

# METAL EXPANSION JOINTS

## A LONG LEGACY OF PRECISION PRODUCTS

Precision Hose & Expansion Joints is one of a very few American companies that manufacture a complete line of metal hose, wire braid, round metal expansion joints, metallic flue duct expansion joints, non-metallic flue duct expansion joints and rubber pressure piping expansion joints. With over 65 years of being in the metal hose and expansion joint business-dating back to the early 1950's-the owners of Precision Hose & Expansion Joints have over 130 years combined experience in this industry.

Our 105,000 square foot manufacturing facility is located on 6 acres in Stone Mountain, Georgia. The plant was designed totally for the state of the art manufacturing of metal hose and expansion joints. We would certainly welcome you to visit our company on your next visit to the Atlanta area.

Quality, service and fair pricing is the basis on how we operate our business.



# METAL EXPANSION JOINTS

#### **QUALITY ASSURANCE**

Precision Hose & Expansion Joints manufactures to the highest quality standards in the industry. All expansion joints and bellows are 100% tested either by hydro, pneumatic, liquid penetrant, or mass spectrometer. We can offer additional tests, if required, such as cycle life, burst test, ultrasonic, chemical analysis, radiography, shock and vibration, and charpy impact testing. Precision Hose & Expansion Joints continually strives for better products and to improve the efficiency of our service without compromising standards. These product and quality improvements are from the standard catalog item to the more complicated aerospace product lines. Precision Hose & Expansion Joints designs all expansion joints and bellows to EJMA, ASME B31.1, ASME B31.3 and ASME section 8.

## Our expansion joints are manufactured to the highest quality standards in the industry.

#### SIZE RANGES AVAILABLE

The metallic bellows products are available from 2-1/2" diameter through 100" diameter and available as single ply and multi-ply bellows. The single ply bellows are offered from a thickness of .008" to .125" and the multi-ply bellows are available up to a thickness of .160" combined wall thickness.

#### MATERIALS AVAILABLE

The standard material for bellows is type 321 stainless steel, but there are many other alloys available. Stainless steel is available in types 304L, 310, 316, and 316L. The nickel alloys available are 400, 600, 625, 800. Please contact the factory for other types of alloys available.

#### DELIVERY

Normal delivery for standard bellows and expansion joints is three to five days—depending on the size, quantity and type of alloy. Please contact the factory for delivery information on exotic alloys and/or high quantity orders.



### **Types of Expansion Joints**



#### SINGLE UNRESTRAINED

This expansion joint is the simplest one available and comes with one bellows section and end connections. This type of expansion joint requires the most control of the adjacent piping in regards to anchors and guiding.

### UNIVERSAL EXPANSION JOINT

This expansion joint has two bellows sections connected by a center pipe section. This design allows for large amounts of lateral deflection. The universal can also allow for axial and angular movements in addition to the lateral movement. This expansion joint does not come with the hardware to resist pressure thrust. Like the single unrestrained expansion joint the universal expansion joint must be properly anchored and supported.



#### SINGLE TIED EXPANSION JOINT

This expansion joint is exactly like the single unrestrained expansion joint but it is provided with tie rods. When adding tie rods to the expansion joint it stops the bellows from overextending. The tie rods act as limit rods and has stops set to allow axial movement to a specifically designed movement.



#### TIED UNIVERSAL EXPANSION JOINT

This expansion joint is exactly like the universal expansion joint but tie rods have been designed into the unit. By adding the tie rods you restrain pressure thrust. The pressure balance expansion joint will not accept external axial movement without overcoming this pressure thrust force.





#### PRESSURE BALANCED ELBOW EXPANSION JOINT

This expansion joint is designed to not only restrain the pressure thrust but in addition balances the pressure thrust so as not to have anchoring of the adjacent piping or equipment. This pressure balanced elbow expansion joint can be designed as single or universal depending on how much lateral movement is required.



#### **GIMBAL EXPANSION JOINT**

This expansion joint has a single bellows section. The gimbal expansion joint is designed to allow angular rotation in any plane by using two pairs of hinges connected to a common central floating ring. The gimbal expansion joint is usually used in pairs of two or in combination with the hinged expansion joint.



#### HINGED EXPANSION JOINT

This expansion joint has a single bellows section and is designed to allow angular rotation in one plane only. The hinge hardware is rigid in the axial direction so as not to allow the expansion joint to allow axial movement in piping systems. The hinged expansion joint is usually used in pairs of two or in combination with a gimbal expansion joint.



#### **IN-LINE PRESSURE BALANCED EXPANSION JOINT**

This expansion joint is unusual in its' design in that it absorbs lateral, axial, and angular movement. This in-line pressure balanced expansion joint is designed for cases when anchoring to the piping system is not feasible or pressure loads are too high for equipment like pumps and turbines.

### Definitions

#### Bellows

The flexible element of an Expansion Joint consisting of one or more convolutions.

#### **Control Rods**

Devices, usually in the form of rods or bars, attached to the Expansion Joint assembly whose primary function is to distribute the movement between the two bellows of a universal Expansion Joint. Control rods are not designed to restrain bellows pressure thrust.

#### Cover

A device used to provide limited protection of the exterior surface of the bellows of an expansion joint from foreign objects or mechanical damage. A cover is sometimes referred to as a shroud.

#### Convolution

The smallest flexible unit of a bellows. The total movement capacity of a bellows is proportional to the number of convolutions.

#### **Equalizing and Reinforcing Rings**

Devices used on some expansion joints fitting snugly in the roots of the convolutions. The primary purpose of these devices is to reinforce the bellows against internal pressure. Equalizing rings are made of cast iron, steel, stainless steel or other suitable alloys and are approximately "T" shaped in cross section. Reinforcing or root rings are fabricated from tubing or solid round bars of carbon steel, stainless steel or other suitable alloys.

#### **Flanged Ends**

The ends of an expansion joint equipped with flanges for the purpose of bolting the expansion joint to the mating flanges of adjacent equipment or piping.

#### **Internal Sleeve**

A device which minimizes contact between the inner surface of the bellows of an expansion joint and the fluid flowing through it. These devices have also been referred to as liners or baffles.

#### **Limit Rods**

Devices, usually in the form of rods or bars, attached to the expansion joint assembly whose primary function is to restrict the bellows movement range (axial, lateral and angular) during normal operation. In the event of a main anchor failure, they are designed to prevent bellows overextension or over-compression while restraining the full pressure loading and dynamic forces generated by the anchor failure.

#### **Purge Connections**

Purge connections, where required, are usually installed at the sealed end of each internal sleeve of an expansion joint for the purpose of injecting a liquid or gas between the bellows and the internal sleeve to keep the area clear of erosive and corrosive media and/or solids that could pack the convolutions. Purging may be continuous, intermittent or just on start-up or shut down, as required. These are sometimes called aeration connections.

#### **Shipping Devices**

Rigid support devices installed on an expansion joint to maintain the overall length of the assembly for shipment. These devices may also be used to precompress, preextend or laterally offset the bellows. They should not be used to resist pressure thrust during testing.

#### **Slotted Hinges**

Devices installed as diametrically opposed pairs on an Expansion Joint permitting axial and one plane angular movement. Slotted hinges can be designed to perform as control devices, distributing movements between two bellows of a universal Expansion Joint but do not restrain pressure thrust. They may also be designed as limiting devices, restricting the bellows movement range and can restrain the full pressure loading and dynamic forces generated by an anchor failure. These devices can be used to transmit extraneous loads and forces, such as system dead weight, wind and seismic loads transverse to the Expansion Joint axis, rather than across the flexible bellows element.

#### Stabilizer

A device, internally or externally attached to the Expansion Joint assembly, whose primary function is to increase the stability of a universal Expansion Joint assembly.

#### Tangents

The straight un-convoluted portions at the end of the bellows.

#### **Tangent Reinforcement**

A reinforcing member located around the circumference of the bellows tangent for the purpose of reducing excessive pressure stresses which could lead to circumferential yielding.

#### **Tie Rods**

Devices, usually in the form of rods, or bars, attached to the expansion joint assembly whose primary function is to continuously restrain the full bellows pressure thrust during normal operation while permitting only lateral deflection. Angular rotation can be accommodated only if two tie rods are use and located 90° opposed to the direction of rotation.

#### Weld Ends

The ends of an expansion joint equipped with pipe suitably beveled for welding to adjacent equipment or piping.





















### Temperature Correction Factors for Elevated Temperature Applications

As the service temperature increases, the maximum pressure a hose assembly can withstand decreases. The material from which the hose is made and the method of fitting attachment (mechanical, soldered, welded, silver brazed) determines the maximum pressure at which an assembly can be used.

Multiply the listed correction factor times the hoses room temperature rating to determine elevated temperature maximum working pressure.

	Material						
Temperature °F	BRONZE	STEEL	MONEL	STAINLESS STEEL			
Room Temperature	1.0	1.0	1.0	1.0			
150	0.92	0.99	0.98	0.97			
200	0.89	0.97	0.94	0.94			
250	0.86	0.96	0.92	0.92			
300	0.83	0.93	0.90	0.88			
350	0.81	0.91	0.89	0.86			
400	0.78	0.87	0.88	0.83			
450	0.75	0.86	0.87	0.81			
500		0.81	0.86	0.78			
600		0.74	0.84	0.74			
700		0.66	0.82	0.70			
800		0.52	0.75	0.66			
900		0.50	0.70	0.62			
1000			0.65	0.60			
1100				0.58			
1200				0.55			
1300				0.50			
1400				0.44			
1500				0.40			

#### **TEMPERATURE CORRECTION FACTORS**

	Saturated Steam	Temperature °F	Saturated Steam	Temperature °F		Saturated Steam	Temperature °F	Saturated Steam	Temperature °F
		0	15	250		90	331	300	422
		20	20	259		95	335	350	436
	29.74	32	25	267		10	338	400	448
	29.67	40	30	274		102	341	450	460
	29.40	60	35	281		110	344	500	470
u HG	28.89	80	40	287		115	347	600	489
	27.99	100	45	292		120	350	700	505
n	26.48	120	50	298		125	353	800	520
วา	24.04	140	55	303		130	356	900	520
Va	20.27	160	60	307		150	366	1000	546
	14.63	180	65	312		175	377	1250	574
	6.46	200	70	316		200	388	1500	606
	0	212	75	320		225	397	2500	669
	5	227	80	324	324	250	406	3000	696
	10	238	85	328		275	414	3191	705

### SATURATED STEAM PRESSURE TEMPERATURE



#### THERMAL EXPANSION DATA

Linear thermal expansion between 70° f and indicated temperature, inches/100 feet

							Mate	erials							
Temp. °F	Carbon Steel Carbon-Moly Low-Chrome (thru 3 Cr Mo)	Austenitic Stainless Steels 18Cr 8 Ni	5 Cr Mo thru 9 Cr Mo	12 Cr 17Cr 27 Cr	310SS 25 Cr 20 Ni	Monel (400) 67 Ni 30 Cr	3-1/2 Nickel	Nickel 200	Alloy 800, 825	Alloy 600, 625, 691	Copper	Brass	70 Cu 30 Ni	Aluminum	Wrought Iron
-325	-2.37	-3.85	-2.22	-2.04	-3.00	-2.62	-2.22	_	-	-	-	-3.88	-3.15	-4.68	-2.70
-300	-2.24	-3.63	-2.10	-1.92	-2.83	-2.50	-2.10	-2.44	_	_	_	-3.64	-2.87	-4.46	-2.55
-250	-1.98	-3.19	-1.86	-1.68	-2.49	-2.26	-1.86	-2.25	-	-2.30	-	-3.16	-2.53	-3.97	-2.25
-225	-1.85	-2.96	-1.74	-1.57	-2.32	-2.14	-1.74	-2.13	_	-2.17	_	-2.93	-2.36	-3.71	-2.10
-200	-1.58	-2.73	-1.52	-1.40	-2.15	-1.90	-2.01	-2.01	_	-2.04	_	-2.47	-2.19	-3.44	-1.95
-150	-1.45	-2.27	-1.37	-1.24	-1.81	-1.79	-1.38	-1.65	-	-1.7	-	-2.24	-1.95	-2.88	-1.67
-125	-1.30 -1.15	-2.01 -1 75	-1.23	-1.11	-1.60 -1.39	-1.59 -1.38	-1.23	-1.47 -1 29	_	-1.54 -1.37	-1.83	-2.00 -1.76	-1.74 -1.53	-2.57	-1.49 -1.31
-75	-1.00	-1.50	-0.94	-0.85	-1.18	-1.18	-0.93	-1.11	_	-1.17	-1.57	-1.52	-1.33	-1.97	-1.13
-50	-0.84	-1.24	-0.79	-0.72	-0.98	-0.98	-0.78	-0.93	-	-0.97	-1.31	-1.29	-1.13	-1.67	-0.96
-25	-0.68	-0.98	-0.63	-0.57	-0.78	-0.77	-0.62	-0.75	_	-0.76	-1.05	-1.02	-0.89	-1.32	-0.76
25	-0.321	-0.46	-0.30	-0.27	-0.37	-0.37	-0.30	-0.36	-	-0.36	-0.51	-0.48	-0.42	-0.63	-0.36
50	-0.14	-0.21	-0.13	-0.12	-0.16	-0.20	-0.14	-0.16	-	-0.16	-0.22	-0.21	-0.19	-0.28	-0.16
100	0.23	0.34	0.22	0.20	0.32	0.28	0.22	0.25	0.28	0.26	0.34	0.35	0.31	0.46	0.26
125	0.42	0.62	0.40	0.36	0.58	0.52	0.40	0.47	0.52	0.48	0.62	0.64	0.56	0.85	0.48
150	0.61	0.90	0.58	0.53	0.84	0.75	0.58	0.69	0.76	0.70	0.90	0.94	0.82	1.23	0.70
200	0.99	1.46	0.94	0.86	1.37	1.22	0.94	1.15	1.23	1.15	1.48	1.52	1.33	2.00	1.14
225	1.21	1.75	1.13	1.03	1.64	1.46	1.13	1.38	1.49	1.38	1.77	1.83	1.59	2.41	1.37
250	1.40	2.03	1.33	1.21	2.18	1./1	1.32	1.61	1.76	1.61	2.05	2.14	2.13	2.83	1.60
300	1.82	2.61	1.71	1.56	2.45	2.21	1.69	2.08	2.30	2.09	2.62	2.76	2.40	3.67	2.06
325	2.04	2.90	1.90	1.74	2.72	2.44	1.88	2.32	2.59	2.32	2.91	3.08	2.68	4.09	2.29
375	2.48	3.50	2.10	2.11	3.26	2.00	2.00	2.80	3.18	2.50	3.48	3.41	3.24	4.95	2.55
400	2.70	3.80	2.50	2.30	3.53	3.25	2.47	3.05	3.48	3.05	3.88	4.05	3.52	5.39	3.01
425 450	2.93 3.16	4.10 4.41	2.72	2.50	3.80 4.07	3.52	2.69 2.91	3.30 3.55	3.76 4.04	3.29	4.17 4.47	4.38 4.72	_	5.83 6.28	3.25
475	3.39	4.71	3.14	2.89	4.34	4.06	3.13	3.80	4.31	3.78	4.76	5.06	-	6.72	3.74
500	3.62	5.01	3.35	3.08	4.61	4.33	3.34	4.05	4.59	4.02	5.06	5.40	-	7.17	3.99
525	4.11	5.62	3.80	3.49	4.00 5.15	4.90	3.80	4.56	5.16	4.27	5.64	6.10	_	8.10	4.25
575	4.35	5.93	4.02	3.69	5.42	5.18	4.03	4.83	5.44	4.77	-	6.45	-	8.56	4.76
600 625	4.60	6.24 6.55	4.24	3.90	5.69	5.46 5.75	4.27	5.09	5.72 6.01	5.02 5.27	_	6.80 7 16	_	9.03	5.01 5.27
650	5.11	6.87	4.69	4.31	6.23	6.05	4.75	5.62	6.30	5.53	-	7.53	-	-	5.53
675	5.37	7.18	4.92	4.52	6.50	6.34	4.99	5.89	6.58	5.79	-	7.89	-	-	5.80
700	5.90	7.82	5.38	4.73	7.04	6.94	5.24	6.44	7.17	6.31	_	8.64	_	_	6.32
750	6.16	8.15	5.62	5.16	7.31	7.25	5.76	6.71	7.47	6.57	-	9.02	-	-	6.59
800	6.43 6.70	8.47 8.80	5.86 6.10	5.38	7.58	7.55 7.85	6.02 6.27	6.99 7.27	7.76	6.84 7.10	_	9.40 9.78	_	_	6.85 7.12
825	6.97	9.13	6.34	5.82	8.15	8.16	6.54	7.54	8.35	7.38	-	10.17	-	-	7.40
850	7.25	9.46	6.59	6.05	8.45	8.48	6.81	7.82	8.66	7.67	-	10.57	-	-	7.69
900	7.81	10.12	7.07	6.49	9.05	9.12	7.08	8.37	9.26	8.23	_	11.35	_	_	8.26
925	8.08	10.46	7.31	6.71	9.35	9.44	7.72	8.64	9.56	8.52	-	11.75	-	-	8.53
950 975	8.35	10.80	7.56	6.94 7 17	9.65	9.77	8.09 8.46	8.92 9.20	9.87 10.18	8.80 9.09	_	12.16	-	-	8.81 9.08
1000	8.89	11.48	8.06	7.40	10.25	10.42	8.83	9.49	10.49	9.37	-	12.98	-	-	9.36
1025	9.17	11.82	8.30	7.62	10.55	10.75	8.98	9.77	10.80	9.66	-	13.39	-	-	-
1050	9.46	12.10	8.80	8.18	11.15	11.43	9.14	10.05	11.42	10.23	-	14.23	-	-	-
1100	10.04	12.84	9.05	8.31	11.45	11.77	9.45	10.63	11.74	10.51	-	14.65	-	-	-
1125 1150	10.31	13.18	9.28	8.53	11.78 12.11	12.11	9.78	10.92	12.05	10.80	_	_	_	_	_
1175	10.83	13.86	9.76	8.98	12.44	12.81	10.44	11.50	12.69	11.37	-	-	-	-	-
1200	11.10	14.20 14.54	10.00	9.20	12.77	13.15	10.78	11.80	13.02	11.66	_	_	_	_	_
1250	11.66	14.88	10.53	9.65	13.43	13.86	_	12.39	13.71	12.29	_	_	_	_	_
1275	11.94	15.22	10.79	9.88	13.76	14.22	-	12.69	14.04	12.61	-	-	-	-	-
1300	12.22	15.56	11.06	10.11	14.09	14.58	Ξ	12.99	14.39	12.93	_	Ξ	_	_	_
1350	12.78	16.24	11.55	10.56	14.69	15.30	-	13.59	15.10	13.56	-	-	-	-	-
1375	13.06 13.34	16.58	11.80 12.05	10.78	14.99 15 20	15.66	-	13.90 14 20	15.44	13.88 14 20	-	-	_	_	-
1400	-	17.30	-	-	-	-	_	14.51	16.16	14.51	_	_	_	_	_
1450	-	17.69	-	-	-	-	-	14.82	16.53	14.83	-	-	-	-	-
1475	_	18.08	_	_	_	_	_	15.13	16.88	15.14	_	Ξ	_	_	_
1525	-	-	-	-	-	-	-	15.76	17.61	15.77	-	-	-	-	-
1550	-	-	-	-	-	-	-	16.07	17.98	16.08 16.40	-	-	-	-	-
1600	_	_	_	_	_	_	_	16.71	18.73	16.71	_	_	_	_	_

NOTES:

Table shows expansion resulting from change in temperature from 70°F to indicated temperature.
This Table is for information only and it is not to be implied that materials are suitable for all temperature ranges shown.
The thermal expansion values in this table may be interpolated to determine values for intermediate temperatures.

### **Installation Instructions**

#### **RECOMMEDED INSTALLATION**

Metal Bellows Expansion Joints have been designed to absorb a specified amount of movement by flexing of the thin-gauge convolutions. If proper care is not taken during installation, it may reduce the cycle life and the pressure capacity of the expansion joints which could result in an early failure of the bellows element or damage the piping system.

The following recommendations are included to avoid the most common errors that occur during installation. When in doubt about an installation procedure, contact Precision Hose & Expansion Joints for clarification before attempting installation.

### DO

Inspect for damage during shipment, i.e, dents, broken hardware, water marks on carton, etc. Store in clean dry area where it will be exposed to heavy traffic or damaging environment.

Use only designated lifting lugs.

Make the piping systems fit the expansion joint. By stretching, compressing, or offsetting the joint to fit the piping, it may be overstressed when the system is in service.

It is good practice to leave one flange loose until the expansion joint has been fitted into position. Make necessary adjustment of loose flange before welding.

Install joint with arrow pointing in the direction of flow.

Install single Van Stone liners pointing in the direction of flow. Be sure to install a gasket between the liner and Van Stone flange as well as between the mating flange and liner. With telescoping Van Stone liners, install the smallest I.D. liner pointing in the direction of flow.

Remove all shipping devices after the installation is complete and before any pressure test of the fully installed system.

Remove any foreign material that my have become lodged between the convolutions.

Refer to EJMA Standards for proper guide spacing and anchor recommendations.

### DON'T

Do not drop or strike carton.

Do not remove shipping bars until installation is complete.

Do not remove any moisture-absorbing dessicant bags or protective coatings until ready for installation.

Do not use hanger lugs as lifting lugs without approval of manufacturer.

Do not use chains or any lifting device directly on the bellows or bellows cover.

Do not allow weld splatter to hit unprotected bellows. Protect with wet chloride-free insulation.

Do not use cleaning agents that contain chlorides.

Do not use steel wool or wire brushes on bellows.

Do not force-rotate one end of an expansion joint for alignment of bolt holes. Ordinary bellows are not capable of absorbing torque.

Do not hydrostatic pressure test or evacuate the system before installation of all guides and anchors. Pipe hangers are not adequate guides.

Do not exceed a pressure test of 11/2 times the rated working pressure of the expansion joint.

Do not use shipping bars to retain thrust if test prior to installation.



## **General Conversion Factors**

Multiply	Ву	To Obtain	Multiply	Ву	To Obtain
Atmospheres	33.9	Feet of water	Inches of water	0.1867	Cms.of mercury
Atmospheres	29.92	Inches of mercury	Inches of water (at 4°C)	2.54 x 10 <sup>-3</sup>	Kgs./sq. cm.
Atmospheres	10332	Kilograms/sq. m.	Inches-pounds/deg.	0.66	Kilogram-meters/rad
Atmospheres	14.7	Pounds/sa. in.	Joules	9.486 x 10 <sup>-4</sup>	B.T.U.
Atmospheres	760	mm of mercury	Joules	0.7376	Foot-pounds
Bars	9.869 x 10 <sup>-1</sup>	Atmospheres	Joules	2.390 x 10 <sup>-4</sup>	Kgcalories
Bars	1.0 x 10°	Dynes/sq. cm.	Kilograms	980665	Dynes
Bars	1.020 X 10"	Ras./sa. meter	Kilograms	1.0 X 10°	Bounds
British Thormal Units	14.5	Founds	Kilogram-calories	2.205	P T II
British Thermal Units	1054.6	loules	Kilogram-calories	3086	Foot-nounds
British Thermal Units	0.2520	Kacalories	Kiloaram-calories	4186	Joules
British Thermal Units	2.928 x 10 <sup>-4</sup>	K.Whours	Kilogram-meters	7.233	Foot-pounds
B.T.U./hr.	0.2520	Kg. cal/Hr.	Kilograms/cu. meters	3.613 x 10 <sup>-5</sup>	Pounds/cu. in.
B.T.U./hr./sq. ft.	2.712	Kgcal/hr./sq. m.	Kilograms/sq. cm.	9.80665 x 10⁵	Dynes/sq. cm.
B.T.U./hr./sq. ft./deg F.	4.882	Kg. cal/hr./sq. m./deg C.	Kilograms/sq. cm.	14.226	Pounds/sq. in.
B.T.U./sq. ft.	2.712	Kg. cal./sq. m.	Kilograms/sq. meter	9.678 x 10 <sup>-5</sup>	Atmospheres
B.T.U./sq. ft./in.	6.892	Kg. cal/sq.m./cm.	Kilograms/sq. meters	9.804 x 10 <sup>-5</sup>	Bars
Centimeters	(°C X 1.8) + 32	Fanrenneit	Kilometers	1.0 X 10 <sup>3</sup>	Centimeters
Centimeters	0.0328	reel	Kilometers	3281 2 027 v 104	reel
Centimeters	0.0357	Meters	Kilonewtons/sa meter	0 145	Pounds/sa in
Centimeters	1. x 10 <sup>4</sup>	Microns	Kilospascals	0.145	Pounds/sq. in.
Centimeters/sec	0.03281	Feet/sec	Liters	1 0 x 10 <sup>3</sup>	Cubic centimeters
Centipoises	0.000672	Lbs./ftsec.	Liters	0.0351	Cubic feet
Cubic centimeters	3.531 x 10 <sup>-5</sup>	Cubic feet	Liters	0.2642	Gallons (U.S.)
Cubic centimeters	6.102 x 10 <sup>-2</sup>	Cubic inches	Liters	1.0 x 10 <sup>-3</sup>	Cubic meters
Cubic centimeters	1.0 x 10 <sup>-3</sup>	Liters	Mega nascals (mPa)	145	Pounds/sq,. in
Cubic feet	1728	Cubic inches	Meters	3.281	Feet
Cubic feet	0.03704	Cubic Yards	Meters	39.37	Inches
Cubic feet	7.481	Gallons	Meters	100	Centimeters
Cubic feet	28.32	Liters Gallons / hour	Motors	1000	Millimotors
Cubic inches	20950 1 620 v 10 <sup>-5</sup>	Gallons/hour	Motors /soc	2 221	Foot /soc
Cubic inches	4.329 x 10 <sup>-3</sup>	Gallons	Microns	3.94 x 10 <sup>-5</sup>	Inches
Cubic meters	1.0 x 10 <sup>6</sup>	Cubic cm.	Millimeters	0.1	Centimeters
Cubic meters	35.31	Cubic feet	Millimeters	0.003281	Feet
Cubic meters	1.308	Cubic yards	Millimeters	0.03937	Inches
Degrees(angle)	1.745 x 10 <sup>-2</sup>	Radians	Millimeters	1.0 x 10 <sup>-6</sup>	Kilometers
Dynes	1.020 x 10 <sup>-6</sup>	Kilograms	Millimeters	0.001	Meters
Dynes	2.248 x 10 <sup>-6</sup>	Pounds	Newtons	1.0 x 10°	Dynes
Dynes/sq. cm.	9.870 X 10 <sup>-7</sup>	Atmosphere	Newtons Newtons (mm	0.2248	Pounds Dounds (inch
Dynes/sq. cm.	0.0102	Dars Kas /sa motor	Newton Meters	5./1	Inch-nounds
Dynes/sa. cm	2 089 x 10 <sup>-3</sup>	Pounds/sa ft	Newtons/sg meter	1	Pascals
Dynes/sq. cm.	1.450 x 10 <sup>-5</sup>	Pounds/sq. in.	Ounces	28.35	Grams
Fahrenheit	5/9(°F-32)	Celsius	Ounces (fluid)	0.02957	Liters
Feet	30.48	Centimeters	Pounds	444823	Dynes
Feet	3.048 x 10 <sup>-4</sup>	Kilometer	Pounds	453.6	Grams
Feet	0.3048	Meters	Pounds	0.4536	Kilograms
Feet	304.8	Millimeters	Pounds of water	0.01602	Cubic feet
Feet/minute	0.01667	Feet/second	Pounds of water	27.68	Cubic inches
Foot-pounds	1.350 3.241 v 10 <sup>-4</sup>	Joules Kg_calories	Pounds of water	0.1198	Gallons Grams/cu. cm
Foot-pounds	0.1383	Kgmeters	Pounds/cubic foot	16.02	Kgs./cu. meter
Gallons (U.S.)	0.1337	Cubic feet	Pounds/cubic foot	5.787 x 10 <sup>-4</sup>	Pounds/cu. in.
Gallons (U.S.)	231	Cubic inches	Pounds/cu. in.	2.768 x 104	Kgs./cu. meter
Gallons (U.S.)	3.785 x 10 <sup>-3</sup>	Cubic meters	Pounds/cu. in.	1.728 x 10 <sup>3</sup>	Pounds/cu. ft.
Gallons (U.S.)	3.785	Liters	Pounds/inch	17.86	Kilograms/meter
Gallons of water	8.337	Pounds of water	Pounds/inch	178.6	Grams/cm.
Gallons/hour	3.71 x 10 <sup>-5</sup>	Cu. ft./sec.	Pounds/square inch	2.036	Inches of mercury
Grams	980.7 2.205 ··· 10-3	Dynes	Pounds/square inch	51.7	Mm of mercury
Grams (cubic cm	2.205 X 10 <sup>-</sup>	Pounds	Pounds/square inch Radians	703.1	Ngs./sq. meter
Grams/sg. cm.	1.422 x 10 <sup>-2</sup>	Lbs./sq. in.	Slugs	3.217 x 10 <sup>1</sup>	Pounds
Inches	2.54	Centimeters	Square centimeters	0.1550	Square inches
Inches	0.0254	Meters	Square feet	929	Square cms.
Inches	25.4	Millimeters	Square feet	0.0929	Square meters
Inches of mercury	0.03342	Atmospheres	Square inches	645.2	Square mms.
Inches of mercury	3.453 x 10 <sup>-2</sup>	Kgs./sq. cm.	Square inches	6.452	Square cms.
Inches of mercury	0.4912	Lbs./sq. in.	Square meters	1.55 x 10 <sup>3</sup>	Square inches
Inches of water	2.458 X 10 <sup>-5</sup>	Atmosphere	Square millimeters	1.0 X 10 <sup>-2</sup>	Square cms.
Inches of water	0.03609	Lbs./ sq. in.	Tons	0.02	Pounds/sq. in.

### **Corrosion Resistance**

	Bronze	Monel	Carbon Steel	304L/321 Stainless	<b>316L Stainless</b>
Acetaldehyde	<b>C</b> <sup>2</sup>	Α	В	Α	Α
Acetanilide	B <sup>3</sup>	В	В	В	В
Acetic Acid	С	В	С	<b>B</b> <sup>1</sup>	A1
Acetic Anhydride	В	В	С	В	В
Acetone	Α	Α	С	В	В
Acetophenone	Α	Α	Α	В	В
Acetylene	C <sup>2</sup>	Α	Α	Α	Α
Acrylates	В	В	В	В	В
Acrylic Acid	В	В	С	В	В
Acrylonitrile	A <sup>4</sup>	A	A	Α	Α
Alcohols	A⁵	A	A⁵	A	A
Alum	В	В	В	В	В
Alumina	A	A	A	A	A
Aluminum Acetate	В	В	В	В	В
Aluminum Chloride-Dry	B <sup>1</sup>	Α	В	Α	A
Aluminum Chloride-Moist	С	В	C <sup>3</sup>	C <sup>3,4</sup>	C <sup>3</sup>
Aluminum Fluoride	В	В	В	С	С
Aluminum Hydroxide	В	В	В	Α	Α
Aluminum Sulfate	С	В	С	B <sup>1,3</sup>	A <sup>3</sup>
Ammonia-Dry	Α	Α	Α	Α	Α
Ammonia-Moist	C <sup>3</sup>	С	C <sup>3</sup>	A	A
Ammonium Acetate	С	A	A	Α	Α
Ammonium Bromide	С	В	C	C⁴	C⁴
Ammonium Chloride-Dry	C⁴	A	В	A	A
Ammonium Chloride-Moist	C⁴	В	С	C <sup>3,4</sup>	C³
Ammonium Hydroxide 6	C <sup>3</sup>	A	B	A	A
Ammonium Nitrate	C <sup>2</sup>	C <sup>2</sup>	C <sup>3</sup>	A	A
Ammonium Sulfate	C	в	C	C <sup>1</sup>	в
Amyl Acetate	A	A	A	A	A
Amyl Alconol	A	A	A	A	A
Amyl Chloride Dry	A	A	В	A 634	A
Amyl Chioride-Ivioist	C	B	C	C <sup>3,4</sup>	0
Aniline Aniline Duce	C <sup>2</sup>	A	C	B	В
Anyline Dyes	<u>ر</u>	A		D A	B
Aspilat	A	A	A	A D4	A A4
Atmosphere-Marine	A	A	C	B4	R4
Atmosphere-Narine	A 	A 	0	<u>ь</u>	
Barium Carbonate	B	R	B	R	B
Barium Chloride-Dry	B	Δ	Δ	Δ	Δ
Barium Chloride-Moist	B	R	R	C <sup>3,4</sup>	C
Barium Hydroxide	C	B	B	B	Δ
Barium Sulfate	В	B	B	B	B
Barium Sulfide	C	C	C	B	B
Beer	A	A	C	A	A
Beet Sugar Syrups	A	A	В	Α	A
Benzaldehyde	С	В	С	В	В
Benzene (Benzol)	A	Α	A	Α	Α
Benzolc Acid	Α	В	C	Α	A
Benzvlamine	С	В	В	В	В
Benzyl Chloride-Drv	В	А	А	Α	Α
Benzyl Chloride-Moist	В	В	С	C <sup>3,4</sup>	<b>C</b> <sup>3</sup>
Black Liquor, Sulfate Process	С	А	С	В	В
Bleaching Powder-Dry	<b>B</b> <sup>1</sup>	Α	с	Α	Α

	Bronze	Monel	Carbon Steel	304L/321 Stainless	<b>316L Stainless</b>
Bleaching Powder-Moist	В	В	С	C <sup>1,3,4</sup>	<b>C</b> <sup>3,4</sup>
Borax	Α	Α	В	Α	Α
Bordeaux Mixture	В	Α	В	Α	Α
Boric Acid	В	В	С	Α	Α
Boron Trichloride-Dry	В	В	Α	В	В
Boron Trichloride-Moist	В	В	В	<b>C</b> <sup>3,4</sup>	C <sup>3</sup>
Boron Trifluoride-Dry	В	В	Α	В	В
Brines	В	В	С	C <sup>3,4</sup>	C <sup>3</sup>
Bromic Acid	С	С	С	С	С
Bromine-Dry	Α	Α	С	В	В
Bromine-Moist	В	В	С	С	С
Butladene	A	A	A	A	A
Butane	A	A	A	A	A
Butano (Butyl Alcohol)	A	A	A	A	A
Butyl Phenois	B	A	B°	B	B
Butylamine	C	A	A	A	A
Butric Acid	В	В	C	B	B
Cadmium Chloride-Ivioist	В	В	C A	C <sup>3,4</sup>	0
Cadmium Chloride-Dry	B	A	A	A	A
Calcium Disulfite	D	A	D	A D1	P
Calcium Bromide	D	D	D	D C <sup>3</sup>	D C <sup>3</sup>
Calcium Chlorida Maist	D	D	C	C <sup>3,4</sup>	C <sup>3</sup>
Calcium Chloride-Dry	B	<u>ь</u>	د ۸	<u>ر</u>	<u>د</u>
Calcium Eluoride	B	R	A C	A C	A C
Calcium Hydrovide	B	B	C	B	B
Calcium Hypochlorite-Moist	C	B	C	C <sup>3,4</sup>	C <sup>3,4</sup>
Calcium Hypochlorite-Dry	В	A	B	A	A
Calcium Nitrate	В	В	<b>C</b> <sup>1</sup>	<b>B</b> <sup>1</sup>	В
Calcium Oxide	A	A	A	A	A
Cane Sugar Syrups	Α	Α	В	Α	Α
Carbolic Acid (Phenol)	В	В	с	В	Α
Carbon Dioxide-Dry	Α	Α	Α	Α	Α
Carbon Dioxide-Moist	<b>C</b> <sup>4</sup>	Α	с	Α	Α
Carbonated Beverages	В	Α	С	Α	Α
Carbonated Water	<b>B</b> <sup>4</sup>	Α	С	Α	Α
Carbon Disululfide	В	В	В	В	В
Carbon Tetrachloride-Dry	Α	Α	В	Α	Α
Carbon Tetrachlorlde·Moist	В	В	С	<b>C</b> <sup>3,4</sup>	<b>C</b> <sup>4</sup>
Castor Oil	Α	Α	Α	Α	Α
Chlorine-Dry	Α	Α	В	Α	Α
Chlorine-Moist	С	В	С	<b>C</b> <sup>3,4</sup>	C <sup>3</sup>
Chloroacetic Acid	С	В	С	<b>C</b> <sup>3,4</sup>	C <sup>3</sup>
Chloric Acid	С	С	С	C <sup>3</sup>	<b>C</b> <sup>3</sup>
Chlorine Dioxide-Dry	В	Α	В	A	Α
Chlorine Dioxide-Moist	C	В	C	C <sup>3,4</sup>	C3
Chloroform-Dry	A	A	A	A	A
Chloroform-Moist	В	В	C	C <sup>3,4</sup>	C <sup>3</sup>
Chromic Acid	C	B	C	C <sup>1,4</sup>	B
Chromic Fluorides	C	B	C	C	C
Chromic Hydroxide	B	B	B	B	B
Chromium Sulfate	В	В	0	В	В
Cider Citate Asid	A	A	C	A	A
	L	В	Ľ	В	В

	Bronze	Monel	Carbon Steel	304L/321 Stainless	316L Stainless
Coffee	Α	Α	С	Α	Α
Copper Chloride-Dry	Α	A	В	Α	A
Copper Chloride-Moist	В	В	C	C <sup>3,4</sup>	C <sup>3</sup>
Copper Nitrate	C	C	C	A	A
Copper Sulatte	C	В	C	B.	В
Corn Oli	A	A	A	A	A
Cottonseed Oil	A	A	A	A	A
Crudo Oil	D	A	A	A C <sup>1</sup>	P
Crude Oli	B	R	B	B	B
DDT	B	B	C	Δ	Δ
Dichloroethane-Dry	Δ	Δ	Δ	Δ	Δ
Dichloroethane-Moist	C	B	C	<b>C</b> <sup>4</sup>	C <sup>4</sup>
Dichloroethylene-Dry	A	A	В	A	A
Dichloroethylene-Moist	C	В	С	<b>C</b> <sup>4</sup>	<b>C</b> <sup>4</sup>
Dichlorophenol	В	В	С	B <sup>3</sup>	B <sup>3</sup>
Diisocyanate	В	Α	В	Α	Α
Dimethyl Sulfate	В	В	В	В	В
Epichlorohydrin-Dry	<b>B</b> <sup>4</sup>	Α	<b>C</b> <sup>4</sup>	Α	Α
Epichlorohydrin-Moist	С	В	<b>C</b> <sup>4</sup>	<b>C</b> <sup>3,4</sup>	<b>C</b> <sup>3</sup>
Ethane	Α	Α	Α	Α	Α
Ethers	Α	Α	В	Α	Α
Ethyl Acetate	Α	В	В	В	В
Ethyl Alcohol	Α	Α	Α	Α	Α
Ethyl Benzene	B⁵	В	В	B <sup>3</sup>	В
Ethyl Chloride-Dry	Α	Α	Α	Α	Α
Ethyl Chloride-Moist	В	В	С	<b>C</b> <sup>3,4</sup>	C <sup>3</sup>
Ethylene	Α	A	Α	Α	A
Ethylene Chlorohydrin-Dry	В	A	В	A	Α
Ethylene Chlorohydrln-Moist	C	B	C	C⁴	C <sup>4</sup>
Ethylene Diamine	C	B	B	В	B
Ethylene Glycol	A C <sup>2</sup>	A	A	A	A
Ethylene Oxide	6	В	В	A	A
Fatty Acids	L D	D A	L P	B=,.	A
Ferric Chloride-Moist	Δ	R	C	C1,3,4	C <sup>3,4</sup>
Ferric Nitrate	C C	C	C	B	B
Ferric Sulfate	c	c	c	<b>B</b> <sup>1</sup>	A
Ferrus Chloride-Dry	В	A	В	A	A
Ferrus Chloride-Moist	С	В	c	C <sup>3,4</sup>	<b>C</b> <sup>3</sup>
Ferrus Sulfate	В	A	C	<b>B</b> <sup>4</sup>	В
Fluorine-Dry	В	Α	A	А	Α
Fluorine-Moist	С	В	С	С	С
Formaldehyde	<b>A</b> ⁵	A⁵	B⁵	В	В
Formic Acid	В	В	С	<b>B</b> <sup>1</sup>	Α
Freon	Α	Α	Α	Α	Α
Fruit Juices	С	Α	С	Α	Α
Fuel Oil	В	Α	С	Α	Α
Furtural	Α	Α	В	Α	Α
Gasoline	Α	Α	В	Α	Α
Gelatine	Α	Α	С	Α	Α
Glucose	Α	Α	В	Α	Α
Glue	В	Α	С	Α	Α
Glutamic Acid	<b>C</b> <sup>4,5</sup>	В	С	<b>B</b> <sup>3,4</sup>	<b>B</b> <sup>3,4</sup>



### **Corrosion Resistance**

	Bronze	Monel	Carbon Steel	304L/321 Stainless	<b>316L Stainless</b>
Glycerin (Glycerol)	А	Α	B⁵	Α	Α
Heptane	Α	Α	Α	Α	Α
Hexacloroethane-Dry	В	Α	В	Α	Α
Hexacloroethane-Moist	С	В	С	<b>C</b> <sup>4</sup>	<b>C</b> <sup>4</sup>
Hydrazine	C <sup>3</sup>	С	С	Α	Α
Hydrobromic Acid	С	С	С	<b>C</b> <sup>4</sup>	С
Hydrocarbons, Pure	Α	Α	Α	Α	Α
Hydrochloric Acid	С	В	С	<b>C</b> <sup>4</sup>	<b>C</b> <sup>4</sup>
Hydrocyanic Acid	С	В	C <sup>3</sup>	<b>C</b> <sup>1,3</sup>	C <sup>3</sup>
Hydrofluoric Acid	С	В	С	<b>C</b> <sup>1,3</sup>	С
Hydrofluorisilic Acid	С	В	С	С	С
Hydrogen	Α	Α	Α	A	Α
Hydrogen Chloride-Dry	Α	Α	В	Α	Α
Hydrogen Chloride-Moist	С	В	С	<b>C</b> <sup>4</sup>	<b>C</b> <sup>4</sup>
Hydrogen Peroxide	С	С	С	В	В
Hydrogen Sulfide-Dry	A⁵	Α	В	Α	Α
Hydrogen Sulfide-Moist	<b>C</b> <sup>4,5</sup>	В	C³	<b>B</b> <sup>4</sup>	Α
Hydroquinone	В	В	B⁵	В	В
Kerosine	Α	Α	В	Α	Α
Lacquers	Α	Α	Α	Α	Α
Lacquer Solvents	Α	Α	Α	Α	Α
Lactic Acid	В	В	С	<b>B</b> <sup>1,4</sup>	B1
Lime	Α	Α	В	Α	Α
Lime Sulfur	с	В	с	В	В
Linseed Oil	Α	Α	В	Α	Α
Lithium Chloride-Dry	В	Α	В	Α	Α
Lithium Chloride-Moist	В	В	В	<b>C</b> <sup>3,4</sup>	C <sup>3</sup>
Lithium Hydroxide	С	В	В	В	В
Magnesium Chloride-Dry	В	Α	В	Α	Α
Magnesium Chloride-Moist	В	В	с	<b>C</b> <sup>3,4</sup>	с
Magnesium Hydroxide	Α	Α	Α	Α	Α
Magnesium Sulfate	Α	Α	В	В	Α
Maleic Acid	С	В	В	B1	В
Mercurio Chloride-Dry	В	Α	В	Α	Α
Mercurio Chloride-Moist	С	В	С	<b>C</b> <sup>3,4</sup>	С
Mercurous Nitrate	C <sup>3</sup>	B <sup>3</sup>	В	В	В
Mercury	С	B <sup>3</sup>	В	В	В
Methyl Alcohol	Α	Α	Α	Α	Α
Methane	Α	Α	Α	Α	Α
Methyl Chloride-Dry	Α	Α	Α	Α	Α
Methyl Chloride-Moist	В	В	С	<b>C</b> <sup>3,4</sup>	С
Methyl Ethyl Ketone	В	в	В	В	в
Milk	В	Α	с	Α	Α
Mine Water	с	В	с	В	В
Naphtalene	В	В	Α	Α	Α
Natural Gas	Α	Α	Α	Α	Α
Nickel Chloride-Drv	В	Α	В	Α	Α
Nickel Chloride-Moist	С	В	С	C <sup>3,4</sup>	<b>C</b> <sup>3</sup>
Nitric Acid	C	C	C	A	A
NitroToluene	В	В	В	В	B
Nitrogen	Δ	Δ	Δ	Δ	Δ
Oleic Acid	B <sup>5</sup>	A	C	B <sup>4</sup>	B
Oleum (Fuming H2S04)	C	C	B <sup>3</sup>	В	B
Oxalid Acid	В	В	c	<b>C</b> <sup>1</sup>	<b>B</b> <sup>1</sup>

	Bronze	Monel	Carbon Steel	304L/321 Stainle	316L Stainless
Oxygen	Α	Α	С	Α	Α
Palmitic Acid	В	Α	С	A	Α
Parafin	Α	Α	В	Α	Α
Pentane	В	В	В	В	В
Phenol	В	В	С	В	Α
Phosphoric Acid	С	В	С	<b>C</b> <sup>1</sup>	<b>B</b> <sup>1</sup>
Phthalic Acid	В	В	С	B1	В
Picric Acid	С	С	С	В	В
Potassium	В	В	С	С	С
Potassium Carbonate	В	Α	В	Α	Α
Potassium Chloride-Dry	Α	Α	Α	A	Α
Potassium Chloride-Moist	B <sup>3</sup>	В	С	C <sup>3,4</sup>	<b>C</b> <sup>3</sup>
Potassium Chromate	В	В	С	В	В
Potassium Cyanide	C⁴	Α	В	В	В
Potassium Dichromate	С	Α	С	A	Α
Potassium Fluoride	В	В	С	С	С
Potassium Hidroxide	C⁵	<b>A</b> <sup>3</sup>	B <sup>3</sup>	B <sup>3</sup>	Α
Potassium Nitrate	В	В	В	В	Α
Potassium Permanganate	В	В	В	В	В
Potassium Sulfate	В	В	С	В	В
Propane	Α	Α	Α	Α	Α
Propylene	A	Α	Α	A	Α
Propylene Oxide	С	С	С	A	Α
Propylene Dichloride-Dry	В	Α	В	A	Α
Propylene Dichloride-Moist	С	В	С	<b>C</b> <sup>4</sup>	<b>C</b> <sup>4</sup>
Pyridine	B⁵	В	B⁵	В	В
Pyrrolidine	C <sup>3</sup>	В	В	В	A
Quinine	В	В	C	В	В
Rosin	As	A	C	A	A
Sea Water	B	В	С	C <sup>3,4</sup>	C <sup>3</sup>
Sewage	A	A	B	A	A
Silver Salts	C	A	C	B	B
Silver Nitrate	C	C	Cs	B	A
Soap Solutions	A	A	B	A	A
Sodium Cadium Diaukauata	C	A	A	A	A
Sodium Bicarbonate	B	A	C	A	A
Sodium Bisulfate	<b>B</b>	D4	C	B-/*	A
Sodium Bisuinte	D D	B		В	В
Sodium Carbonata	D		D		
Sodium Chlorata Dry	D	A		A	A
Sodium Chlorate-Dry	D	A	A	A C3.4	A C <sup>3</sup>
Sodium Chlorida Dry	D	D		Δ.	Δ.
Sodium Chloride Moist	D	A P	D C	A (3.4	A (3
Sodium Chromate	۵ ۵	Δ	R	Δ.	Δ
Sodium Citrate	A C	R	B	R	R
Sodium Cranide	C <sup>4</sup>	B	B	B	B
Sodium Dichromate	C	B	C	Δ	Δ
Sodium Eluorido	R	A	R	C4	C C
Sodium Hydrovido 6	P4	A	<b>B</b> <sup>3</sup>	R <sup>3</sup>	R <sup>3</sup>
Sodium Hypochlarita Dry	P	A .	B	Δ	Δ.
Sodium Hypochlorite-Dry	0	B	C	A C1,4	A C4
Sodium Metasilicate	B	Δ	B	Δ.	Δ
Sodium Nitrate	P	A	<b>B</b> 3	A .	A A
Sourum withdle	D	А	0'	A	A

	Bronze	Monel	Carbon Steel	304L/321 Stainless	316L Stainless
Sodium Nitrite	В	В	В	В	В
Sodium Peroxide	С	В	С	Α	Α
Sodium Phosphate	В	Α	С	Α	Α
Sodium Silicate	Α	Α	В	Α	Α
Sodium Sulfate	Α	Α	В	B <sup>3</sup>	В
Sodium Sulfide	С	Α	С	<b>B</b> <sup>4</sup>	В
Sodium Sulfite	В	Α	С	В	В
Sodium Thiosulfate	С	Α	С	В	В
Stannic Chloride-Dry	В	Α	В	Α	Α
Stannic Chloride-Moist	С	В	С	<b>C</b> <sup>3,4</sup>	<b>C</b> <sup>3</sup>
Stannous Chloride-Dry	В	Α	В	Α	Α
Stannous Chloride-Moist	С	В	С	<b>C</b> <sup>3,4</sup>	C <sup>3</sup>
Steam	Α	<b>A</b> <sup>3</sup>	С	Α	Α
Stearic Acld	В	В	C⁵	В	В
Stronium Nitrate	В	В	С	В	В
Sulfate Black Liquor	С	В	В	В	В
Sulfate Green Liquor	С	В	В	B <sup>3</sup>	В
Sugar Solutions	Α	Α	В	Α	Α
Sulfur-Dry	С	Α	В	Α	Α
Sulfur-Molten	С	С	С	С	В
Sulfur Chloride-Dry	В	Α	С	Α	Α
Sulfur Chloride-Moist	С	В	С	<b>C</b> <sup>3,4</sup>	<b>C</b> <sup>3</sup>
Sulfur Dioxide-Dry	В	В	С	<b>C</b> <sup>1</sup>	В
Sulfur Dioxide-Moist	<b>C</b> <sup>4</sup>	С	С	<b>C</b> <sup>1</sup>	В
Sulfur Trioxide-Dry	Α	Α	С	Α	Α
Sulfuric Acid 95-100%	В	В	В	Α	Α
Sulfuric Acid 80-95%	В	В	С	В	Α
Sulfuric Acid 40-80%	С	С	С	<b>C</b> <sup>1</sup>	<b>C</b> <sup>1</sup>
Sulfuric Acid 40%	С	С	С	<b>C</b> <sup>1</sup>	<b>C</b> <sup>1</sup>
Sulturous Acid	В	В	С	<b>C</b> <sup>1,4</sup>	<b>C</b> <sup>1,4</sup>
Tall Oil	С	В	В	В	В
Tannic Acid	В	В	C⁵	В	В
Tar	Α	A	В	Α	Α
Tartaric Acid	С	В	С	В	В
Tetraphosphoric Acid	С	C	C	В	В
Toluene	Α	Α	Α	Α	Α
Trichloroacetic Acid	C	В	С	<b>C</b> <sup>3,4</sup>	<b>C</b> <sup>4</sup>
Trichloroethane-Dry	Α	Α	Α	Α	Α
Trichloroethane-Moist	С	В	С	<b>C</b> <sup>4</sup>	C⁴
Trichloroethylene-Dry	Α	Α	Α	Α	Α
Trichloroethylene-Moist	С	В	С	<b>C</b> <sup>4</sup>	C⁴
Turpentine	Α	Α	В	Α	Α
Varnish	A	A	B	A	Α
Vinegar	В	В	С	Α	Α
Water, Potable	A	A	C	A	A
Xylene	В	A	В	A	A
Zinc Chloride-Dry	B	A	A	A	A
Zinc Chloride-Moist	C"	B	C	C <sup>3,4</sup>	C <sup>3</sup>
Zinc Sulfate	B	B	C	В	Α

NOTES: 1. Susceptible to intergranular corrosion 2. May cause explosive reaction 3. Susceptible to stress corrosion cracking 4. Susceptible to pitting type corrosion 5. Discolors

Discolors
Concentration over 50% and/or temperature over 200°F, refer to our Engineeering Dept.

## **Specification Inquiry Sheet**

Customer			Date	Page
Project			Prepared By	
Item or Tag N	umber			
Quantity				
Size				
Style or Type	(single, univers	al, hinged, gimbal, etc.)		
End Con	nections	Thickness/Flange Rating		
		Material		
*Drog	SUIRA	Operating		
ries	sure	Tost		
		Dosign		
*Tomo	akatuka	Design		
Tempe	erature			
		Installation		
		Media		
Me	dia	Flow Velocity		
		Flow Direction		
		Axial Extension		
		Axial Compression		
	Installation	Lateral		
		Angular		
Movements		Number of Cycles		
		Axial Extension		
and	Design	Axial Compression		
		Lateral		
Life Cycles		Angular		
Elic Cycles		Number of Cycles		
		Axial Extension		
		Axial Compression		
	Operating			
	Operating	Apoular		
		Angular Numera and Constant		
		Number of Cycles		
		Bellows		
Mate	erials	Liner		
		Cover		
		Overall Length		
Dimer	nsions	Maximum O.D.		
		Minimum I.D.		
		Maximum Axial Spring Rate		
Spring	Rates	Maximum Lateral Spring Rate		
		Maximum Angular Spring Rate		
Quality A	ssurance			
Require	d Code			

### Warranty

- 1. DEFINITION: "Document" shall refer to these General Terms and Conditions and the Purchase Order, Invoice, or Delivery Ticket, as the case may be, printed on the face hereof.
- 2. DELIVERY: Time is of the essence in this transaction, and if delivery of conforming Product(s) or performance of conforming services is not completed by the time(s) promised, Buyer reserves the right, in addition to its other rights and remedies, to cancel this order, to reject such Product(s) or services in whole or part on reasonable notice to Seller, and/ or to purchase substitute Products or services elsewhere and charge Seller with any loss incurred. Shipments sent C.O.D. without Buyer's written consent will not be accepted and will be at Seller's risk.
- 3. PRICE: Buyer shall not be billed at prices higher than stated herein unless authorized in writing by Buyer. Seller agrees to notify Buyer of any price reduction made in Products or services covered by this Document subsequent to the date hereof and prior to delivery or performance and agrees that any such reduction will be applicable to this Document.
- 4. TERMS: This sale is limited of these terms and conditions. Any additional or different terms or conditions proposed by you are rejected unless we expressly agree there to in writing. A contract embodying all and only these terms and conditions shall be formed by (i) delivery of materials or goods ("Product(s)") or performance of services and (ii) acceptance of such Product(s) or services by buyer. References to this document shall, unless the context otherwise requires, include any contract resulting from this Document. No modification of this document shall be effective without our written consent. No course of prior dealings, no usage of trade, and no course of performance shall be used to modify, supplement, or explain any terms used in this Document.
- 5. PAYMENT: All payments are due pursuant to the payment term on the face of this Document.
- 6. TERMINATION: Buyer expressly reserves the right, in the event that this Document is issued pursuant to a prime contact with the Government or to a subcontract thereunder, to terminate the work under this Document at any time by written or telegraphic notice to Seller stating the extent and effective date of such termination, in which event the rights and obligations of the parties hereto shall be determined in accordance with the termination provisions applicable to such Government contract.
- 7. CONTINGENCIES: Failure of either party to perform hereunder, except for the payment of money, in whole or in part, occasioned by act of God, act of the public enemy, fire, explosion, perils of sea, flood, drought, war, riot, sabotage, terrorism, accident, embargo, government priority, requisition or allocation, or any circumstance of like or different character beyond the reasonable control of the party so failing to perform, shall not subject said party to any liability to the other party for such period of time and to the extent that such contingency precludes performance.

#### 8. WARRANTIES:

- (a) Seller makes NO WARRANTY WHATSOEVER, except as to title, with respect to any Product(s) manufactured and/or designed to Buyer's own specifications (other than mere dimensions), and Buyer shall, at its own expense, indemnify, defend and hold Seller harmless from and against any claim, suit, or expense which shall be asserted or brought against Seller by reason of its manufacture or sale of such Product(s).
- (b) Seller makes NO WARRANTY WHATSOEVER concerning any Product(s) manufactured by others, but will extend to Buyer any warranties respecting such Product(s) as made by the manufacturer of such Product(s). Seller will repair or replace any Product(s) manufactured by Seller which prove defective within one (1) year from the date of shipment if such defects are due to defective workmanship of Seller's employees, provided that the Product(s) has or has been (i) properly assembled and utilized in accordance with Seller's design thereof and instructions relating thereto AND (ii) returned to the Seller at Buyer's expense. This warranty shall be voided by any changes made in the Product(s) prior to or in connection with their assembly or use.
- (c) EXCEPT FOR THE EXPRESS WARRANTY DESCRIBED ABOVE THERE ARE NO WARRANTIES INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, WHICH EXTEND BEYOND THE DESCRIPTION OF THE PRODUCT(S) ON THE FACE HEREOF NO WARRANTIES OF REPRESENTATIONS AT ANY TIME MADE BY ANY REPRESENTATIVE OF SELLER SHALL BE EFFECTIVE TO VARY OR EXTEND THE ABOVE REFERENCED EXPRESS WARRANTIES OR ANY OTHER TERMS HEREOF.
- (d) In no event shall Seller be liable for consequential, incidental, or special damages resulting from or in any matter related to the Product(s), the design, use, or any inability to use the Product(s), including without limitation, damages arising out of or in any manner relating to the delivery of the Product(s), or any delay with respect to delivery of the Product(s). The sole and exclusive remedy with respect to any defective Product(s) manufactured by Seller shall be repair, correction, or replacement thereof pursuant to the "WARRANTY" provisions above. Should the Product(s) prove so defective, however, as to preclude the remedying of warranted defects by repair or replacement. Buyer's sole and exclusive remedy shall be the refund of the purchase price of the defective Product(s) involved, upon return of the Product(s) to Seller.
- (e) Seller warrants that the use or sale of any Product(s) delivered hereunder, or any part thereof, except any Product(s) produced to Buyer's drawings or specifications, does not infringe any adverse valid existing patent. Seller shall indemnify, defend, and hold harmless Buyer, Buyer's customers, users of the Product(s), and any of their successors and assigns, from and against any and all liability, damage, loss, cost, or expense incurred in connection with any claim, suit, or action for actual or alleged infringement of any such patent, arising out of or in connection with the use or sale of such Product(s).
- 9. LOSS IN TRANSIT: Title and risk of loss in transit shall pass to Buyer upon delivery to (i) Buyer or (ii) a carrier, where shipment is made F.O.B. Seller's shipping point.
- **10. ASSIGNMENT:** Either party's assignment of this Document, of any interest herein, or of any money due or to become due hereunder without the prior written consent of the other party shall be void, unless such assignment is made to an affiliate of the assigning party.
- 11. INDEPENDENT CONTRACTOR: In performing any services hereunder, each party is and undertakes performance hereof as an independent contractor, with sole responsibility for all persons employed in connection therewith, including without limitation, exclusive liability for the payment of all Federal, State, and local Unemployment and Disability Insurance and all Social Security and/or other taxes and contributions payable in respect of such persons from and against which liability each party agrees to indemnify, defend, and hold harmless the other part.

#### 12. MANNER OF PERFORMANCE:

- (a) Each party shall comply with all laws, regulations, and/or other requirements of local, state, and federal governments in connection with its manufacture or delivery of any Product(s) or performance of any services hereunder, including without limitation, those pertaining to financial capability responsibility and security for pollution damage and the price production sale, or delivery of the Product(s) or services. Specifically, but not by way of limitation, each party agrees to comply with Executive Order 11246 regarding equal employment opportunity, the Rehabilitation Act of 1973, the Vietnam Era Veterans Readjustment Act of 1972, the Occupational Safety and Health Act, the Fair Labor Standards Act. the Americans with Disabilities Act, and all regulations promulgated pursuant to any of the above.
- (b) If this order involves the presence of either party on the other party's premises, such party comply with all safety, health, and security laws, regulations, and the other party's policies and shall take all necessary precautions to prevent injury or damage to persons or property while so engaged.



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