - The length specified on the purchase order shall be the minimum length furnished when measured per paragraph 4.7.1.2.

3.3.1.3 As Received Thickness - Unless otherwise specified on the purchase order, the material shall be manufactured to the following thickness tolerances when measured per paragraph 4.7.1.3:

	Tolerance (Inches)	
Nominal Thickness (Inches)	Plus	Minus
1/64 and less	0.005	0.003
Over 1/64 and less than 1/16	0.005	0.005
1/16 and over	0.008	0.008

3.3.1.4 Thickness After Immersion In Aromatic Fuel - The Type 1 and Type 2 specimens shall not swell more than 10 percent temporarily and shrink more than five percent of the original thickness permanently when tested per paragraph 4.7.1.4.

3.3.1.5 Thickness After Immersion In Distilled Water - The Type 1 and Type 2 specimens shall not swell more than 10 percent when tested per paragraph 4.7.1.5.

3.3.2 Compressibility

3.3.2.1 Compressibility As Received - When tested per paragraph 4.7.2.1 the Type 1 and Type 2 specimens, as received, shall compress from five to 20 percent.

3.3.2.2 Compressibility After Fluid Immersion - When tested per paragraph 4.7.2.2, the Type 1 specimens shall not compress more than 25 percent in aromatic fuel and shall not rupture, and shall not compress more than 25 percent in distilled water. The Type 2 specimens shall not compress more than 25 percent in aromatic fuel and more than 25 percent in distilled water.

3.3.3 Flexibility - The material shall not crack when tested per paragraph 4.7.3.

3.3.4 Tensile Strength - The material shall meet the following pounds per square inch minimum when tested per paragraph 4.7.4:

	Type 1	Type 2
As Received:		
Parallel to Direction of Rolling	4000	3000
Perpendicular to Direction of Rolling	2000	1000
After Immersion In:		
Water-Alcohol	1000	600
MIL-H-5606	1100	700
Petroleum-Base Oil	1600	1000
Jet A Fuel	1100	800
Distilled Water	900	700

3.3.5 Corrosion - The material shall achieve a zero rating indicating no visible corrosion when tested per paragraph 4.7.5.

3.3.6 Shelf Life - The shelf life of this material shall be unlimited under normal storage.

3.3.7 Construction - The Type 1 gaskets shall be constructed of nonasbestos high temperature resistant fibers and polychloroprene (neoprene) rubber. The Type 2 gaskets shall be constructed of nonasbestos high temperature resistant fibers and nitrile rubber.

3.3.8 Workmanship - The product shall be uniform in quality and condition, clean, and free from foreign materials and from internal and external imperfections detrimental to fabrication, appearance, or performance of parts.

4. QUALITY ASSURANCE PROVISIONS

4.1 Supplier Responsibilities - The supplier is responsible for the performance of all test and inspection requirements as specified herein. The supplier may use his own or any other test facility acceptable to the procuring activity. Test records shall be retained for a minimum of one year and shall be made available to the procuring activity. The procuring activity reserves the right to perform any of the tests or inspections to confirm that the product complies with the specification requirements. Procuring activity is defined as the Douglas Aircraft Company or any subcontractor purchasing the product for use as a Douglas end item.

4.2 Lot - For the purpose of sampling, inspection, and tests, a lot shall consist of all the materials processed at one time to produce the finished product.

4.3 Sampling - A representative sample shall be taken from each lot. The sample unit shall consist of a minimum four square foot section of material cut from a sheet or roll. The sample shall not be taken within three inches of any edge.

4.4 Classification of Tests - Tests shall be classified per paragraphs 4.4.1 and 4.4.2.

4.4.1 Preproduction - Preproduction tests are those tests required to enable the procuring activity to determine that the product meets all DMS requirements and is acceptable for addition to the DMS Qualified Products List. These requirements and tests consist of all those listed in the Table to paragraph 4.4.2.

4.4.2 Production - Production tests are those tests that shall be conducted by the manufacturer to assure conformity to the requirements of this specification and enable the manufacturer to certify the quality of his product to the procuring activity. Preproduction and production requirements and tests are listed in the following Table:

TEST	REQUIREMENT PARAGRAPH	PREPRODUCTION TEST PARAGRAPH	PRODUCTION TEST PARAGRAPH
Size	3.3.1	4.7.1	4.7.1
Compressibility	3.3.2	4.7.2	-
Flexibility	3.3.3	4.7.3	-
Tensile As Received	3.3.4	4.7.4.1	4.7.4.1
Tensile After Fluid Immersion	3.3.4	4.7.4.2	-
Corrosion	3.5.5	4.7.5	-

4.5 Specimen Conditioning - "As received" test specimens for compressibility and recovery (paragraph 4.7.2.1), bending (paragraph 4.7.3.1), and tensile strength (paragraph 4.7.4.1) shall be cut from material which has been conditioned in a circulating air oven for 60 minutes at 212°F (100°C), then cooled and stored in a desiccator. Each specimen shall be stored in a desiccator until immediately before test.

4.6 Immersion Fluids - Unless otherwise specified, all immersion fluids shall be a minimum of 12 times the volume of the test specimen and shall completely cover the test specimen. Table 1 identifies the immersion fluids and exposure conditions for testing.

TABLE 1
IMMERSION FLUID

FLUID	SPECIFICATION OR TEST MEDIUM	TEST CONDITIONS		
		TEMPERATURE ± 5°F (±3°C)		EXPOSURE HOURS ± 10 MIN.
Water-Alcohol	50% Distilled Water 50% O-M-232 Grade A Methanol By Weight	151	(66)	22
Hydraulic Fluid	MIL-H-5606 Red Oil	300	(149)	5
Petroleum-Base Oil	ASTM D 471 Oil #1	300	(149)	5
Jet A Fuel	DMS 1877	73	(23)	22
Distilled Water	FTMS 601, Method 6001	212	(100)	70

4.7 Test Methods and Procedures

4.7.1 Size

4.7.1.1 Width - The width shall be measured by visually aligning the material along a suitable scale capable of measuring to 0.25 inch.

4.7.1.2 Length - The length shall be measured by visually aligning the material along a suitable scale capable of measuring to 0.25 inch.

4.7.1.3 As Received Thickness - The thickness of the specimen shall be determined in accordance with Method 2011 of Federal Test Method Standard Number 601, except that a total force of 10 ± 0.1 ounces shall be exerted by the dial micrometer on the specimen.

4.7.1.4 Thickness After Immersion In Aromatic Fuel - The specimens shall be immersed in Jet A fuel. Temperature and exposure time shall be as specified in Table 1. Immediately after exposure, the temporary change in thickness shall be determined in accordance with Method 6231 of Federal Test Method Standard Number 601. The same specimens shall then be conditioned 22 hours at room temperature before determining the permanent change in thickness using the same method.

4.7.1.5 Thickness After Immersion In Distilled Water - The specimens shall be immersed in distilled water. Temperature and exposure time shall be as specified in Table 1. Immediately after exposure, temporary change in thickness shall be determined as specified in paragraph 4.7.1.3.

4.7.2 Compressibility and Recovery

4.7.2.1 Compressibility As Received - Compressibility and recovery shall be determined in accordance with paragraph 4.7.2.3 (ASTM F 36 is an acceptable alternative).

4.7.2.2 Compressibility After Fluid Immersion - Compressibility after fluid immersion shall be determined on specimens prepared specifically for this test after immersion in jet A fuel. Temperature and exposure time shall be as specified in Table 1. The specimens shall be blotted lightly with filter paper and tested within 15 seconds after removal from the fluid. The test method shall be per paragraph 4.7.2.3 (ASTM F 36 is an acceptable alternative).

4.7.2.3 Method for Determining Compressibility and Recovery - Specimens for the following procedure shall be punched with a one inch diameter circular die.

4.7.2.3.1 Measure and record the original thickness to 1.0 mil prior to the application of a load.

4.7.2.3.2 Place the sample in the testing machine operating with a constant rate of crosshead movement and apply the penetrator so that a minimum load registers on the graph. The penetrator area shall be determined as specified in ASTM F 36.

4.7.2.3.3 Set the dial indicator to read zero after performing step 4.7.2.3.2.

4.7.2.3.4 Apply a preload of 5.0 pounds for 15 seconds and record the indicator reading to 1.0 mil.

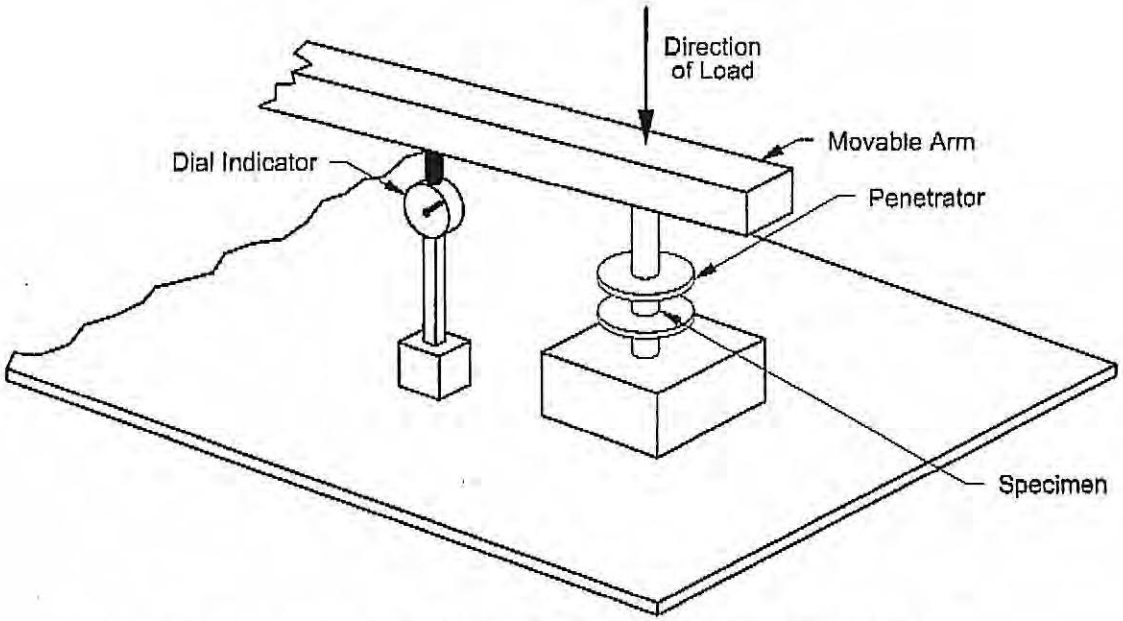
4.7.2.3.5 Immediately apply the load in a slow uniform manner so the total load (sum of load and preload) of 250 pounds is attained within 10 seconds. Maintain the total load for a period of 60 to 65 seconds and record the indicator reading to 1.0 mil.

4.7.2.3.6 Immediately remove the total load and after 60 seconds, reapply the original preload and record the indicator reading to 1.0 mil.

4.7.2.3.7 The difference between the original thickness and the indicator readings in the steps indicated in paragraphs 4.7.2.3.4, 4.7.2.3.5, and 4.7.2.3.6 is the thickness of the sample under the preload (P), load (L), and recovery (R) measurements, respectively.

$$\text{Compressibility (percent)} = [(P - L) / P] \times 100$$

$$\text{Recovery (percent)} = [(R - L) / (P - L)] \times 100$$



COMPRESSIBILITY AND RECOVERY TEST APPARATUS
FIGURE 1

4.7.3 Flexibility - Twelve 1 x 6 inch specimens, six cut parallel to the direction of rolling and six perpendicular to the direction of rolling shall be prepared and tested as specified below:

4.7.3.1 Flexibility As Received - Three specimens parallel to the direction of rolling and three perpendicular to the direction of rolling shall be conditioned as specified in paragraph 4.5, then subjected to a 180 degree bend around a mandrel whose diameter is equal to 12 times the nominal thickness of the material.

4.7.3.2 Flexibility After Oven Aging - Three specimens parallel to the direction of rolling and three perpendicular to the direction of rolling shall be conditioned in an air circulating oven for 70 ± 0.2 hours at 212°F (100°C). After conditioning, the specimens shall be cooled for 30 minutes in a desiccator, then subjected to a 180 degree bend around a mandrel whose diameter is equal to 16 times the nominal thickness of the material.

4.7.4 Tensile Strength - The tensile strength shall be determined in accordance with ASTM F 152 using Die "A" and a jaw speed of 12 inches per minute.

4.7.4.1 As Received - Three specimens shall be cut parallel to the direction of rolling and three perpendicular to the direction of rolling. The weaker grain direction specimen shall be determined by test and reported as the average of three specimens.

4.7.4.2 After Fluid Immersion - Cut twelve weaker grain direction specimens. The cross sectional areas used to calculate tensile strength shall be determined from the specimens prior to immersion. Immerse three specimens in distilled water and three in each of the remaining fluids of Table 1. Exposure times and temperatures shall be as specified in Table 1. Upon completion of these exposures, the specimens shall be transferred to fresh fluids at room temperature for 30 minutes. The specimens shall then be individually removed from the fluids, blotted lightly with filter paper, and tested within three minutes of removal from the fluid.

NOTE: The oil immersed specimens may be wiped with a clean dry cloth, dampened with acetone and blotted before test.

CAUTION: Acetone is flammable and toxic.

4.7.5 Corrosion - Corrosion properties shall be determined in accordance with DPS 8.86, Sandwich Corrosion Test.

4.8 Inspection of Product - The supplier shall conduct inspections to determine conformance of the product to the requirements of paragraphs 3.3.1 and 3.3.8.

4.9 Inspection of Packaging - The supplier shall make such inspections as are necessary to ensure the requirements for preservation, packaging, and package marking are met.

4.10 Reports - The supplier shall furnish with each shipment a report stating the quantitative results of production tests and inspections performed on each lot submitted. CERTIFICATES OF CONFORMANCE ARE NOT ACCEPTABLE. The report shall identify the tests to the lot and to the corresponding purchase order or contract.

5. PREPARATION FOR DELIVERY

5.1 Preservation and Packaging - Packaging shall be accomplished in such a manner as to ensure that the product, during shipment and storage, will not be damaged or distorted and will be protected against damage from exposure to weather or any normal hazard. Product packaging and package identification shall be in accordance with DPS 3.301.

5.2 Marking - Each exterior package and the shipping container shall be permanently and legibly marked with the following information:

GASKET, ELASTOMER AND FIBER, COMPRESSED SHEET
DMS 2334 (Current Revision Letter) _____

TYPE _____

PURCHASE ORDER NUMBER _____

MANUFACTURER'S IDENTIFICATION _____

LOT NUMBER _____

6. NOTES

6.1 Intended Use - The material covered by this specification is primarily intended to be used as a replacement for compressed asbestos and synthetic rubber material used as gaskets to seal between metal surfaces, in contact with fuels; lubricants, coolant, or water at temperatures up to 300°F (150°C) and is not recommended in areas exposed to phosphate-ester based hydraulic fluid. Where applicable, this specification is also intended to supersede:

1. MIL-A-7021 Asbestos-Rubber Compressed Sheet, for Fuel, Lubricant, Coolant, Water, and Temperature Resistant Gaskets.
2. MIL-G-7021 Gaskets and Sheet; Fuel, Lubricant, Coolant, and Temperature Resistant.
3. AN-G-171 (Air force-Navy Aeronautical Specification) Gaskets and Sheet; Fuel, Lubricant, Coolant, and Temperature Resistant.
4. AMS 3232 (Aerospace Material Specification) Asbestos and Synthetic Rubber Sheet, Hot Oil Resistant.
5. DMS 1626 Gasket Material, Asbestos-Neoprene.
6. DMS 1627 Gasket Material, Asbestos-Nitrile.

6.2 Ordering Data - Procurement of the product shall be per the current issue of this DMS 2334 Qualified Products List (QPL). Invitations to bid, contracts, or order shall include the following:

Title, Number and Revision Letter of this DMS
Type to be Supplied
Size
Preproduction Approval and Sample Requirements
(See paragraphs 3.1 and 3.2)

KC:ww

Exhibit E

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
WASHINGTON, D.C. 20362

IN REPLY REFER TO
05M3/RLD
Ser 91

MAY 25 1983

RECEIVED

Garlock, Inc.
Mechanical Packing Division
1666 Division Street
Palmyra, New York 14522

Attn: Mr. James Hurley

Dear Mr. Hurley:

This letter is in response to your letter of April 20, 1983, concerning the use of non-asbestos substitute materials. Naval Sea Systems Command (NAVSEA) has been conducting an asbestos substitution program for several years to eliminate the use of asbestos in all NAVSEA applications. Priorities were established early in this program with substitutes for asbestos insulation given first consideration. NAVSEA has authorized non-asbestos materials for all insulation applications and has been using non-asbestos insulation for all overhauls, repairs and new construction for several years.

The final major area in the asbestos substitution program that remains is the area of compression packings and gaskets. Some non-asbestos gasket materials have already been authorized to replace asbestos in NAVSEA applications, such as Garlock's Blue Gylon gasket material for divers air compressors. Testing is currently in progress to establish performance requirements for non-asbestos sheet gasket material which can ultimately replace compressed asbestos gaskets. Garlock products are included in this testing.

Much testing remains to be done, however, in the field of packings and gaskets. NAVSEA has been seeking alternative methods to accomplish this testing and greatly appreciates Garlock's willingness to provide assistance. In this regard, what kind of testing would Garlock be willing to do, would Garlock be willing to allow this testing to be witnessed by outside services and be willing to test other manufacturer's products in order to help develop meaningful test criteria so new specifications can be written?

The task of replacing all asbestos packings and gaskets is replete with problems and certainly cannot be accomplished overnight. Many of these packings and gaskets are used in systems which operate at extremely high temperatures and pressures, and NAVSEA must ensure that the safety of all Navy personnel is maintained. Within those constraints, it is still the intent of NAVSEA to introduce non-asbestos substitute materials into Fleet use as soon as possible. NAVSEA appreciates Garlock's interest in this matter and the offer to extend assistance.

Peter G. Gauthier

PETER G. GAUTHIER
Head, Non-Metallic Materials &
Packaging Branch
By Direction of the Commander,
Naval Sea Systems Command

Exhibit F

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
2531 JEFFERSON DAVIS HWY
ARLINGTON VA 22242-5160

IN REPLY REFER TO

4123
OPR:03Q223
Ser 03Q2/510
JUL 2

Garlock, Inc.
Mechanical Packing Division
Attn: Mr. Roy L. Whittaker
1666 Division Street
Palmyra, NY 14522-9355

Dear Mr. Whittaker:

We are in receipt of a satisfactory test report via the Defense Contract Management Area Operations (DCMAO), Syracuse for your "Blue-Gard^{R} 3200" gasket dated 7 April 1993.

We also received a toxicological assessment of your product from the Navy Environmental Health Center (NEHC), enclosure (1). Based on NEHC's assessment, your product can be safely used for the intended purpose, provided the measures pointed out in enclosure (1) are taken.

Based on the above, your "Blue-Gard^{R} 3200" gasket indicates conformance with the requirements of Military Specification MIL-G-24696A. Therefore, your "Blue-Gard^{R} 3200" manufactured at your Palymra, New York plant is hereby granted qualification approval subject to the conditions printed on the reverse side of this page. Your product will appear on QPL-24696 as follows:

GOVERNMENT DESIGNATION	MANUFACTURER'S DESIGNATION	TEST OR QUALIFICATION REFERENCE	MANUFACTURER'S NAME AND ADDRESS
	Blue-Gard^{R} 3200	Garlock, Inc. Test Rpt. TR-1589-3200 dtd 9 Feb 93	Garlock Inc. Mechanical Packing Division 1666 Division St. Palmyra, NY 14522-9355 Plant: same address

Subj: APPROVAL OF GARLOCK'S "BLUE-GARD^{R} 3200" - QPL-24696

NAVSEA's point of contact regarding QPL-24696 is Ms. Adrianne Alexander, (703) 746-3597.

Sincerely,

CHERYL A. TURNER
Branch Head
Vendor and Product
Qualification Branch

Encl:
(1) Toxicological Assessment
via NEHC

Copy to:
DCMAO, Syracuse
NEHC
MEDCOM 242
NMQAO-3 (S. Dewitt)
DISC-L

Exhibit G

James Heffron

Testimony List (Jan. 2009-Feb. 2013)

CAPTION	COURT	STATE	DATE	CIVIL ACTION NO.
Moeller	District Court, Western District	KY	2/9/2009	3:07CV-65-H
Phillips	District Court, Harris County	TX	2/17/2009	2008-41366
Flynt	Circuit Court, Volusia County	FL	4/24/2009	2007-32098
Bick	Circuit Court, Madison County	IL	5/6/2009	08 L 865
Creek	Circuit Court, Hillsborough Co.	FL	5/27/2009	07-CA-011285
Cochran	Circuit Court, Madison County	IL	8/5/2009	08-L-1118
Ang	Circuit Court, Jefferson County	KY	9/30/2009	08-CI-10986
Strebler	Common Pleas, Summit County	OH	12/2/2009	AC 2008 04 3264
Torres	District Court, Cameron County	TX	1/21/2010	2009-06-00374
Savarese	Superior Court, Middlesex County	NJ	2/3/2010	L-4527-09
In re Garlock Sealing Technologies, LLC.	US Bankruptcy Court, WD North Carol	NC	11/13/2012	10-31607
In re Garlock Sealing Technologies, LLC	US Bankruptcy Court, WD North Carol	NC	1/24/2013	10-31607