

CHAPTER 4

SECTION IV - APPENDIX

CHEMICAL RESISTANCE CHART NON-METALLIC MATERIALS

A: Good Resistance
B: Moderate Resistance
U: Unsatisfactory

Media	Compressed Sheet						Metal Reinforced FG		PTFE	MICA
	L-441	L-430	L-640W	L-450	L-443	L-540	LG-SS	LG-TC		
Acetic Acid (Room Temp.)	A	A	B	A	A	B	A	A	A	A
Acetic Anhydride (Room Temp.)							A	A	A	
Acetone	B	B	A	B	B	B	A	A	A	B
Aluminum Chloride (Room Temp.)	A	A	A	A	A	A	B	B	A	A
Aluminum Fluoride (Room Temp.)									A	
Aluminum Sulphate							A	A	A	
Ammonia (Anhydrous)	A	A	B	A	A	A	A	A	A	A
Ammonium Chloride	A	A	A	A	A	A	A	A	A	A
Ammonium Hydroxide	B	B	B	A	A	B	A	A	A	A
Ammonium Nitrate							A	A	A	
Ammonium Phosphate							A	A	A	
Ammonium Sulphate							A	A	A	
Amyl Acetate	B	B	B	B	B	A	A	A	A	A
Aniline	U	U	B	U	U	U	A	A	A	B
Barium Chloride	A	A	A	A	A	A	A	A	A	A
Beer							A	A	A	
Benzene	A	A	U	A	A	A	A	A	A	B
Benzol							A	A		
Borax							A	A	A	A
Boric Acid	A	A	A	A	A	A			A	A
Bromine							U	U	A	
Butyl Alcohol	A	A	A	A	A	A	A	A	A	B
Calcium Carbonate							A	A		
Calcium Chloride	A	A	A	A	A	A	B	B	A	A
Calcium Hydroxide	A	A	A	A	A	A	A	A	A	A
Calcium Hypochlorite	A	A	A	A	A	B	A	A		A
Carbolic Acid									A	
Carbon Tetrachloride	B	B	U	B	B	U	A	A	A	B
Chlorine - Dry	A	A	B	A	A	A	B	B	A	B
Chlorine - Wet	B	B	B	U	B	U	U	U	A	
Chromic Acid	B	B	U	B	U	U			A	B
Citric Acid	A	A	A	A	A	A			A	A
Copper Chloride							U	U	A	
Copper Sulphate	A	A	A	A	A	A	B	B	A	A
Creosote (Coal Tar)	U	U	B	U	U	B	A	A	A	
Crude Oil							A	A	A	A
Ether							A	A	A	
Ethyl Acetate	B	B	B	B	B	B	A	A	A	B
Ethyl Chloride	B	B	U	B	B	B	A	A	A	B
Ferric Chloride							U	U	A	
Ferric Sulphate							A	A	A	
Formaldehyde	A	A	A	A	A	A	A	A	A	B
Formic Acid									A	A
Fuel Oil							A	A	A	
Fuel Oil (Acid)							A	A	A	A
Furfural							A	A	A	
Gasoline							A	A		B
Glue							A	A		
Glycerin	A	A	A	A	A	A	A	A	A	A
Hydrobromic Acid									A	
Hydrochloric Acid Room Temp. 150 F									A	A
Hydrocyanic Acid									A	
Hydrofluoric Acid							U	U	A	
Hydrofluosilicic Acid									A	
Hydrogen Peroxide	A	A	A	A	A	A	B	B	A	A
Hydrogen Sulphide	A	A	U	A	A	A	B	B	A	
Kerosene	A	A	U	A	A	A	A	A	A	A
Lactic Acid	A	A	A	A	A	A			A	A
Linseed Oil	A	A	B	A	A	A			A	A
Lye (Caustic)									A	

CHEMICAL RESISTANCE CHART (CONT.)

NON-METALLIC MATERIALS

A: Good Resistance
B: Moderate Resistance
U: Unsatisfactory

Media	Compressed Sheet						Metal Reinforced FG		PTFE	MICA
	L-441	L-430	L-640W	L-450	L-443	L-540	LG-SS	LG-TC		
Manganese Carbonate										
Manganese Chloride							U	U	A	
Magnesium Carbonate										
Magnesium Chloride							A	A	A	
Magnesium Hydroxide							A	A	A	
Magnesium Nitrate							B	B		
Magnesium Sulphate	A	A	A	A	A	A	B	B	A	A
Methylene Chloride	U	U	B	U	U	U	B	B	A	
Mercuric Chloride							B	B		
Mercury							A	A		
Muriatic Acid							U	U		
Nitric Acid-Diluted	U	U	U	U	U	U	A	A		A
Nitric Acid-Concentrated	U	U	U	U	U	U				A
Nitrous Acid									A	
Nitrous Oxide							U	U	A	
Oleic Acid	A	A	A	A	A	A	A	A	A	A
Oxalic Acid	B	B	U	B	B	B	A	A	A	A
Petroleum Oils-Crude							A	A	A	
Phosphoric Acid	A	A	A	A	A	A	A	A	A	A
Picric Acid							B	B	A	
Potassium Bromide							B	B	A	
Potassium Carbonate	A	A	A	A	A	A	A	A		A
Potassium Chloride	A	A	A	A	A	A	A	A	A	A
Potassium Cyanide	A	A	A	A	A	A	A	A	A	A
Potassium Hydroxide	B	B	B	A	B	B	B	B	A	A
Potassium Suphate							A	A	A	
Sea Water	A	A	A	A	A	A	A	A	A	A
Sewage							B	B		
Silver Nitrate							A	A	A	
Soaps							A	A	A	
Sodium Bicarbonate	A	A	A	A	A	A	A	A	A	A
Sodium Bisulphate	A	A	A	A	A	A	A	A	A	
Sodium Bromide									A	
Sodium Carbonate							B	B		A
Sodium Chloride	A	A	A	A	A	A	U	U	A	A
Sodium Hydroxide	B	B	B	A	B	B			A	A
Sodium Hyperchlorite							U	U	A	
Sodium Nitrate									A	
Sodium Peroxide							U	U	A	
Sodium Phosphate							A	A	A	
Sodium Silicate	A	A	A	A	A	A	A	A	A	A
Sodium Sulphate	A	A	A	A	A	A	A	A	A	A
Sodium Sulphide	A	A	A	A	A	A	A	A	A	A
Soy Bean Oil										
Steam	B	B	B	A	A	B	A	A	A	A
Stearic Acid	A	A	A	A	A	A			A	A
Stannic Chloride							U	U	A	
Sulphur Chloride									A	
Sulphur Dioxide-Dry	U	U	B	B	U	B	B	B	A	A
Sulphuric Acid - <10%-Cold									A	U
Sulphuric Acid - <10%-Hot									A	U
Sulphuric Acid - 10-50% Cold	U	U	U	U	U	B			A	U
Sulphuric Acid - 10-50% Hot									A	U
Sulphuric Acid - Fuming							U	U	A	
Sulphurous Acid	B	B	B	B	U	B	U	U	A	A
Sulphur-Molten							B	B		
Tannic Acid	A	A	A	A	A	A	A	A	A	A
Tartaric Acid	A	A	A	A	A	A	A	A	A	A
Vinegar							A	A	A	
Zinc Chloride							B	B	A	
Zinc Sulphate							A	A	A	

A: Good Resistance
B: Moderate Resistance
U: Unsatisfactory

CHEMICAL RESISTANCE CHART (CONT.)

METALLIC MATERIALS

Media	Metal										
	Aluminum	Alloy 20	Copper	Hastelloy®	Inconel®600	Monel®400	Nickel 200	304 SS	316 SS	410 SS	Steel
Acetic Acid (Room Temp.)	A	A	A	A	B	B	B	A	A	A	U
Acetic Anhydride (Room Temp.)	A	A	A	A	B	B	A	A	A	A	B
Acetone	A	A	A	A	A	A	A	A	A	A	A
Aluminum Chloride (Room Temp.)	U	A	B	A	--	B	B	U	U	U	U
Aluminum Fluoride (Room Temp.)	B	A	B	A	--	B	B	U	U	U	B
Aluminum Sulphate	B	A	B	A	B	B	B	A	A	B	U
Ammonia (Anhydrous)	A	A	U	A	A	B	B	A	A	A	B
Ammonium Chloride	U	A	U	A	A	B	B	U	B	B	B
Ammonium Hydroxide	B	A	U	A	A	U	U	A	A	A	A
Ammonium Nitrate	A	A	U	A	B	U	U	A	A	A	A
Ammonium Phosphate	A	A	B	A	B	B	B	A	A	A	U
Ammonium Sulphate	U	A	B	A	B	B	B	U	A	A	A
Amyl Acetate	A	A	A	A	A	A	A	A	A	--	B
Aniline	B	A	A	A	B	B	B	A	A	A	A
Barium Chloride	B	A	B	A	A	--	B	B	A	A	B
Beer	A	A	A	A	A	A	A	A	A	A	A
Benzene	A	A	A	A	A	A	B	A	A	A	A
Benzol	A	A	A	A	B	A	B	A	A	A	A
Borax	A	--	A	A	A	A	--	A	A	A	A
Boric Acid	A	A	A	A	B	B	B	A	A	A	U
Bromine	A	A	A	A	A	A	A	U	U	U	U
Butyl Alcohol	A	A	A	A	A	A	A	A	A	A	A
Calcium Carbonate	A	A	A	A	A	A	A	A	A	A	A
Calcium Chloride	B	A	A	A	A	B	B	B	A	U	A
Calcium Hydroxide	B	A	A	A	B	B	B	B	B	A	A
Calcium Hypochlorite	U	U	U	A	U	U	B	B	A	B	U
Carbolic Acid	A	A	A	A	B	B	B	A	A	U	U
Carbon Tetrachloride	B	A	B	A	A	A	A	A	A	A	U
Chlorine - Dry	A	A	A	A	A	A	A	U	U	U	A
Chlorine - Wet	U	U	U	U	B	B	B	U	U	U	U
Chromic Acid	B	A	U	A	B	U	U	A	A	B	--
Citric Acid	A	A	A	A	B	B	B	A	A	A	U
Copper Chloride	U	--	U	A	U	U	U	U	B	B	B
Copper Sulphate	U	A	B	A	B	B	B	A	A	A	U
Creosote (Coal Tar)	B	A	A	--	B	B	B	A	A	--	A
Crude Oil	A	A	B	A	--	B	--	A	A	A	A
Ether	A	A	A	A	B	B	B	A	A	A	A
Ethyl Acetate	A	A	A	A	A	A	A	A	A	--	A
Ethyl Chloride	B	A	A	A	--	B	B	A	A	A	A
Ferric Chloride	U	U	U	A	U	U	U	U	U	U	U
Ferric Sulphate	B	A	B	A	U	U	U	A	A	A	U
Formaldehyde	B	A	A	A	A	A	A	A	A	A	B
Formic Acid	U	A	A	A	B	B	B	B	A	U	U
Fuel Oil	A	A	A	A	B	B	A	A	A	--	A
Fuel Oil (Acid)	B	A	B	A	U	B	U	U	B	--	B
Furfural	A	A	A	A	B	A	B	A	A	--	A
Gasoline	A	A	A	A	A	A	A	A	A	A	A
Glue	A	A	A	A	A	A	A	A	A	A	A
Glycerin	A	A	A	A	A	A	A	A	A	A	A
Hydrobromic Acid	U	U	U	A	U	U	U	U	U	U	U
Hydrochloric Acid Room Temp. 150 F	U	U	U	A	U	U	U	U	U	U	U
Hydrocyanic Acid	A	A	C	A	--	B	--	A	A	U	B
Hydrofluoric Acid	U	U	U	A	A	A	A	U	U	U	U
Hydrofluosilicic Acid	--	A	U	A	B	--	B	U	U	--	U
Hydrogen Peroxide	A	A	C	A	B	B	B	A	A	A	U
Hydrogen Sulphide	A	A	A	A	B	B	B	A	A	A	U
Kerosene	A	A	A	A	A	A	A	A	A	A	A
Lactic Acid	B	A	A	A	B	U	U	B	B	A	U
Linseed Oil	A	A	B	A	A	A	A	A	A	A	A
Lye (Caustic)	U	A	B	A	A	A	A	A	A	B	A
Manganese Carbonate	A	A	A	--	B	B	B	A	A	A	--
Manganese Chloride	U	B	B	--	B	B	B	A	A	--	--
Magnesium Carbonate	B	A	A	A	A	A	A	A	A	A	--
Magnesium Chloride	B	A	B	A	A	A	A	A	A	U	B

CHEMICAL RESISTANCE CHART (CONT.)

METALLIC MATERIALS

A: Good Resistance
B: Moderate Resistance
U: Unsatisfactory

Media	Metal										
	Aluminum	Alloy 20	Copper	Hastelloy [®]	Inconel [®] 600	Monel [®] 400	Nickel 200	304 SS	316 SS	410 SS	Steel
Magnesium Hydroxide	U	A	A	A	A	A	A	A	A	--	A
Magnesium Nitrate	A	A	B	A	B	B	--	A	A	A	B
Magnesium Sulphate	A	A	A	A	B	B	B	A	A	A	A
Methylene Chloride	U	U	U	A	U	U	U	U	U	U	B
Mercuric Chloride	U	U	U	A	U	U	U	U	U	U	U
Mercury	U	A	U	A	A	B	B	A	A	A	A
Muriatic Acid	U	U	U	A	U	U	U	U	U	U	U
Nitric Acid-Diluted	U	A	U	A	U	U	U	A	A	A	U
Nitric Acid-Concentrated	A	A	U	A	U	U	U	A	A	A	U
Nitrous Acid	B	A	B	--	B	--	--	A	A	A	--
Nitrous Oxide	A	A	A	A	U	A	U	--	--	--	B
Oleic Acid	A	A	A	A	A	B	B	A	A	B	B
Oxalic Acid	B	A	A	A	B	B	B	A	A	--	U
Petroleum Oils-Crude	A	A	U	A	A	A	A	A	A	A	A
Phosphoric Acid	U	A	B	A	B	B	B	A	A	B	U
Picric Acid	A	A		A	U	U	U	A	A	A	A
Potassium Bromide	B	A	A	A	B	A	B	B	A	--	B
Potassium Carbonate	B	A	A	A	B	A	B	A	A	A	B
Potassium Chloride	B	A	B	A	B	B	B	A	A	A	A
Potassium Cyanide	U	A	U	A	B	B	B	A	A	A	A
Potassium Hydroxide	U	A	U	A	B	A	A	B	A	--	B
Potassium Suphate	A	A	A	--	B	B	B	A	A	--	A
Sea Water	B	A	B	A	B	B	B	A	A	U	B
Sewage	B	--	B	--	--	--	--	A	A	--	B
Silver Nitrate	U	A	U	B	B	U	U	A	A	A	U
Soaps	B	A	B	A	A	A	A	A	A	A	A
Sodium Bicarbonate	B	A	A	A	A	A	A	A	A	A	B
Sodium Bisulphate	B	A	B	A	B	B	B	A	A	--	U
Sodium Bromide	B	A	A	A	B	B	B	A	A	--	B
Sodium Carbonate	B	A	A	A	B	B	B	A	A	A	A
Sodium Chloride	B	A	A	A	A	A	A	A	A	--	A
Sodium Hydroxide	U	A	B	A	A	A	A	A	A	A	A
Sodium Hyperchlorite	U	B	U	A	U	U	U	B	A	U	U
Sodium Nitrate	A	A	A	A	A	B	B	A	A	A	A
Sodium Peroxide	A	A	B	A	B	B	B	A	A	--	B
Sodium Phosphate	A	A	A	A	B	B	B	A	A	--	B
Sodium Silicate	B	A	A	A	--	B	--	A	A	A	A
Sodium Sulphate	A	A	A	A	B	B	B	A	A	A	A
Sodium Sulphide	U	A	U	A	B	--	B	B	--	B	A
Soy Bean Oil	A	A	A	A	--	B	--	A	A	--	--
Steam	A	A	B	--	A	A	A	A	A	A	A
Stearic Acid	A	A	A	A	B	B	B	A	A	A	B
Stannic Chloride	U	A	U	A	B	B	B	A	A	U	--
Sulphur Chloride	U	A	A	A	--	B	B	U	U	U	B
Sulphur Dioxide-Dry	A	A	A	A	A	A	A	A	A	--	A
Sulphuric Acid - <10%-Cold	B	A	B	A	U	B	B	U	B	U	U
Sulphuric Acid - <10%-Hot	U	B	U	A	U	B	U	U	U	U	U
Sulphuric Acid - 10-50% Cold	U	A	U	A	U	B	U	U	U	--	U
Sulphuric Acid - 10-50% Hot	U	U	U	A	U	U	U	U	U	U	U
Sulphuric Acid - Fuming	A	A	U	A	U	U	U	A	A	--	B
Sulphurous Acid	B	A	U	A	U	U	U	U	B	U	A
Sulphur-Molten	A	A	U	A	A	U	U	A	A	A	A
Tannic Acid	B	A	A	A	B	B	B	A	A	A	U
Tartaric Acid	B	A	A	A	B	B	B	A	A	U	U
Vinegar	B	A	B	A	A	A	A	A	A	A	B
Zinc Chloride	U	A	B	B	B	B	B	U	U	U	B
Zinc Sulphate	B	A	A	A	B	B	B	A	A	A	B

RECOGNIZED TEMPERATURE LIMITS

COMPRESSED SHEET MATERIALS

Material	Temperature (°F)		Temperature (°C)	
	Minimum	Maximum	Minimum	Maximum
L-441	-40	400	-40	204
L-430	-40	400	-40	204
L-640W	-40	400	-40	204
L-450	-40	650	-40	343
L-443	-40	500	-40	260
L-540	-40	400	-40	204

NON-METALLIC MATERIALS

Material	Temperature (°F)		Temperature (°C)	
	Minimum	Maximum	Minimum	Maximum
Buna-N Rubber (Nitrile, NBR)	-60	250	-51	121
Ceramic Fiber	Cryogenic	2000	Cryogenic	1093
Chlorosulfonated Polyethylene (Hypalon®)	-50	275	-46	135
CR (Chloroprene) (Neoprene)	-60	250	-51	121
EPDM (Ethylene Propylene) Monomer	-70	350	-57	177
Fluorocarbon (Viton®)	-15	450	-26	232
Oxidation Inhibited Graphite	Cryogenic	975	Cryogenic	524
Graphite	Cryogenic	850	Cryogenic	454
Natural Rubber	-70	200	-57	93
PTFE (Polytetrafluoroethylene)	-140	450	-96	232
SBR (Styrene-Butadiene)	-65	250	-54	121
Silicones	-65	500	-54	260
Mica	Cryogenic	1832	Cryogenic	1000

METALLIC MATERIALS

Material	Maximum Temperature	
	°F	°C
Carbon Steel	1000	538
304 SS	1400	760
309 SS	2000	1095
310 SS	2100	1150
316 SS	1400	760
321 SS	1500	815
347 SS	1700	925
410 SS	1300	705
430 SS	1500	815
501 SS	1200	649
Alloy 20	1500	815
Aluminum	800	427
Brass	500	260
Copper	500	260
Hastelloy® B & C	2000	1095
Inconel® 600	2000	1095
Incolloy® 800	1600	871
Monel®	1500	815
Nickel	1400	760
Phosphor Bronze	500	260
Tantalum	3000	1649
Titanium	2000	1095

Note: Maximum temperature ratings are based upon hot air constant temperatures. The presence of contaminating fluids and cyclic conditions may drastically affect the maximum temperature range.

GALVANIC CORROSION

Galvanic Corrosion is the corrosion that results when two different metals with different potentials are placed in electrical contact in an electrolyte. Difference in electrical potential exists between the different metals and serves as the driving force for electrical current flow through the corroding electrolyte. The current flow results in corrosion of one of the metals. The larger the potential difference, the greater the probability of galvanic corrosion. Galvanic corrosion only causes deterioration of one of the metals. The less resistant, active metal becomes the anodic corrosion site. The stronger, more noble metal is cathodic and protected.

Metals close to one another on the chart generally do not have a strong effect on one another, but the farther apart any two metals are separated, the stronger the corroding effect on the one higher in the list. The following list represents the potential available to promote a corrosive reaction, however the actual corrosion in each application is difficult to predict. Typically, the presence of an electrolyte is necessary to promote galvanic corrosion.

GALVANIC CORROSION CHART

Anodic (least noble) Corroded	Magnesium	Anodic (least noble) Corroded
	Magnesium Alloys	
	Zinc	
	Beryllium	
	Aluminum 1100, 3003, 3004, 5052, 6053	
	Cadmium	
	Aluminum 2017, 2024, 2117	
	Mild Steel 1018, Wrought Iron	
	HSLA Steel, Cast Iron	
	Chrome Iron (Active)	
	430 Stainless (Active)	
	302, 303, 321, 347, 410, 416 Stainless Steel (Active)	
	Ni-Resist	
	316, 317 Stainless (Active)	
	Carpenter 20Cb-3 Stainless (Active)	
	Aluminum Bronze (CA687)	
	Hastelloy® C (Active) Inconel® 625 (Active) Titanium (Active)	
	Lead / Tin Solder	
	Lead / Tin Solder	
	Tin	
	Inconel® 600 (Active)	
	Nickel (Active)	
	60% Ni 15% Cr (Active)	
	80% Ni 20% Cr (Active)	
	Hastelloy® B (Active)	
	Naval Brass (CA464), Yellow Brass (CA268)	
	Reb Brass (CA230), Admiralty Brass (CA443)	
	Copper (CA102)	
	Manganese Bronze (CA675), Tin Bronze (CA903, 905)	
	410, 416 Stainless (passive) Phosphor Bronze (CA521, 524)	
	Silicon Bronze (CA651, 655)	
	Nickel Silver (CA732, 735, 745, 752, 754, 757, 765, 770, 794)	
	Cupro Nickel 90-10	
	Cupro Nickel 80-20	
	430 Stainless (passive)	
	Cupro Nickel 70-30	
	Nickel Aluminum Bronze (CA 630, 632)	
	Monel® 400, K500	
	Sliver Solder	
	Nickel (passive)	
	60% Ni 15% Cr (passive)	
	Inconel® 600 (passive)	
	80% Ni 20% Cr (passive)	
	Chrome Iron (passive)	
	302, 303, 304, 321, 347 Stainless (passive)	
	316, 317 Stainless (passive)	
	Carpenter 20Cb-3 Stainless (passive), Incoloy 825 (passive)	
	Silver	
	Titanium (passive), Hastelloy® C & C276 (passive)	
	Graphite	
	Zirconium	
	Gold	
	Platinum	
Cathodic (most noble) Protected		Cathodic (most noble) Protected

TEMPERATURE CONVERSION

To convert between degrees Fahrenheit (°F) and degrees Celsius (°C):

$$T_c = (5/9) \times (T_f - 32)$$

$$T_f = (9/5) \times T_c + 32$$

Where: T_c is temperature in Celsius
 T_f is temperature in Fahrenheit

To convert between degrees Fahrenheit (°F) and Kelvin (K):

$$T_f = ((9/5) \times (T_k - 273.15)) + 32$$

$$T_k = (5/9 \times (T_f - 32)) - 273.15$$

Where: T_f is temperature in Fahrenheit
 T_k is temperature in Kelvin

To convert between degrees Fahrenheit (°F) to Rankine (R):

$$T_f = T_R - 459.69$$

$$T = T_f + 459.69$$

Where: T_f is temperature in Fahrenheit
 T_R is temperature in Rankine

To convert between degrees Celsius (°C) to Kelvin (K):

$$T_c = T_k + 273.15$$

$$T_k = T_c - 273.15$$

Where: T_c is temperature in Celsius
 T_k is temperature in Kelvin

To convert between degree Celsius (°C) to Rankine (R):

$$T_c = (5/9) \times (T_R - 491.69)$$

$$T_R = (9/5) \times T_c + 491.69$$

Where: T_c is temperature in Celsius
 T_R is temperature in Rankine

To convert between Kelvin (K) and Rankine (R):

$$T_k = (5/9) \times (T_R - 764.84)$$

$$T_R = 9/5 \times T_k + 764.84$$

Where: T_k is temperature in Kelvin
 T_R is temperature in Rankine

PRESSURE CONVERSION

To convert between inches of mercury (inHg) and millimeters of mercury (mmHg) or torr:

$$P \text{ mmHg} = 25.4 \times P \text{ inHg}$$

$$P \text{ inHg} = 0.03937008 \times P \text{ mmHg}$$

To convert between inches of mercury (inHg) and millibars (mb) or hectopascals (hPa)

$$P \text{ mb} = 33.8639 \times P \text{ inHg}$$

$$P \text{ inHg} = 0.0295300 \times P \text{ mb}$$

To convert between inches of mercury (inHg) and kilopascals (kPa)

$$P \text{ kPa} = 3.38639 \times (P \text{ inHg}/10)$$

$$P \text{ inHg} = 0.295300 \times P \text{ kPa}$$

To convert between inches of mercury (inHg) and pounds per square inch (psi)

$$P \text{ psi} = 0.491130 \times P \text{ inHg}$$

$$P \text{ inHg} = 2.03602 \times P \text{ psi}$$

To convert between torr or millimeters of mercury (mmHg) and millibars (mb) or hectopascals (hPa)

$$P \text{ mb} = 1.333224 \times P \text{ mmHg}$$

$$P \text{ mmHg} = 0.750062 \times P \text{ mb}$$

To convert between torr or millimeters of mercury (mmHg) and kilopascals (kPa)

$$P \text{ kPa} = 0.1333224 \times (P \text{ mmHg}/10)$$

$$P \text{ mmHg} = 7.50062 \times P \text{ kPa}$$

To convert between torr or millimeters of mercury (mmHg) and pounds per square inch (psi)

$$P \text{ psi} = 0.0193368 \times P \text{ mmHg}$$

$$P \text{ mmHg} = 51.7149 \times P \text{ psi}$$

To convert between millibars (mb) or hectopascals (hPa) and kilopascals (kPa)

$$P \text{ kPa} = P \text{ mb}/10$$

$$P \text{ mb} = 10 \times P \text{ kPa}$$

To convert between millibars (mb) or hectopascals (hPa) and pounds per square inch (psi)

$$P \text{ psi} = 0.0145038 \times P \text{ mb}$$

$$P \text{ mb} = 68.9476 \times P \text{ psi}$$

To convert between kilopascals (kPa) and pounds per square inch (psi)

$$P \text{ psi} = 0.145038 \times P \text{ kPa}$$

$$P \text{ mb} = 6.89476 \times P \text{ psi}$$

HARDNESS CONVERSION CHART

Rockwell						Rockwell Superficial				Brinell		Vickers	Shore	Approx Tensile Strength (psi)
A	B	C	D	E	F	15-N	30-N	45-N	30-T	3000 kg	500 kg	136		
60 kg Brale	100 kg 1/16" Ball	150 kg Brale	100 kg Brale	100 kg 1/8" Ball	60 kg 1/16" Ball	15 kg Brale	30 kg Brale	45 kg Brale	30 kg 1/16" Ball	10mm Ball Steel	10mm Ball Steel	Diamond Pyramid	Sclero- scope	
86.5	--	70	78.5	--	--	94.0	86.0	77.6	--	--	--	1076	101	--
86.0	--	69	77.7	--	--	93.5	85.0	76.5	--	--	--	1044	99	--
85.6	--	68	76.9	--	--	93.2	84.4	75.4	--	--	--	940	97	--
85.0	--	67	76.1	--	--	92.9	83.6	74.2	--	--	--	900	95	--
84.5	--	66	75.4	--	--	92.5	82.8	73.2	--	--	--	865	92	--
83.9	--	65	74.5	--	--	92.2	81.9	72.0	--	739	--	832	91	--
83.4	--	64	73.8	--	--	91.8	81.1	71.0	--	722	--	800	88	--
82.8	--	63	73.0	--	--	91.4	80.1	69.9	--	705	--	772	87	--
82.3	--	62	72.2	--	--	91.1	79.3	68.8	--	688	--	746	85	--
81.8	--	61	71.5	--	--	90.7	78.4	67.7	--	670	--	720	83	--
81.2	--	60	70.7	--	--	90.2	77.5	66.6	--	654	--	697	81	320000
80.7	--	59	69.9	--	--	89.8	76.6	65.5	--	634	--	674	80	310000
80.1	--	58	69.2	--	--	89.3	75.7	64.3	--	615	--	653	78	300000
79.6	--	57	68.5	--	--	88.9	74.8	63.2	--	595	--	633	76	380000
79.0	--	56	67.7	--	--	88.3	73.9	62.0	--	577	--	613	75	282000
78.5	120	55	66.9	--	--	87.9	73.0	60.9	--	560	--	595	74	274000
78.0	120	54	66.1	--	--	87.4	72.0	59.8	--	543	--	577	72	266000
77.4	119	53	65.4	--	--	86.9	71.2	58.6	--	525	--	560	71	257000
76.8	119	52	64.6	--	--	86.4	70.2	57.4	--	500	--	544	69	245000
76.3	118	51	63.8	--	--	85.9	69.4	56.1	--	487	--	528	68	239000
75.9	117	50	63.1	--	--	85.5	68.5	55.0	--	475	--	513	67	233000
75.2	117	49	62.1	--	--	85.0	67.6	53.8	--	464	--	498	66	227000
74.7	116	48	61.4	--	--	84.5	66.7	52.5	--	451	--	484	64	221000
74.1	116	47	60.8	--	--	83.9	65.8	51.4	--	442	--	471	63	217
73.6	115	46	60.0	--	--	83.5	64.8	50.3	--	432	--	458	62	212000
73.1	115	45	59.2	--	--	83.0	64.0	49.0	--	421	--	446	60	206000
72.5	114	44	58.5	--	--	82.5	63.1	47.8	--	409	--	434	58	200000
72.0	113	43	57.7	--	--	82.0	62.2	46.7	--	400	--	423	57	196000
71.5	113	42	56.9	--	--	81.5	61.3	45.5	--	390	--	412	56	191000
70.9	112	41	56.2	--	--	80.9	60.4	44.3	--	381	--	402	55	187000
70.4	112	40	55.4	--	--	80.4	59.5	43.1	--	371	--	392	54	182000
69.9	111	39	54.6	--	--	79.9	58.6	41.6	--	362	--	382	52	177000
69.4	110	38	53.8	--	--	79.4	57.7	40.8	--	353	--	372	51	173000
68.9	110	37	53.1	--	--	78.8	56.8	39.6	--	344	--	363	50	169000
68.4	109	36	52.3	--	--	78.3	55.9	38.4	--	336	--	354	49	165000
67.9	109	35	51.5	--	--	77.7	55.0	37.2	--	327	--	345	48	160000
67.4	108	34	50.8	--	--	77.2	54.2	36.1	--	319	--	336	47	156000
66.8	108	33	50.0	--	--	76.6	53.3	34.9	--	311	--	327	46	152000
66.3	107	32	49.2	--	--	76.1	52.1	33.7	--	301	--	318	44	147000
65.8	106	31	48.4	--	--	75.6	51.3	32.5	--	294	--	310	43	144000
65.3	105	30	47.7	--	--	75.0	50.4	31.3	--	286	--	302	42	140000
64.7	104	9	47.0	--	--	74.5	49.5	30.1	--	279	--	294	41	137000
64.3	104	28	46.1	--	--	73.9	48.6	28.9	--	271	--	286	41	133000
63.8	103	27	45.2	--	--	73.3	47.7	27.8	--	264	--	279	40	129000
63.3	103	26	44.6	--	--	72.8	46.8	26.7	--	258	--	272	39	126000
62.8	102	25	43.8	--	--	72.2	45.9	25.5	--	253	--	266	38	124000
62.4	101	24	43.1	--	--	71.6	45.0	24.3	--	247	--	260	37	121000
62.0	100	23	42.1	--	--	71.0	44.0	23.1	82	240	201	254	36	118000
61.5	99	22	41.6	--	--	70.5	43.2	22.0	81.5	234	195	248	35	115000
61.0	98	21	40.9	--	--	69.9	42.3	20.7	81	228	189	243	35	112000
60.5	97	20	40.1	--	--	69.4	41.5	19.6	80.5	222	184	238	34	109000
59.0	96	18	--	--	--	--	--	--	80	216	179	230	33	106000
58.0	95	16	--	--	--	--	--	--	79	210	175	222	32	103000
57.5	94	15	--	--	--	--	--	--	78.5	205	171	213	31	100000
57.0	93	13	--	--	--	--	--	--	78	200	167	208	30	98000
56.5	92	12	--	--	--	--	--	--	77.5	195	163	204	29	96000

HARDNESS CONVERSION CHART (CONT.)

Rockwell						Rockwell Superficial				Brinell		Vickers	Shore	Approx Tensile Strength (psi)
A	B	C	D	E	F	15-N	30-N	45-N	30-T	3000 kg	500 kg	136		
60 kg Brale	100 kg 1/16" Ball	150 kg Brale	100 kg Brale	100 kg 1/8" Ball	60 kg 1/16" Ball	15 kg Brale	30 kg Brale	45 kg Brale	30 kg 1/16" Ball	10mm Ball Steel	10mm Ball Steel	Diamond Pyramid	Sclero- scope	
56.0	91	10	--	--	--	--	--	--	77	190	160	193	28	93000
55.5	90	9	--	--	--	--	--	--	76	185	157	192	27	91000
55.0	89	8	--	--	--	--	--	--	75.5	180	154	188	26	88000
54.0	88	7	--	--	--	--	--	--	75	176	151	184	26	86000
53.5	87	6	--	--	--	--	--	--	74.5	172	148	180	26	84000
53.0	86	5	--	--	--	--	--	--	74	169	145	176	25	83000
52.5	85	4	--	--	--	--	--	--	73.5	165	142	173	25	81000
52.0	84	3	--	--	--	--	--	--	73	162	140	170	25	79000
51.0	83	2	--	--	--	--	--	--	72	159	137	166	24	78000
50.5	82	1	--	--	--	--	--	--	71.5	156	135	193	24	76000
50.0	81	0	--	--	--	--	--	--	71	153	133	160	24	75000
49.5	80	--	--	--	--	--	--	--	70	150	130	--	--	73000
49.0	79	--	--	--	--	--	--	--	69.5	147	128	--	--	--
48.5	78	--	--	--	--	--	--	--	69	144	126	--	--	--
48.0	77	--	--	--	--	--	--	--	68	141	124	--	--	--
47.0	76	--	--	--	--	--	--	--	67.5	139	122	--	--	--
46.5	75	--	--	--	99.5	--	--	--	67	137	120	--	--	--
46.0	74	--	--	--	99	--	--	--	66	135	118	--	--	--
45.5	73	--	--	--	98.5	--	--	--	65.5	132	116	--	--	--
45.0	72	--	--	--	98	--	--	--	65	130	114	--	--	--
44.5	71	--	--	100	97.5	--	--	--	64.2	127	112	--	--	--
44.0	70	--	--	99.5	97	--	--	--	63.5	125	110	--	--	--
43.5	69	--	--	99	93	--	--	--	62.8	123	109	--	--	--
43.0	68	--	--	98	95.5	--	--	--	62	121	107	--	--	--
42.5	67	--	--	97.5	95	--	--	--	61.4	119	106	--	--	--
42.0	66	--	--	97	94.5	--	--	--	60.5	117	104	--	--	--
41.8	65	--	--	93	94	--	--	--	60.1	116	102	--	--	--
41.5	64	--	--	95.5	93.5	--	--	--	59.5	114	101	--	--	--
41.0	63	--	--	95	93	--	--	--	58.7	112	99	--	--	--
40.5	62	--	--	94.5	92	--	--	--	58	110	98	--	--	--
40.0	61	--	--	93.5	91.5	--	--	--	57.3	108	96	--	--	--
39.5	60	--	--	93	91	--	--	--	56.5	107	95	--	--	--
39.0	59	--	--	92.5	90.5	--	--	--	55.9	106	94	--	--	--
38.5	58	--	--	92	90	--	--	--	55	104	92	--	--	--
38.0	57	--	--	91	89.5	--	--	--	54.6	102	91	--	--	--
37.8	56	--	--	90.5	89	--	--	--	54	101	90	--	--	--
37.5	55	--	--	90	88	--	--	--	53.2	99	89	--	--	--
37.0	54	--	--	89.5	87.5	--	--	--	52.5	--	87	--	--	--
36.5	53	--	--	89	87	--	--	--	51.8	--	86	--	--	--
36.0	52	--	--	88	86.5	--	--	--	51	--	85	--	--	--
35.5	51	--	--	87.5	86	--	--	--	50.4	--	84	--	--	--
35.0	50	--	--	87	85.5	--	--	--	49.5	--	83	--	--	--
34.8	49	--	--	86.5	85	--	--	--	49.1	--	82	--	--	--
34.5	48	--	--	85.5	84.5	--	--	--	48.5	--	81	--	--	--
34.0	47	--	--	85	84	--	--	--	47.7	--	80	--	--	--
33.5	46	--	--	84.5	83	--	--	--	47	--	79	--	--	--
33.0	45	--	--	84	82.5	--	--	--	46.2	--	79	--	--	--
32.5	44	--	--	83.5	82	--	--	--	45.5	--	78	--	--	--
32.0	43	--	--	82.5	81.5	--	--	--	44.8	--	77	--	--	--
31.5	42	--	--	82	81	--	--	--	44	--	76	--	--	--
31.0	41	--	--	81.5	80.5	--	--	--	43.4	--	75	--	--	--
30.8	40	--	--	81	79.5	--	--	--	43	--	74	--	--	--
30.5	39	--	--	80	79	--	--	--	42.1	--	74	--	--	--
30.0	38	--	--	79.5	78.5	--	--	--	41.5	--	73	--	--	--
29.5	37	--	--	79	78	--	--	--	40.7	--	72	--	--	--
29.0	36	--	--	78.5	77.5	--	--	--	40	--	71	--	--	--
28.5	35	--	--	78	77	--	--	--	39.3	--	71	--	--	--
28.0	34	--	--	77	76.5	--	--	--	38.5	--	70	--	--	--

HARDNESS CONVERSION CHART (CONT.)

Rockwell						Rockwell Superficial				Brinell		Vickers	Shore	Approx Tensile Strength (psi)
A	B	C	D	E	F	15-N	30-N	45-N	30-T	3000 kg	500 kg	136		
60 kg Brale	100 kg 1/16" Ball	150 kg Brale	100 kg Brale	100 kg 1/8" Ball	60 kg 1/16" Ball	15 kg Brale	30 kg Brale	45 kg Brale	30 kg 1/16" Ball	10mm Ball Steel	10mm Ball Steel	Diamond Pyramid	Sciero- scope	
27.8	33	--	--	76.5	75.5	--	--	--	37.9	--	69	--	--	--
27.5	32	--	--	76	75	--	--	--	37.5	--	68	--	--	--
27.0	31	--	--	75.5	74.5	--	--	--	36.6	--	68	--	--	--
26.5	30	--	--	75	74	--	--	--	36	--	67	--	--	--
26.0	29	--	--	74	73.5	--	--	--	35.2	--	66	--	--	--
25.5	28	--	--	73.5	73	--	--	--	34.5	--	66	--	--	--
25.0	27	--	--	73	72.5	--	--	--	33.8	--	65	--	--	--
24.5	26	--	--	72.5	72	--	--	--	33.1	--	65	--	--	--
24.2	25	--	--	72	71	--	--	--	32.4	--	64	--	--	--
24.0	24	--	--	71	70.5	--	--	--	32	--	64	--	--	--
23.5	23	--	--	70.5	70	--	--	--	31.1	--	63	--	--	--
23.0	22	--	--	70	69.5	--	--	--	30.4	--	63	--	--	--
22.5	21	--	--	69.5	69	--	--	--	29.7	--	62	--	--	--
22.0	20	--	--	68.5	68.5	--	--	--	29	--	62	--	--	--
21.5	19	--	--	68	68	--	--	--	28.1	--	61	--	--	--
21.2	18	--	--	67.5	67	--	--	--	27.4	--	61	--	--	--
21.0	17	--	--	67	66.5	--	--	--	26.7	--	60	--	--	--
20.5	16	--	--	66.5	66	--	--	--	26	--	60	--	--	--
20.0	15	--	--	65.5	65.5	--	--	--	25.3	--	59	--	--	--
--	14	--	--	65	65	--	--	--	24.6	--	59	--	--	--
--	13	--	--	64.5	64.5	--	--	--	23.9	--	58	--	--	--
--	12	--	--	64	64	--	--	--	23.5	--	58	--	--	--
--	11	--	--	63.5	63.5	--	--	--	22.6	--	57	--	--	--
--	10	--	--	62.5	63	--	--	--	21.9	--	57	--	--	--
--	9	--	--	62	62	--	--	--	21.2	--	56	--	--	--
--	8	--	--	61.5	61.5	--	--	--	20.5	--	56	--	--	--
--	7	--	--	61	61	--	--	--	19.8	--	56	--	--	--
--	6	--	--	60.5	60.5	--	--	--	19.1	--	55	--	--	--
--	5	--	--	60	60	--	--	--	18.4	--	55	--	--	--
--	4	--	--	59	59.5	--	--	--	18	--	55	--	--	--
--	3	--	--	58.5	59	--	--	--	17.1	--	54	--	--	--
--	2	--	--	58	58	--	--	--	16.4	--	54	--	--	--
--	1	--	--	57.5	57.5	--	--	--	15.7	--	53	--	--	--
--	0	--	--	57	57	--	--	--	15	--	53	--	--	--

PIPE DIMENSIONS AND WEIGHTS

NPS	OD	Schedule Designations			Wall		ID		Weight	
					Inches	mm	Inches	mm	Lbs/Ft	Kg/m
1/8	0.405	10		10S	0.049	1.2	0.307	7.8	0.19	0.28
		STD	40	40S	0.068	1.7	0.269	6.8	0.24	0.36
		XS	80	80S	0.095	2.4	0.215	5.5	0.31	0.47
1/4	0.540	10		10S	0.065	1.7	0.410	10.4	0.33	0.49
		STD	40	40S	0.088	2.2	0.364	9.2	0.42	0.63
		XS	80	80S	0.119	3.0	0.302	7.7	0.54	0.80
3/8	0.675	10		10S	0.065	1.7	0.545	13.8	0.42	0.63
		STD	40	40S	0.091	2.3	0.493	12.5	0.57	0.84
		XS	80	80S	0.126	3.2	0.423	10.7	0.74	1.10
1/2	0.840	5		5S	0.065	1.7	0.710	18.0	0.54	0.80
		10		10S	0.083	2.1	0.674	17.1	0.67	1.00
		STD	40	40S	0.109	2.8	0.622	15.8	0.85	1.26
		XS	80	80S	0.147	3.7	0.546	13.9	1.09	1.62
		160			0.188	4.8	0.464	11.8	1.31	1.95
		XX			0.294	7.5	0.252	6.4	1.71	2.55
3/4	1.050	5		5S	0.065	1.7	0.920	23.4	0.68	1.02
		10		10S	0.083	2.1	0.884	22.5	0.86	1.28
		STD	40	40S	0.113	2.9	0.842	21.4	1.13	1.68
		XS	80	80S	0.154	3.9	0.742	18.8	1.47	2.19
		160			0.219	5.6	0.612	15.5	1.94	2.89
		XX			0.308	7.8	0.434	11.0	2.44	3.63
1	1.315	5		5S	0.065	1.7	1.185	30.1	0.87	1.29
		10		10S	0.109	2.8	1.097	27.9	1.40	2.09
		STD	40	40S	0.133	3.4	1.049	26.6	1.68	2.50
		XS	80	80S	0.179	4.5	0.957	24.3	2.17	3.23
		160			0.250	6.4	0.815	20.7	2.84	4.23
		XX			0.358	9.1	0.599	15.2	3.66	5.44
1 1/4	1.660	5		5S	0.065	1.7	1.530	38.9	1.11	1.65
		10		10S	0.109	2.8	1.442	36.6	1.81	2.69
		STD	40	40S	0.140	3.6	1.380	35.1	2.27	3.38
		XS	80	80S	0.191	4.9	1.278	32.5	3.00	4.46
		160			0.250	6.4	1.160	29.5	3.77	5.60
		XX			0.382	9.7	0.896	22.8	5.21	7.76
1 1/2	1.900	5		5S	0.065	1.7	1.770	45.0	1.27	1.90
		10		10S	0.109	2.8	1.682	42.7	2.09	3.10
		STD	40	40S	0.145	3.7	1.610	40.9	2.72	4.04
		XS	80	80S	0.200	5.1	1.500	38.1	3.63	5.40
		160			0.281	7.1	1.338	34.0	4.86	7.23
		XX			0.400	10.2	1.100	27.9	6.41	9.54
2	2.375	5		5S	0.065	1.7	2.245	57.0	1.60	2.39
		10		10S	0.109	2.8	2.157	54.8	2.64	3.93
		STD	40	40S	0.154	3.9	2.067	52.5	3.65	5.44
		XS	80	80S	0.218	5.5	1.939	49.3	5.02	7.47
		160			0.344	8.7	1.687	42.8	7.46	11.10
		XX			0.436	11.1	1.503	38.2	9.03	13.44

PIPE DIMENSIONS AND WEIGHTS (CONT.)

NPS Inches	OD Inches	Schedule Designations			Wall		ID		Weight	
					Inches	mm	Inches	mm	Lbs/Ft	Kg/m
2 1/2	2.875	5		5S	0.083	2.1	2.709	68.8	2.48	3.68
		10		10S	0.120	3.0	2.635	66.9	3.53	5.25
		STD	40	40S	0.203	5.2	2.469	62.7	5.79	8.62
		XS	80	80S	0.276	7.0	2.323	59.0	7.66	11.40
		160			0.375	9.5	2.125	54.0	10.01	14.89
		XX			0.552	14.0	1.771	45.0	13.69	20.37
3	3.500	5		5S	0.083	2.1	3.334	84.7	3.03	4.51
		10		10S	0.120	3.0	3.260	82.8	4.33	6.45
		STD	40	40S	0.216	5.5	3.068	77.9	7.58	11.27
		XS	80	80S	0.300	7.6	2.900	73.7	10.25	15.25
		160			0.438	11.1	2.624	66.6	14.32	21.31
		XX			0.600	15.2	2.300	58.4	18.58	27.65
3 1/2	4.000	5		5S	0.083	2.1	3.834	97.4	3.47	5.17
		10		10S	0.120	3.0	3.760	95.5	4.97	7.40
		STD	40	40S	0.226	5.7	3.548	90.1	9.11	13.55
		XS	80	80S	0.318	8.1	3.364	85.4	12.50	18.60
		XX			0.636	16.2	2.728	69.3	22.85	34.00
4	4.500	5		5S	0.083	2.1	4.334	110.1	3.92	5.83
		10		10S	0.120	3.0	4.260	108.2	5.61	8.35
					0.156	4.0	4.188	106.4	7.24	10.77
					0.188	4.8	4.124	104.7	8.66	12.88
		STD	40	40S	0.237	6.0	4.026	102.3	10.79	16.06
		XS	80	80S	0.337	8.6	3.826	97.2	14.98	22.29
		120			0.438	11.1	3.624	92.0	19.00	28.27
		160			0.531	13.5	3.438	87.3	22.51	33.49
4 1/2	5.000	XX			0.674	17.1	3.152	80.1	27.54	40.98
		STD	40	40S	0.247	6.3	4.506	114.5	12.53	18.64
		XS	80	80S	0.355	9.0	4.290	109.0	17.61	26.20
5	5.563	XX			0.710	18.0	3.580	90.9	32.43	48.26
		5		5S	0.109	2.8	5.345	135.8	6.35	9.45
		10		10S	0.134	3.4	5.295	134.5	7.77	11.56
		STD	40	40S	0.258	6.6	5.047	128.2	14.62	21.75
		XS	80	80S	0.375	9.5	4.813	122.3	20.78	30.92
					0.500	12.7	4.563	115.9	27.04	40.24
6	6.625	160			0.625	15.9	4.313	109.6	32.96	49.04
		XX			0.750	19.1	4.063	103.2	38.55	57.36
		5		5S	0.109	2.8	6.407	162.7	7.59	11.29
		10		10S	0.134	3.4	6.357	161.5	9.29	13.82
					0.188	4.8	6.249	158.7	12.92	19.22
		STD	40	40S	0.280	7.1	6.065	154.1	18.97	28.23
		XS	80	80S	0.432	11.0	5.761	146.3	28.57	42.51
		120			0.562	14.3	5.501	139.7	36.39	54.15
7	7.625	160			0.719	18.3	5.187	131.7	45.35	67.48
		XX			0.864	21.9	4.897	124.4	53.16	79.10
		STD	40	40S	0.301	7.6	7.023	178.4	23.57	35.07
		XS	80	80S	0.500	12.7	6.625	168.3	39.05	58.11
		XX			0.875	22.2	5.875	149.2	63.08	93.86

PIPE DIMENSIONS AND WEIGHTS (CONT.)

NPS	OD	Schedule Designations			Wall		ID		Weight	
					Inches	mm	Inches	mm	Lbs/Ft	Kg/m
8	8.625			5S	0.109	2.8	8.407	213.5	9.91	14.75
		10		10S	0.148	3.8	8.329	211.6	13.40	19.94
		20			0.250	6.4	3.125	79.4	22.36	33.27
		30			0.277	7.0	8.071	205.0	24.70	36.75
		STD	40	40S	0.322	8.2	7.981	202.7	28.55	42.48
		60			0.406	10.3	7.813	198.5	35.64	53.03
		XS	80	80S	0.500	12.7	7.625	193.7	43.39	64.56
		100			0.594	15.1	7.437	188.9	50.95	75.81
		120			0.719	18.3	7.187	182.5	60.71	90.34
		140			0.812	20.6	7.001	177.8	67.76	100.83
		XX			0.875	22.2	6.875	174.6	72.42	107.76
		160			0.906	23.0	6.813	173.1	74.69	111.14
9	9.625	STD	40	40S	0.342	8.7	8.941	227.1	33.90	50.44
		XS	80	80S	0.500	12.7	9.625	244.5	48.72	72.50
		XX			0.875	22.2	7.875	200.0	81.77	121.67
10	10.750			5S	0.134	3.4	10.482	266.2	15.19	22.60
				10S	0.165	4.2	10.420	264.7	18.70	27.83
					0.188	4.8	10.374	263.5	21.21	31.56
		20			0.250	6.4	10.250	260.4	28.04	41.72
		30			0.307	7.8	10.136	257.5	34.24	50.95
		STD	40	40S	0.365	9.3	10.020	254.5	40.48	60.23
		XS	60	80S	0.500	12.7	9.750	247.7	54.74	81.45
		80			0.594	15.1	9.562	242.9	64.43	95.87
		100			0.719	18.3	9.312	236.5	77.03	114.62
		120			0.844	21.4	9.062	230.2	89.29	132.86
		140			1.000	25.4	8.750	222.3	104.13	154.95
		160			1.125	28.6	8.500	215.9	115.64	172.07
11	11.750	STD	40	40S	0.375	9.5	11.000	279.4	45.55	67.78
		XS	80	80S	0.500	12.7	10.750	273.1	60.07	89.38
		XX			0.875	22.2	10.000	254.0	101.63	151.23
12	12.750			5S	0.156	4.0	12.438	315.9	20.98	31.22
				10S	0.180	4.6	12.390	314.7	24.20	36.01
		20			0.250	6.4	12.250	311.2	33.38	49.67
		30			0.330	8.4	12.090	307.1	43.77	65.13
		STD		40S	0.375	9.5	12.000	304.8	49.56	73.75
		40			0.406	10.3	11.938	303.2	53.52	79.64
		XS		80S	0.500	12.7	11.750	298.5	65.42	97.34
		60			0.562	14.3	11.626	295.3	73.15	108.85
		80			0.688	17.5	11.374	288.9	88.62	131.87
		100			0.844	21.4	11.062	281.0	107.32	159.69
		120			1.000	25.4	10.750	273.1	125.49	186.73
		140			1.125	28.6	10.500	266.7	139.67	207.83
		160			1.312	33.3	10.126	257.2	160.27	238.48

PIPE DIMENSIONS AND WEIGHTS (CONT.)

NPS Inches	OD Inches	Schedule Designations			Wall		ID		Weight	
					Inches	mm	Inches	mm	Lbs/Ft	Kg/m
14	14.000			10S	0.188	4.8	13.624	346.0	27.73	41.26
		10			0.250	6.4	13.500	342.9	36.71	54.62
		20			0.312	7.9	13.376	339.8	45.61	67.87
		STD	30	40S	0.375	9.5	13.250	336.6	54.57	81.20
		40			0.438	11.1	13.124	333.3	63.44	94.40
		XS		80S	0.500	12.7	13.000	330.2	72.09	107.27
		60			0.594	15.1	12.812	325.4	85.05	126.55
		80			0.750	19.1	12.500	317.5	106.13	157.92
		100			0.938	23.8	12.124	307.9	130.85	194.70
		120			1.094	27.8	11.812	300.0	150.90	224.54
		140			1.250	31.8	11.500	292.1	170.21	253.27
		160			1.406	35.7	11.188	284.2	189.10	281.38
16	16.000			10S	0.188	4.8	15.624	396.8	31.75	47.24
		10			0.250	6.4	15.500	393.7	42.05	62.57
		20			0.312	7.9	15.376	390.6	52.27	77.78
		STD	30	40S	0.375	9.5	15.250	387.4	62.58	93.12
		XS	40	80S	0.500	12.7	15.000	381.0	82.77	123.16
		60			0.656	16.7	14.688	373.1	107.50	159.96
		80			0.844	21.4	14.312	363.5	136.61	203.28
		100			1.031	26.2	13.938	354.0	164.82	245.25
		120			1.219	31.0	13.562	344.5	192.43	286.34
		140			1.438	36.5	13.124	333.3	223.64	332.78
18	18.000			10S	0.188	4.8	17.624	447.6	35.76	53.21
		10			0.250	6.4	17.500	444.5	47.39	70.52
		20			0.312	7.9	17.376	441.4	58.94	87.70
		STD		40S	0.375	9.5	17.250	438.2	70.59	105.04
		30			0.438	11.1	17.124	434.9	82.15	122.24
		XS		80S	5.000	127.0	17.000	431.8	93.45	139.05
		40			0.562	14.3	16.876	428.7	104.67	155.75
		60			0.750	19.1	16.500	419.1	138.17	205.60
		80			0.938	23.8	16.124	409.5	170.92	254.33
		100			1.156	29.4	15.688	398.5	207.96	309.44
		120			1.375	34.9	15.250	387.4	244.14	363.28
		140			1.562	39.7	14.876	377.9	274.22	408.04
20	20.000			10S	0.218	5.5	19.564	496.9	46.06	68.54
		10			0.250	6.4	19.500	495.3	52.73	78.46
		STD		40S	0.375	9.5	19.250	489.0	78.60	116.96
		XS		80S	0.500	12.7	19.000	482.6	104.13	154.95
		40			0.594	15.1	18.812	477.8	123.11	183.19
		60			0.812	20.6	18.376	466.8	166.40	247.60
		80			1.031	26.2	17.938	455.6	208.87	310.80
		100			1.261	32.0	17.438	442.9	256.10	381.08
		120			1.500	38.1	17.000	431.8	296.37	441.00
		140			1.750	44.5	16.500	419.1	341.09	507.54
20	20.000	160			1.969	50.0	16.062	408.0	379.17	564.20

PIPE DIMENSIONS AND WEIGHTS (CONT.)

NPS Inches	OD Inches	Schedule Designations			Wall		ID		Weight	
					Inches	mm	Inches	mm	Lbs/Ft	Kg/m
22	22.000			10S	0.218	5.5	21.564	547.7	50.71	75.46
			10		0.250	6.4	21.500	546.1	58.07	86.41
		STD	20	40S	0.375	9.5	21.250	539.8	86.61	128.88
		XS	30	80S	0.500	12.7	21.000	533.4	114.81	170.84
		60			0.875	22.2	20.250	514.4	197.41	293.75
		80			1.125	28.6	19.750	501.7	250.81	373.21
		100			1.375	34.9	19.250	489.0	302.88	450.69
		120			1.625	41.3	18.750	476.3	353.61	526.17
		140			1.875	47.6	18.250	463.6	403.00	599.66
		160			2.125	54.0	17.750	450.9	451.06	671.18
24	24.000	10		10S	0.250	6.4	23.500	596.9	63.41	94.35
		STD	20	40S	0.375	9.5	23.250	590.6	94.62	140.79
		XS		80S	0.500	12.7	23.000	584.2	125.49	186.73
		30			0.562	14.3	22.876	581.1	140.68	209.33
		40			0.688	17.5	22.624	574.6	171.29	254.88
		60			0.969	24.6	22.062	560.4	238.35	354.66
		80			1.219	31.0	21.562	547.7	296.58	441.31
		100			1.531	38.9	20.938	531.8	367.39	546.68
		120			1.812	46.0	20.376	517.6	429.39	638.93
		140			2.062	52.4	19.876	504.9	483.10	718.85
26	26.000		10		0.312	7.9	25.376	644.6	85.60	127.37
		STD		40S	0.375	9.5	25.250	641.4	102.63	152.71
		XS		80S	0.500	12.7	25.000	635.0	136.17	202.62
28	28.000		10		0.312	7.9	27.376	695.4	92.26	137.28
		STD		40S	0.375	9.5	27.250	692.2	110.64	164.63
		XS	20	80S	0.500	12.7	27.000	685.8	146.85	218.51
			30		0.625	15.9	26.750	679.5	182.73	271.90
30	30.000		10		0.312	7.9	29.376	746.2	98.93	147.21
		STD		40S	0.375	9.5	29.500	749.3	118.65	176.55
			20	80S	0.500	12.7	29.000	736.6	157.53	234.40
			30		0.625	15.9	28.750	730.3	196.08	291.77
32	32.000		10		0.312	7.9	31.376	797.0	105.59	157.12
		STD			0.375	9.5	31.250	793.8	126.66	188.47
			20		0.500	12.7	31.000	787.4	168.21	250.30
			30		0.625	15.9	30.750	781.1	209.43	311.63
			40		0.688	17.5	30.624	777.8	230.08	342.36
34	34.000		10		0.312	7.9	33.376	847.8	112.25	167.03
		STD			0.375	9.5	33.250	844.6	134.67	200.39
			20		0.500	12.7	33.000	838.2	178.89	266.19
			30		0.625	15.9	32.750	831.9	222.78	331.50
			40		0.688	17.5	32.624	828.6	244.77	364.22
36	36.000		10		0.312	7.9	35.376	898.6	118.92	176.95
		STD		40S	0.375	9.5	35.250	895.4	142.68	212.31
		XS		80S	0.500	12.7	35.000	889.0	189.57	282.08
42	42.000	STD		40S	0.375	9.5	41.250	1047.8	166.71	248.06
		XS		80S	0.500	12.7	41.000	1041.4	221.61	329.76
			30		0.625	15.9	40.750	1035.1	276.18	410.96
			40		0.750	19.1	40.500	1028.7	330.41	491.65
48	48.000	STD		40S	0.375	9.5	47.250	1200.2	190.74	283.82
		XS		80S	0.500	12.7	47.000	1193.8	253.65	377.43

CIRCUMFERENCES AND AREAS OF CIRCLES

Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)
1/32	.0981	.00076	1/2	1.570	.1963	1	3.141	.7854	2	6.283	3.141	3	9.424	7.068
1/16	.1963	.00306	9/16	1.767	.2485	1 1/8	3.534	.9940	1 1/8	6.675	3.546	1 1/8	9.817	7.669
1/8	.3926	.01227	5/8	1.963	.3097	1 1/4	3.927	1.227	1 1/4	7.068	3.976	1 1/4	10.21	8.295
3/16	.5890	.02761	11/16	2.159	.3712	3/8	4.319	1.484	3/8	7.461	4.430	3/8	10.60	8.946
1/4	.7854	.04908	3/4	2.356	.4417	1/2	4.712	1.767	1/2	7.854	4.908	1/2	10.99	9.621
5/16	.9817	.07669	13/16	2.552	.5184	5/8	5.105	2.073	5/8	8.246	5.411	5/8	11.38	10.320
3/8	1.178	.1104	7/8	2.748	.6013	3/4	5.497	2.405	3/4	8.639	5.939	3/4	11.78	11.044
7/16	1.374	.1503	15/16	2.945	.6902	7/8	5.890	2.761	7/8	9.032	6.491	7/8	12.17	11.793
4	12.65	12.566	5	15.70	19.635	6	18.84	28.274	7	21.90	38.484	8	25.13	50.265
1 1/8	12.95	13.364	1 1/8	16.10	20.629	1 1/8	29.24	29.464	1 1/8	22.38	39.871	1 1/8	25.52	51.848
1 1/4	13.35	14.186	1 1/4	16.49	21.647	1 1/4	19.63	30.679	1 1/4	22.77	41.282	1 1/4	25.91	53.456
3/8	13.74	15.033	3/8	16.88	22.690	3/8	20.02	31.919	3/8	23.16	42.718	3/8	26.31	55.088
1/2	14.13	15.904	1/2	17.27	23.758	1/2	20.42	33.183	1/2	23.56	44.178	1/2	26.70	56.745
5/8	14.52	16.800	5/8	17.17	24.840	5/8	20.81	34.471	5/8	23.95	45.663	5/8	27.09	58.426
3/4	14.92	17.720	3/4	18.06	25.967	3/4	21.20	35.784	3/4	24.34	47.173	3/4	27.47	60.132
7/8	15.31	18.665	7/8	18.45	27.108	7/8	21.57	37.122	7/8	24.74	48.707	7/8	27.88	61.862
9	28.27	63.617	10	31.41	78.539	11	34.55	95.033	12	37.69	113.00	13	40.84	132.73
1 1/8	28.66	65.396	1 1/8	31.80	80.515	1 1/8	34.95	97.205	1 1/8	38.09	115.46	1 1/8	41.23	135.29
1 1/4	29.05	67.200	1 1/4	32.20	82.516	1 1/4	35.34	99.402	1 1/4	38.48	117.85	1 1/4	41.62	137.88
3/8	29.45	69.029	3/8	32.59	84.540	3/8	35.73	101.62	3/8	38.87	120.27	3/8	42.01	140.50
1/2	29.84	70.882	1/2	32.98	86.590	1/2	36.12	103.86	1/2	39.27	122.71	1/2	42.41	143.13
5/8	30.23	72.759	5/8	33.37	88.664	5/8	36.52	106.13	5/8	39.66	125.18	5/8	42.80	145.80
3/4	30.63	74.662	3/4	33.77	90.762	3/4	36.91	108.43	3/4	40.05	127.67	3/4	43.19	148.48
7/8	31.02	76.588	7/8	34.16	92.885	7/8	37.30	110.75	7/8	40.55	130.19	7/8	43.58	151.20
14	43.98	153.92	15	47.12	176.71	16	50.26	201.06	17	53.40	226.98	18	56.54	254.46
1 1/8	44.37	156.69	1 1/8	47.51	179.67	1 1/8	50.65	204.21	1 1/8	53.79	230.33	1 1/8	56.94	258.01
1 1/4	44.76	159.48	1 1/4	47.90	182.72	1 1/4	51.05	207.39	1 1/4	54.19	233.70	1 1/4	57.33	261.58
3/8	45.16	162.29	3/8	48.30	185.66	3/8	51.44	210.59	3/8	54.58	237.10	3/8	57.72	265.18
1/2	45.55	165.13	1/2	48.69	188.69	1/2	51.83	213.82	1/2	54.97	240.52	1/2	58.11	268.80
5/8	45.94	167.98	5/8	49.08	191.74	5/8	52.22	217.07	5/8	55.37	243.97	5/8	58.51	272.44
3/4	46.33	170.87	3/4	49.48	194.82	3/4	52.62	220.35	3/4	55.76	247.45	3/4	58.90	276.11
7/8	46.73	173.78	7/8	49.88	197.73	7/8	53.01	223.65	7/8	56.16	250.94	7/8	59.29	279.81
19	59.69	283.52	20	62.83	314.16	21	65.97	346.36	22	69.11	380.13	23	72.25	415.47
1 1/8	60.08	287.27	1 1/8	63.22	318.09	1 1/8	66.37	350.49	1 1/8	69.50	384.46	1 1/8	72.64	4200.00
1 1/4	60.47	291.03	1 1/4	63.61	322.06	1 1/4	66.75	354.65	1 1/4	69.90	388.82	1 1/4	73.04	424.55
3/8	60.86	294.83	3/8	64.01	326.05	3/8	67.15	358.84	3/8	70.29	393.20	3/8	73.43	429.13
1/2	61.26	298.64	1/2	64.40	330.06	1/2	67.54	363.05	1/2	70.68	397.60	1/2	73.82	433.73
5/8	61.65	302.48	5/8	64.79	334.10	5/8	67.93	367.28	5/8	71.07	402.03	5/8	74.21	438.30
3/4	62.04	306.35	3/4	65.18	338.16	3/4	68.32	371.54	3/4	71.47	406.49	3/4	74.61	443.01
7/8	62.43	310.24	7/8	65.58	342.25	7/8	68.72	375.82	7/8	71.86	410.97	7/8	75.00	447.69
24	75.39	452.39	25	78.54	490.87	26	81.68	530.93	27	84.82	572.55	28	87.96	615.75
1 1/8	75.79	475.11	1 1/8	78.93	495.79	1 1/8	82.07	536.04	1 1/8	85.21	577.87	1 1/8	88.35	621.26
1 1/4	76.18	461.86	1 1/4	79.32	500.74	1 1/4	82.46	541.18	1 1/4	85.60	583.20	1 1/4	88.75	626.79
3/8	76.57	466.63	3/8	79.71	505.71	3/8	82.85	546.35	3/8	86.00	588.57	3/8	89.14	632.35
1/2	76.96	471.43	1/2	80.10	510.70	1/2	83.25	551.54	1/2	86.39	593.95	1/2	89.59	637.94
5/8	77.36	476.25	5/8	80.50	515.72	5/8	83.64	556.76	5/8	86.78	599.37	5/8	89.92	643.54
3/4	77.75	481.10	3/4	80.89	520.70	3/4	84.03	562.00	3/4	87.17	604.80	3/4	90.32	649.18
7/8	78.14	485.97	7/8	81.28	525.83	7/8	84.43	567.26	7/8	87.57	610.26	7/8	90.71	654.83
29	91.10	660.52	30	94.24	706.86	31	97.38	754.76	32	100.5	804.24	33	103.6	855.30
1 1/8	91.49	666.22	1 1/8	94.64	712.86	1 1/8	97.78	760.86	1 1/8	100.9	810.45	1 1/8	104.0	861.79
1 1/4	91.89	671.95	1 1/4	95.03	718.69	1 1/4	98.17	766.99	1 1/4	101.3	816.86	1 1/4	104.4	868.30
3/8	92.23	677.71	3/8	95.42	724.64	3/8	98.56	773.14	3/8	101.7	822.21	3/8	104.8	874.88
1/2	92.67	683.49	1/2	95.81	730.61	1/2	98.96	779.31	1/2	102.1	828.57	1/2	105.2	881.41
5/8	93.06	689.29	5/8	96.21	736.61	5/8	99.35	785.51	5/8	102.4	835.97	5/8	105.6	888.00
3/4	93.46	695.12	3/4	96.60	742.64	3/4	99.74	791.73	3/4	102.8	842.39	3/4	106.0	894.61
7/8	93.85	700.98	7/8	96.99	748.69	7/8	100.1	797.97	7/8	103.2	848.83	7/8	106.4	901.25

CIRCUMFERENCES AND AREAS OF CIRCLES (CONT.)

Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)
34	106.8	907.92	35	109.9	962.11	36	113.0	101.8	37	116.2	1075.2	38	119.3	1134.1
1/8	107.2	914.61	1/8	110.3	968.99	1/8	113.4	1024.9	1/8	116.6	1082.4	1/8	119.7	1141.5
1/4	107.5	921.32	1/4	110.7	975.90	1/4	113.8	1032.0	1/4	117.0	1089.7	1/4	120.1	1149.0
3/8	107.9	928.06	3/8	111.1	982.84	3/8	114.2	1039.1	3/8	117.4	1097.1	3/8	120.5	1156.6
1/2	108.3	934.82	1/2	111.5	989.80	1/2	114.6	1049.3	1/2	117.8	1104.4	1/2	120.9	1164.1
5/8	108.7	941.60	5/8	111.9	996.78	5/8	115.0	1053.5	5/8	118.2	1111.8	5/8	121.3	1171.7
3/4	109.1	948.41	3/4	112.3	1003.7	3/4	115.4	1060.7	3/4	118.6	1119.2	3/4	121.7	1179.3
7/8	109.5	955.25	7/8	112.7	1010.8	7/8	115.8	1067.9	7/8	118.9	1126.6	7/8	122.1	1186.9
39	122.5	1194.5	40	125.6	1256.6	41	128.8	1320.2	42	131.9	1385.4	43	135.0	1452.2
1/8	122.9	1202.2	1/8	126.0	1264.5	1/8	129.1	1328.3	1/8	132.3	1393.7	1/8	135.4	1460.6
1/4	123.3	1209.9	1/4	126.4	1272.3	1/4	129.5	1336.4	1/4	132.7	1401.9	1/4	135.8	1469.1
3/8	123.7	1217.6	3/8	126.8	1280.3	3/8	129.9	1344.5	3/8	133.1	1410.2	3/8	136.2	1477.6
1/2	124.0	1225.4	1/2	127.2	1288.2	1/2	130.3	1352.6	1/2	133.5	1418.6	1/2	136.6	1486.1
5/8	124.4	1233.1	5/8	127.6	1291.2	5/8	130.7	1360.8	5/8	133.9	1426.9	5/8	137.0	1494.7
3/4	124.8	1240.9	3/4	128.0	1304.2	3/4	131.1	1369.0	3/4	134.3	1435.3	3/4	137.4	1503.3
7/8	125.2	1248.7	7/8	128.4	1312.2	7/8	131.5	1377.2	7/8	134.6	1443.7	7/8	137.8	1511.9
44	138.2	1520.5	45	141.3	1590.4	46	144.5	1661.9	47	147.6	1734.9	48	150.7	1809.5
1/8	138.6	1529.1	1/8	141.7	1599.2	1/8	144.9	1670.9	1/8	148.0	1744.1	1/8	151.1	1818.9
1/4	139.0	1537.8	1/4	142.1	1608.1	1/4	145.2	1680.0	1/4	148.4	1753.4	1/4	151.5	1828.4
3/8	139.4	1546.5	3/8	142.5	1617.0	3/8	145.6	1689.1	3/8	148.8	1762.7	3/8	151.9	1837.9
1/2	139.8	1555.2	1/2	142.9	1625.9	1/2	146.0	1698.2	1/2	149.2	1772.0	1/2	152.3	1847.4
5/8	140.1	1564.0	5/8	143.3	1634.9	5/8	146.4	1707.3	5/8	149.6	1781.3	5/8	152.7	1856.9
3/4	140.5	1572.8	3/4	143.7	1643.8	3/4	146.8	1716.5	3/4	150.0	1790.7	3/4	153.1	1866.5
7/8	140.9	1581.6	7/8	144.1	1652.8	7/8	147.2	1725.7	7/8	150.4	1800.1	7/8	153.5	1876.1
49	153.9	1885.7	50	157.0	1963.5	51	160.2	2042.8	52	163.3	2123.7	53	166.5	2206.1
1/8	154.4	1895.3	1/8	157.4	1973.3	1/8	160.6	2025.8	1/8	163.7	2133.9	1/8	166.8	2216.6
1/4	154.7	1905.0	1/4	157.8	1983.1	1/4	161.0	2062.9	1/4	164.1	2144.1	1/4	167.2	2227.0
3/8	155.5	1914.7	3/8	158.2	1993.0	3/8	161.3	2072.9	3/8	164.5	2154.4	3/8	167.6	2237.5
1/2	155.5	1924.4	1/2	158.6	2002.9	1/2	161.7	2083.0	1/2	164.9	2164.7	1/2	168.0	2248.0
5/8	155.9	1934.1	5/8	159.0	2012.8	5/8	162.1	2093.2	5/8	165.3	2175.0	5/8	168.4	2258.5
3/4	156.2	1943.9	3/4	159.4	2022.8	3/4	162.5	2103.3	3/4	165.7	2185.4	3/4	168.8	2269.0
7/8	156.6	1953.6	7/8	159.8	2032.8	7/8	162.9	2113.5	7/8	166.1	2195.7	7/8	169.2	2279.6
54	169.6	2290.2	55	172.7	2375.8	56	175.9	2463.0	57	179.0	2551.7	58	182.2	2642.0
1/8	170.0	2300.8	1/8	173.1	2386.6	1/8	176.3	2474.0	1/8	179.4	2562.9	1/8	182.6	2653.4
1/4	170.4	2311.4	1/4	173.5	2397.4	1/4	176.7	2485.0	1/4	179.8	2574.1	1/4	182.9	2664.9
3/8	170.8	2322.1	3/8	173.9	2408.3	3/8	177.1	2496.1	3/8	180.2	2585.4	3/8	183.3	2676.3
1/2	171.2	2332.8	1/2	174.3	2419.2	1/2	177.5	2507.1	1/2	180.6	2596.7	1/2	183.7	2687.8
5/8	171.6	2343.5	5/8	174.7	2430.1	5/8	177.8	2518.2	5/8	181.0	2608.0	5/8	184.1	2690.3
3/4	172.0	2354.2	3/4	175.1	2441.0	3/4	178.2	2529.4	3/4	181.4	2619.3	3/4	184.5	2710.8
7/8	172.3	2365.0	7/8	175.5	2452.0	7/8	178.6	2540.5	7/8	181.8	2630.7	7/8	184.9	2722.4
59	185.3	2733.9	60	188.4	2827.4	61	191.6	2922.4	62	194.7	3019.0	63	197.9	3117.2
1/8	185.7	2745.5	1/8	188.8	2839.2	1/8	192.0	2934.4	1/8	195.1	3031.2	1/8	198.3	3129.6
1/4	186.1	2757.1	1/4	189.2	2851.0	1/4	192.4	2946.4	1/4	195.5	3043.4	1/4	198.7	3142.0
3/8	186.5	2768.8	3/8	189.6	2862.8	3/8	192.8	2958.5	3/8	195.9	3055.7	3/8	199.0	3144.4
1/2	186.9	2780.5	1/2	190.0	2874.7	1/2	193.2	2970.5	1/2	196.3	3067.9	1/2	199.4	3166.9
5/8	187.3	2792.2	5/8	190.4	2886.6	5/8	193.6	2982.6	5/8	196.7	3080.2	5/8	199.8	3179.4
3/4	187.7	2803.9	3/4	190.8	2898.5	3/4	193.9	2994.6	3/4	197.1	3092.5	3/4	200.2	3191.9
7/8	188.1	2815.6	7/8	191.2	2910.5	7/8	194.3	3006.9	7/8	197.5	3104.8	7/8	200.6	3204.4
64	201.0	3216.9	65	204.2	3318.3	66	207.3	3421.2	67	210.4	3525.6	68	213.6	3631.6
1/8	201.4	3229.5	1/8	204.5	3331.0	1/8	207.7	3434.1	1/8	210.9	3538.8	1/8	214.0	3645.0
1/4	201.8	3242.1	1/4	204.9	3343.8	1/4	208.1	3447.1	1/4	211.2	3552.0	1/4	214.4	3658.4
3/8	202.2	3254.8	3/8	205.3	3356.7	3/8	208.5	3460.1	3/8	211.6	3565.2	3/8	214.8	3671.8
1/2	202.6	3267.4	1/2	205.7	3369.5	1/2	208.9	3473.2	1/2	212.0	3578.4	1/2	215.1	3685.2
5/8	203.0	3280.1	5/8	206.1	3382.4	5/8	209.3	3486.3	5/8	212.4	3591.7	5/8	215.1	3698.7
3/4	203.4	3292.8	3/4	206.5	3395.3	3/4	209.7	3499.3	3/4	212.8	3605.0	3/4	215.9	3712.2
7/8	203.8	3305.5	7/8	206.9	3408.2	7/8	210.0	3512.5	7/8	213.2	3618.3	7/8	216.3	3725.7

CIRCUMFERENCES AND AREAS OF CIRCLES (CONT.)

Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)	Diam. (in)	Circ. (in)	Area (in ²)
69	216.7	3739.2	70	219.9	3848.4	71	223.0	3959.2	72	226.1	4071.5	73	229.3	4185.3
$\frac{1}{8}$	217.1	3752.8	$\frac{1}{8}$	220.3	3862.2	$\frac{1}{8}$	223.4	3973.1	$\frac{1}{8}$	226.5	4085.6	$\frac{1}{8}$	229.7	4199.7
$\frac{1}{4}$	217.5	3766.4	$\frac{1}{4}$	220.6	3875.9	$\frac{1}{4}$	223.8	3987.1	$\frac{1}{4}$	226.9	4099.8	$\frac{1}{4}$	230.1	4214.1
$\frac{3}{8}$	217.9	3780.0	$\frac{3}{8}$	221.0	3889.8	$\frac{3}{8}$	224.2	4001.1	$\frac{3}{8}$	227.3	4114.0	$\frac{3}{8}$	230.5	4228.5
$\frac{1}{2}$	218.3	3793.6	$\frac{1}{2}$	221.4	3903.6	$\frac{1}{2}$	224.6	4015.1	$\frac{1}{2}$	227.7	4128.2	$\frac{1}{2}$	230.9	4242.9
$\frac{5}{8}$	218.7	3807.3	$\frac{5}{8}$	221.8	3917.4	$\frac{5}{8}$	225.0	4029.2	$\frac{5}{8}$	228.1	4142.5	$\frac{5}{8}$	231.3	4257.3
$\frac{3}{4}$	219.1	3821.0	$\frac{3}{4}$	222.2	3931.3	$\frac{3}{4}$	225.4	4043.2	$\frac{3}{4}$	228.5	4156.7	$\frac{3}{4}$	231.6	4271.8
$\frac{7}{8}$	219.5	3834.7	$\frac{7}{8}$	222.6	3945.2	$\frac{7}{8}$	225.8	4067.3	$\frac{7}{8}$	228.9	4171.0	$\frac{7}{8}$	232.0	4286.3
74	232.4	4300.8	75	235.6	4417.8	77	241.9	4666.6	79	248.1	4901.6	81	254.4	5153.0
$\frac{1}{8}$	232.8	4315.3	$\frac{1}{4}$	236.4	4447.3	$\frac{1}{4}$	242.6	4686.9	$\frac{1}{4}$	248.9	4932.7	$\frac{1}{4}$	255.2	5184.8
$\frac{1}{4}$	233.2	4329.9	$\frac{1}{2}$	237.1	4476.9	$\frac{1}{2}$	243.4	4717.3	$\frac{1}{2}$	249.7	4963.9	$\frac{1}{2}$	256.0	5216.8
$\frac{3}{8}$	233.6	4344.5	$\frac{3}{4}$	237.9	4506.6	$\frac{3}{4}$	244.2	4747.7	$\frac{3}{4}$	250.5	4995.1	$\frac{3}{4}$	256.8	5248.8
$\frac{1}{2}$	234.0	4359.1	76	238.7	4536.4	78	245.0	4778.3	80	251.3	5026.5	82	257.6	5281.0
$\frac{5}{8}$	234.4	4378.8	$\frac{1}{4}$	239.5	4566.3	$\frac{1}{4}$	245.8	4809.0	$\frac{1}{4}$	252.1	5058.0	$\frac{1}{4}$	258.3	5313.2
$\frac{3}{4}$	234.8	4388.4	$\frac{1}{2}$	240.3	4596.3	$\frac{1}{2}$	246.6	4839.8	$\frac{1}{2}$	252.8	5089.5	$\frac{1}{2}$	259.1	5345.6
$\frac{7}{8}$	235.2	4403.1	$\frac{3}{4}$	241.1	4626.4	$\frac{3}{4}$	247.4	4870.7	$\frac{3}{4}$	253.6	5121.2	$\frac{3}{4}$	259.9	5378.0

FASTENER DETAILS

FASTENER DETAILS										Mechanical Properties				
Grade Mark	Bolt Spec.	Bolt Grade	Material	Nut Spec.	Suggested Nut Grade	Temperature Ratings	Service Environment	Nominal Stud Size (in)	Proof Load KSI (Mpa)	Yield Strength		Tensile Strength		
										KSI	Mpa	KSI	Mpa	
	ASTM A193	B5	AISI 501	ASTM A194	Any	-50 to 1200°F (-45 to 649°C)	High Temperature Service	1/4 thru 4	-	80	550	100	125	
		B6	AISI 410		Any			1/4 thru 4	-	85	585	110	758	
		B7	CrMo Alloy Steel AISI 4140, 4142, or 4105		2H, 4, 7, or 8	-50 to 900°F (-45 to 482°C)		1/4 thru 2 1/2	-	105	720	125	862	
						Over 2 1/2 thru 4		-	95	655	115	793		
B7M		2HM, 4M, 7M, 19, 8M						Over 4 thru 7	-	75	515	100	690	
								1/4 thru 2 1/2	-	80	550	100	690	
								Over 2 1/2 thru 4	-	80	550	100	690	
		B8 Class 1	AISI 304		8	Cryogenic to 1500°F (815°C)		All	-	30	205	75	515	
		B8 Class 2							-	100	690	125	862	
		B8M Class 1							-	80	550	115	793	
		ASTM A307	B16		CrMoVa Alloy Steel	4, 7, or 8		-50 to 1100°F (-45 to 593°C)	All	-	50	345	100	690
				-						30	205	75	515	
				-						105	720	125	862	
	ASTM A320	L7	Carbon Steel Grades	ASTM A563	A, B, C, D, DH, DH3	Amb. to 450°F (232°C)		60 KSI (414 Mpa) Tensile Strength	Over 2 1/2 thru 4	-	95	655	110	758
										-	85	585	100	690
									-	-	-	60	414	
	ASTM A320	L7M	CrMo Alloy Steel AISI 4140, 4142, or 4105	ASTM A194	4 or 7	-50 to 1100°F (-45 to 593°C)	Low Temperature Service	Over 4 thru 7	-	36	248	60-100	414-690	
									-	105	720	125	862	
									-	80	550	100	690	
	ASTM A320	L43	NiCrMo Alloy Steel AISI 4340	ASTM A194	4 or 7			1/4 thru 2 1/2	-	105	720	125	862	
									-	105	720	125	862	
									-	105	720	125	862	
	ASTM A320	L1	Low Carbon Boron	ASTM A194	4 or 7			1/4 thru 1	-	30	205	75	515	
									-	30	205	75	515	
									-	30	205	75	515	

APPENDIX

FASTENER DETAILS (CONT.)

FASTENER DETAILS (CONT.)										Mechanical Properties																		
Grade Mark	Bolt Spec.	Bolt Grade	Material	Nut Spec.	Suggested Nut Grade	Temperature Ratings	Service Environment	Nominal Stud Size (in)	Proof Load KSI (Mpa)	Yield Strength		Tensile Strength																
										KSI	Mpa	KSI	Mpa															
	ASTM A320	B8 Class 2	AISI 304	ASTM A194	8	Cryogenic to 1500°F (815°C)	Low Temperature Service	3/4 and under			100	690	125	862														
								Over 3/4 to 1			80	550	115	793														
		Over 1 to 1 1/4							65	450	105	720																
		1 1/4 to 1 1/2							50	345	100	690																
		3/4 and under							95	655	110	758																
		B8M Class 2	AISI 316					Over 3/4 to 1			80	550	100	690														
								Over 1 to 1 1/4			65	450	95	655														
		1 1/4 to 1 1/2							50	345	90	620																
		1/2 to 1							85 (585)	92	634	120	827															
		Over 1 to 1 1/2							74 (510)	81	558	105	720															
	A354	Grade BC		A194 or A563	2 or 2H/C3, D, DH, DH3	Amb. to 650°F (343°C)	120/105 KSI Min. Tensile	1/4 to 2 1/2			109	752	125	862														
								Over 2 1/2			99	683	115	793														
		Grade 8D						A563	C3, D, DH, DH3	Amb. to 650°F (343°C)	Quenched and Tempered	1/4 to 2 1/2			130	896	150	1034										
												Over 2 1/2			115	793	140	965										
		Type 1												1/4 to 1			92	634	120	827								
	A449					Amb. to 650°F (343°C)						Over 1 to 1 1/2			81	558	105	720										
												Over 1 1/2 to 3			58	400	90	620										
													A, B, and C		85	585	130	896										
																			Class A (3 and Under)		70	483	100	690				
																									Over 3		60	414
Class B (3 and Under)		60	414	95	655																							
						Over 3																						
	A453			A453		-50 to 1000°F (-45 to 538°C)	High Temperature Service	Class A			85	585	130	896														
								Class B			80	550	125	862														
								Class A			120	827	170	1172														
								Class B			120	827	155	1069														

FASTENER DETAILS (CONT.)

FASTENER DETAILS (CONT.)										Mechanical Properties				
Grade Mark	Bolt Spec.	Bolt Grade	Material	Nut Spec.	Suggested Nut Grade	Temperature Ratings	Service Environment	Nominal Stud Size (in)	Proof Load KSI (Mpa)	Yield Strength		Tensile Strength		
										KSI	Mpa	KSI	Mpa	
	A490	Grade 1		A563 or A194	DH, DH3, 2H			1/2 to 1 1/2		130	896	150-170	1034-1172	
		Grade 2					1/2 to 1		130	896	150-170	1034-1172		
		Grade 3					1/2 to 1 1/2		130	896	150-170	1034-1172		
	A540	B21, 23 & 24 CL1		A540		Amb. to 700 °F (371 °C)	Special Applications	1/4 to 4		150	1034	115-165	793-1138	
		B21, 23 & 24 CL2			1/4 to 4				140	965				
		B21-24 CL3			1/4 to 6				130	896				
		B21, 23 & 24 CL4			1/4 to 6				120	827				
		B21, 23 & 24 CL5			1/4 to 2				105	720				
	SAE J429	Grade 1		SAE J995	2			2 1/8 to 8		100	690	60	414	
		Grade 2			2			1/4 to 1 1/2	33 (228)	36	248	74	510	
		Grade 4			2, 5	Bolts, Screws, Studs	1/4 to 3/4	55 (379)	57	393	60	414		
		Grade 5		5, 8	Over 3/4 to 1 1/2		33 (228)	36	248	115	793			
		Grade 7		5, 8	1/4 to 1 1/2			100	690					
		Grade 8			8									
		Metric Materials												
		ISO 898/1	4.6		4									
		OR	4.8		4									
		ASTM	5.8		5									
	F568	8.8			8			All		96	662	120	827	
		OR	9.8		9					104	717	131	903	
		SAE	10.9		12					136	938	151	1041	
	J1199	12.9			12					160	1103	177	1220	

General Notes:

1. The Data that are listed is for general reference only. The properties of bolts can differ from the norm.
2. Consult Lamons Engineering Department for further technical questions.
3. Blank data indicates that no sufficient information at this time is available for such material.

APPENDIX