

Champion Engineering Specifications

General

Fiberglass Conduit Specifications for Use Below Ground

The conduit shall be fiberglass conduit, also known as Reinforced Thermosetting Resin Conduit (RTRC), manufactured using the **single-circuit filament winding process**. Multi-circuit windings are not allowed. The conduit shall have a winding angle as close as possible to 54.75°.

- The resin system shall be epoxy based, with no fillers, using an anhydride curing agent. The fiberglass shall consist of continuous **E-glass “Grade A” roving**.
- The conduit shall not contain any halogen compounds containing chlorine, bromine, fluorine and iodine in more than trace amounts when burning.
- Conduit and elbows shall be manufactured from the same resin/hardener/glass systems manufactured by the same filament wound system.
- Fiberglass conduit fittings and accessories shall be manufactured using one of two manufacturing procedures.
 - The first method shall use the same process, methods and components as used to manufacture the fiberglass conduit.
 - The second method shall use the compression molding process, Sheet Molding Compound (SMC), for the manufacture of the finished component. The SMC material shall be a vinyl ester resin with +30% reinforcement of glass. The glass fibers should be approximately 1" in length. The SMC material shall be fire resistant to UL 2515.
- Conduit shall be integral bell and spigot or bonded coupling and spigot.
- Conduit, elbows and fittings are specified for use throughout a temperature range of -60°F (-51°C) to 250°F (121°C).
- Manufacturer shall have a current Certificate of Compliance, issued by an independent and accredited company, with an **ISO 9001: 2008 Quality Management System**.

Electrical Characteristics

Volume Resistivity	3.8 x 10 ¹⁴ ohm-cm	ASTM D257
Surface Resistivity	1.1 x 10 ¹⁴ ohms	ASTM D257
Dielectric Constant	3.5 (at 10 ³ cps)	ASTM D150
Dissipation Factor	0.005 (at 10 ³ cps)	ASTM D150
Dielectric Strength	500 volts/mil (19.7 kv/mm)	ASTM D149

Physical and Mechanical Characteristics

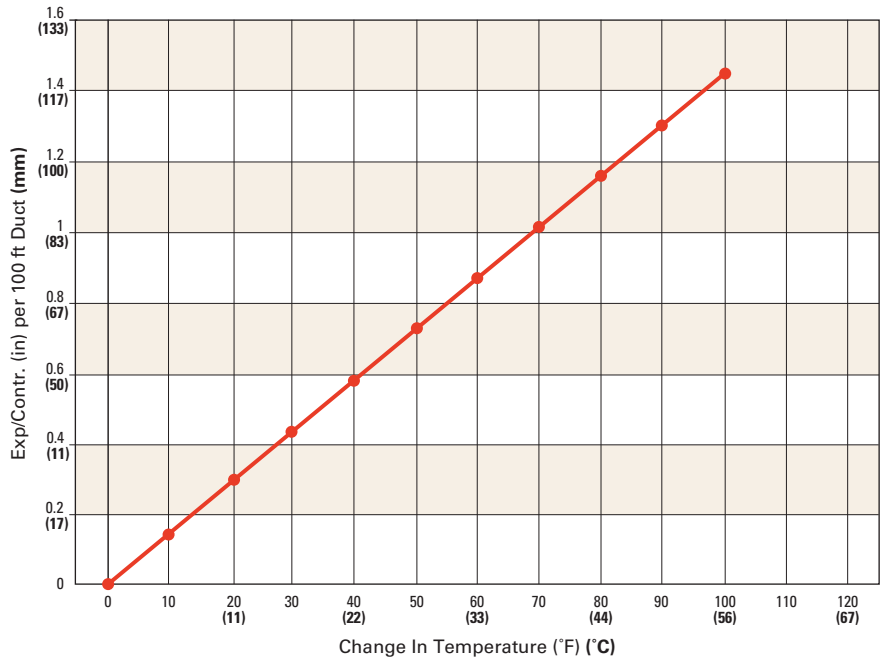
Tensile Strength, Axial	11,000 psi (76 MPa)	ASTM D2105
Compressive Strength, Axial	12,000 psi (83 MPa)	ASTM D695
Ultimate Elongation	2% psi (9.6 GPa)	ASTM D2105
Modulus of Elasticity (4" conduit)	1.4 x 10 ⁶ psi (9.6 GPa)	ASTM D2105
Thermal Conductivity	2.0 Btu.in/ft ² .hr.°F (0.30 W/m.K)	ASTM D5930-1
Specific Gravity	1.9	ASTM D792
Glass Content	70% + 5%	API SPEC 15LR
Water Absorption	Less than 1%	ASTM D570
Barcol Hardness	54 + 2	ASTM D2583
Flammability Above Ground Conduit Below Ground Conduit	Conform to UL 2515 and CSA C22.2 HB Rating	No 211.3-96 UL 94
Coefficient of Thermal Expansion	1.2 x 10 ⁻⁵ in/in/°F (2.2 x 10 ⁻⁵ m/m/°C)	ASTM D696

Heat Distortion

The minimum heat distortion temperature shall be 230°F (110°C) when tested at 264 psi in accordance with ASTM D 648.

Joint Pullout

A 12" length shall be cut from both the belled end and spigot end of a length of conduit. The two parts shall be assembled in accordance with Champion's instructions. The assembly shall be tested in accordance with ASTM D 2105 and shall meet the requirements of the table below.



JOINT PULLOUT RESISTANCE / MINIMUM FORCE – LBS (N)						
NOMINAL SIZE	INTERFERENCE JOINT		GASKET WITH INTERFERENCE JOINT		GASKET WITHOUT INTERFERENCE JOINT	
All	1,000	(4,450)	2,000	(8,900)	500	(2,220)
TIGHT LOCK JOINTS (ADHESIVE)						
11,000 psi x (cross sectional area of conduit)						

Toxicity

Champion Duct conduit does not contain any compounds that can release halogens – bromine or chlorine – when burning.

GASES	VALUES (MAX PPM)
Hydrogen Chloride	0
Hydrogen Bromide	0
Hydrogen Cyanide	<1
Hydrogen Sulfide	0
Ammonia	0
Aldehydes as HCHO	<10
Oxides of Nitrogen	<50
Carbon Dioxide	<12,500
Carbon Monoxide	<250

Surface Finish

- Exterior Surface: Normally less than 2,000 microinches (50.8 micron)
- Interior Surface: Normally less than 125 microinches (3.2 micron)

Available Colors

Standard colors are black and dark grey. Other optional colors are available. These include red, orange, blue and white, and additional colors beyond these options are also available as well. Contact Champion Fiberglass for additional information regarding colors.

Water Tightness

There should be no evidence of water leakage through the joint when tested in accordance to UL 2515 and CSA C22.2 No. 2515. In order to achieve water tightness use Champion Mix® or Epoxy Adhesive Kit for Tight Lock Joint.

Coefficient of Friction

The following data for static coefficient of friction is for dry conduit and non-lubricated cable at a temperature of 72°F (22°C).

CABLE MATERIAL	CONDUIT MATERIAL					
	EPOXY FIBERGLASS CONDUIT	PVC CONDUIT	STEEL CONDUIT	ALUMINUM CONDUIT	CONCRETE CONDUIT	POLYETHYLENE CONDUIT
PVC	0.38	0.90	0.57	0.61	0.95	1.90
XLP (Cross-linked Polyethylene)	0.23	0.90	0.75	1.50	0.75	2.00
LDPE (Polyethylene)	0.25	0.50	0.50	0.62	0.60	1.70
Neoprene	0.53	2.60	1.60	0.26	1.35	3.30
Concentric Neutral	0.16	–	–	–	–	–
Tech (Armored) Cable	0.16	2.60	1.60	0.26	1.35	3.30

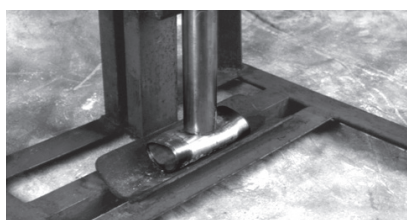
Impact Resistance

The minimum impact resistance values for the conduit shall be as shown in the table below when tested in accordance with ASTM D2444.

NOMINAL SIZE	AT 73.4°F (23°C)		AT 32°F (0°C)	
	IMPACT RESISTANCE LBS/FT (NM)		IMPACT RESISTANCE LBS/FT (NM)	
	XW		XW	
3/4"	150	(202)	150	(202)
1"	400	(540)	400	(540)
1-1/4"	400	(540)	400	(540)
1-1/2"	500	(675)	500	(675)
2"	550	(742)	550	(742)
2-1/2"	600	(810)	600	(810)
3"	700	(945)	700	(945)
3-1/2"	850	(1,150)	850	(1,150)
4"	1,000	(1,350)	1,000	(1,350)
5"	1,200	(1,620)	1,200	(1,620)
6"	1,300	(1,755)	1,300	(1,755)



For high-impact situations as well as during cold weather, PVC can shatter and/or flatten.



For high-impact, steel conduit will collapse and can pinch the cable. This will make repair of damaged conduit more difficult.

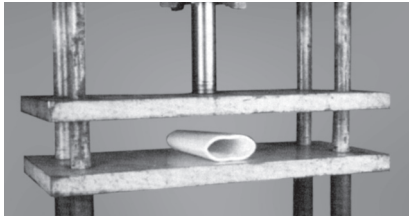


XW conduit has the highest impact value of all conduit materials available. If impacted, it will flex back close to its original diameter. SW, MW and HW will also flex back similarly after impact. They will not shatter.

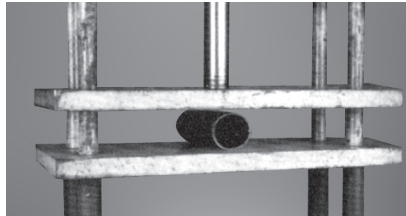
Stiffness

The minimum conduit stiffness at 5% deflection for all sizes of conduit shall not be less than the values given in table below when tested in accordance with ASTM D2412.

NOMINAL SIZE	PIPE STIFFNESS (PS) = (F/ΔY)			
	AT 73.4°F (23°C) LBF/IN ² (MPA)		AT 32°F (0°C) LBF/IN ² (MPA)	
	XW		XW	
3/4"	2,500	(17.5)	2,500	(17.5)
1"	2,400	(16.8)	2,400	(16.8)
1-1/4"	2,100	(14.7)	2,100	(14.7)
1-1/2"	2,000	(14)	2,000	(14)
2"	1,300	(9.0)	1,300	(9.0)
2-1/2"	800	(5.6)	800	(5.6)
3"	600	(4.1)	600	(4.1)
3-1/2"	450	(3.1)	450	(3.1)
4"	250	(1.7)	250	(1.7)
5"	180	(1.2)	180	(1.2)
6"	150	(1.0)	150	(1.0)



PVC Conduit
PVC conduit will stay compressed if it is crushed. (Same for steel conduit.)



Fiberglass Conduit
Epoxy Fiberglass conduit will flex back to almost its original shape after crushing.

Wire Fill

Maximum allowable percentage wire fill per National Electric Code.

TRADE SIZE	ID SIZES										
	INTERNAL DIAMETER		TOTAL AREA		PERCENT OF CROSS SECTION OF CONDUIT AND TUBING FOR CONDUCTORS						
	IN	(MM)	IN ²	(MM ²)	1 WIRE 53%		2 WIRE 31%		OVER 2 WIRE 40%		
				IN ²	(MM ²)	IN ²	(MM ²)	IN ²	(MM ²)	IN ²	(MM ²)
2" (51)	2.000"	(51)	3.142"	(2,027)	1.665"	(1,074)	0.974"	(628)	1.257"	(811)	
2-1/2" (64)	2.500"	(64)	4.909"	(3,167)	2.602"	(1,678)	1.522"	(982)	1.963"	(1,267)	
3" (76)	3.000"	(76)	7.069"	(4,560)	3.746"	(2,417)	2.191"	(1,414)	2.827"	(1,824)	
3-1/2" (89)	3.500"	(89)	9.621"	(6,207)	5.099"	(3,290)	2.983"	(1,924)	3.848"	(2,483)	
4" (102)	4.000"	(102)	12.566"	(8,107)	6.660"	(4,297)	3.896"	(2,513)	5.027"	(3,243)	
5" (127)	5.000"	(127)	19.635"	(12,668)	10.407"	(6,714)	6.087"	(3,927)	7.854"	(5,067)	
6" (152)	6.000"	(152)	28.274"	(18,241)	14.985"	(9,668)	8.765"	(5,655)	11.310"	(7,297)	

Conduit Conductor Fill

Based on Wire Fill Data as outlined in the national electric code.

RHW

TRADE SIZE	ID SIZES											
	ALLOWABLE CONDUIT IN ²	MAX 1 CONDUCTOR SIZE	IN ² OF 1 CONDUCTOR	ALLOWABLE CONDUIT IN ²	MAX 2 CONDUCT. SIZE	IN ² OF 2 CONDUCTORS	ALLOWABLE CONDUIT IN ²	MAX 3 CONDUCT. SIZE	IN ² OF 3 CONDUCTORS	ALLOWABLE CONDUIT IN ²	MAX 4 CONDUCT. SIZE	IN ² OF 4 CONDUCTORS
2" (51)	1.665"	1000	1.4784"	0.974"	250	0.9193"	1.257"	4/0	1.1153"	1.257"	3/0	1.2469"
2-1/2" (64)	2.602"	1750	2.4773"	1.522"	400	1.3237"	1.963"	350	1.7875"	1.963"	250	1.8385"
3" (76)	3.746"	2000	2.7818"	2.191"	600	1.9459"	2.827"	500	2.3704"	2.827"	400	2.6475"
3-1/2" (89)	5.099"	—	—	2.983"	900	2.7121"	3.848"	800	3.6816"	3.848"	500	3.1605"
4" (102)	6.660"	—	—	3.896"	1250	3.7205"	5.027"	1000	4.4353"	5.027"	800	4.9087"
5" (127)	10.407"	—	—	6.087"	2000	5.5636"	7.854"	1750	7.4319"	7.854"	1250	7.4409"
6" (152)	14.985"	—	—	8.765"	—	—	11.310"	2000	8.3455"	11.310"	2000	11.1273"

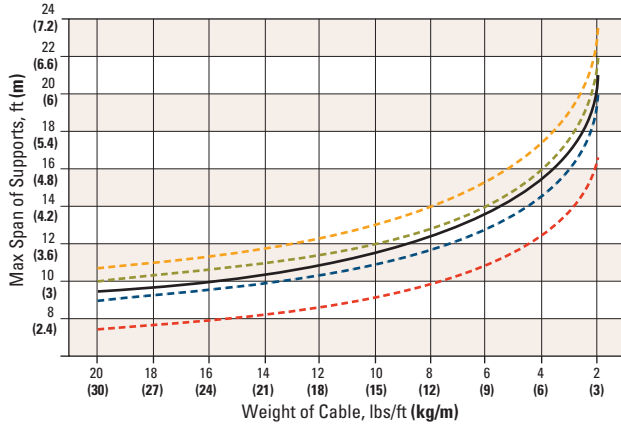
THHN

TRADE SIZE	ID SIZES											
	ALLOWABLE CONDUIT IN ²	MAX 1 CONDUCT. SIZE	IN ² OF 1 CONDUCTOR	ALLOWABLE CONDUIT IN ²	MAX 2 CONDUCT. SIZE	IN ² OF 2 CONDUCTORS	ALLOWABLE CONDUIT IN ²	MAX 3 CONDUCT. SIZE	IN ² OF 3 CONDUCTORS	ALLOWABLE CONDUIT IN ²	MAX 4 CONDUCT. SIZE	IN ² OF 4 CONDUCTORS
2" (51)	1.665"	1000	0.3237"	0.974"	300	0.9216"	1.257"	250	1.1910"	1.257"	3/0	1.0716"
2-1/2" (64)	2.602"	—	—	1.522"	500	1.4146"	1.963"	400	1.7589"	1.963"	300	1.8432"
3" (76)	3.746"	—	—	2.191"	750	2.0992"	2.827"	600	2.6028"	2.827"	400	2.3452"
3-1/2" (89)	5.099"	—	—	2.983"	1000	2.6956"	3.848"	900	3.6933"	3.848"	600	3.4704"
4" (102)	6.660"	—	—	3.896"	—	—	5.027"	1000	4.0434"	5.027"	900	4.9244"
5" (127)	10.407"	—	—	6.087"	—	—	7.854"	—	—	7.854"	1000	5.3912"
6" (152)	14.985"	—	—	8.765"	—	—	11.310"	—	—	11.310"	—	—

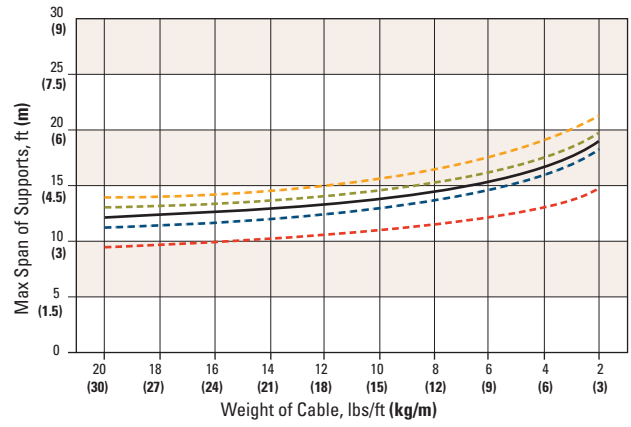
Deflection

Deflection is always determined at mid-span.

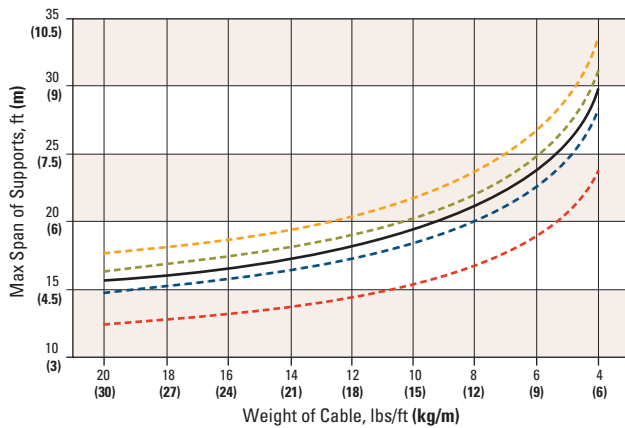
2" XW DIAMETER



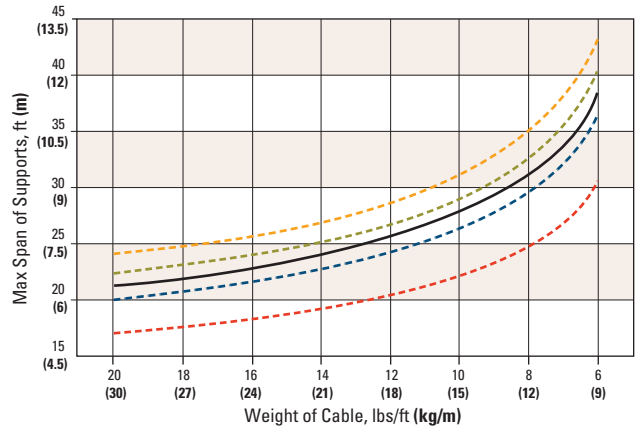
3" XW DIAMETER



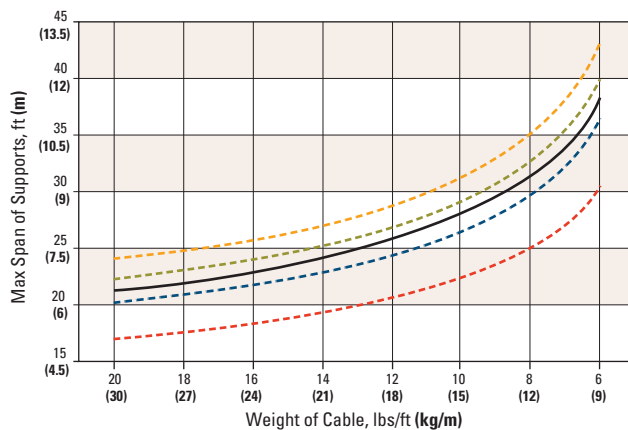
4" XW DIAMETER



5" XW DIAMETER



6" XW DIAMETER



It is recommended that mid-span deflection never exceeds 5/8 in (16 mm).

Above are easy graphs for determining support distance between hangers for various diameters and wall thicknesses of conduit.

Legend:

- 1/4" (6) Deflection
- 1/2" (13) Deflection
- 5/8" (16) Deflection
- 3/4" (19) Deflection
- 1" (25) Deflection
- D = Mid-span deflection (in)
- OD = Outside diameter of conduit (in)
- ID = Inside diameter of conduit (in)
- E = Modulus of elasticity of conduit (psi), which is 1,400,000 for epoxy fiberglass conduit
- L = Distance between hangers (ft)
- W = Total weight of cable and conduit (lbs/ft)

The empirical formula for deflection is:

$$D = \frac{131 \times W \times L^4}{E(OD^4 - ID^4)}$$

Corrosion Resistance Guide

The corrosion guidelines tests were performed by immersing epoxy coupons for 30 days in the chemical at the temperatures shown. This is a very severe test. It has been shown that Champion Duct® can often be used for chemicals listed as “Not Recommended” (NR) as real cases often are limited to fumes, vapors and occasional splashes at the temperatures indicated.

This information is provided solely as a guide since it is impossible to anticipate all individual site conditions. For specific applications which are not covered in this guide, and may require screening tests to evaluate resin system suitability, consultation with Champion Fiberglass is recommended.

UP TO TEMPERATURE, °F			UP TO TEMPERATURE, °F			UP TO TEMPERATURE, °F		
EPOXY CONDUIT			EPOXY CONDUIT			EPOXY CONDUIT		
CHEMICAL	120°	210°	CHEMICAL	120°	210°	CHEMICAL	120°	210°
Acetaldehyde	N	N	Bromine, liquid	N	N	Dioxane – 1,4	–	–
Acetaldehyde, aq. 40%	N	N	Bromine, gas, 25%	N	N	Dimethylamine	N	N
Acetic Acid, glacial	N	N	Bromine, aq.	N	N	Dimethyl formamide	N	N
Acetic Acid, 20% (25)	R	C	Butane	R	R	Detergents, aq.	R	R
Acetic Acid, 80%	N	N	Butanetriol (erythriol)	–	–	Disbutylphthalate	R	N
Acetic Anhydride	N	N	Butanediol	–	–	Dibutyl sebacate	R	N
Acetone, 10%	N	N	Butyl Acetate	N	N	Dichlorobenzene	N	N
Adipic Acid	C	N	Butyl phenol	N	N	Dichlorethylene	N	N
Alcohol, allyl	N	N	Butyric acid <50%	R	R	Ether (diethyl)	N	N
Alcohol, benzyl	N	N	Calcium salts, aq.	R	R	Ethyl halides	N	N
Alcohol, butyl (n-butanol)	C	N	Calcium hypochlorite	C	N	Ethylene halides	N	N
Alcohol, butyl (2-butanol)	N	N	Calcium hydroxide, 100%	R	R	Ethylene glycol	R	R
Alcohol, ethyl	C	N	Cane sugar liquors	R	N	Ethylene oxide	N	N
Alcohol, hexyl	R	C	Carbon disulfide	N	N	Fatty acids	C	R
Alcohol, isopropyl (2-propanol)	C	N	Carbon dioxide	C	C	Ferric salts	R	R
Alcohol, methyl	N	N	Carbon dioxide, aq.	C	C	Fluorine, gas, dry	N	N
Alcohol, propyl (1-propanol)	R	N	Carbon monoxide	R	C	Fluorine, gas, wet	N	N
Allyl chloride	N	N	Carbon tetrachloride	R	N	Fluoroboric acid, 25%	R	R
Alum	R	C	Casein	R	R	Fluoroboric acid, 10%	C	N
Ammonia, gas	C	N	Castor oil	R	N	Formaldehyde	C	N
Ammonia, liquid	N	N	Caustic potash (KOH)	C	N	Formic acid	C	N
Ammonia, aq. 20%	–	–	Caustic soda (NaOH)	C	N	Freon, F11, F12, 113, 114	N	N
Ammonia salts, except fluoride	R	C	Chlorine, gas, dry	R	C	Freon, F21, F22	N	N
Ammonia fluoride, 25%	R	N	Chlorine, gas, wet	N	N	Fruit Juices and pulps	N	N
Amyl acetate	N	N	Chlorine, liquid	N	N	Fuel oil	R	C
Amyl chloride	R	N	Chlorine, water	C	N	Furfural	N	N
Aniline	N	N	Chloroacetic acid	R	N	Gas, natural, methane	R	N
Aniline hydrochloride	R	N	Chlorobenzene	N	N	Gasoline	N	N
Antimony trichloride	–	–	Chloroform	N	N	Gelatin	R	N
Aqua regia	–	–	Chlorosulfonic acid, 10%	N	N	Glycerine (glycerol)	R	R
Arsenic Acid, 80%	C	N	Chromic acid, 10%	N	N	Glycols	R	C
Aryl-sulfonic acid	R	R	Chromic acid, 30%	N	N	Glycolic acid	C	N
Barium salts	R	C	Chromic acid, 40%	N	N	Green Liquor–paper	R	N
Beer	C	N	Chromic acid, 50%	N	N	Heptane	R	R
Beet sugar liquor	R	N	Citric acid	R	R	Hexane	R	N
Benzaldehyde, 10%	–	–	Coconut oil	R	N	Hydrobromic acid, 25%	C	N
Benzaldehyde, 10–100%	N	N	Copper salts, aq.	R	R	Hydrobromic acid	C	N
Benzene (benzoin)	C	N	Corn oil	R	C	Hydrofluoric acid, 10%	R	N
Benzene sulfonic acid, 10%	R	R	Corn syrup	R	R	Hydrofluoric acid, 60%	N	N
Benzene sulfonic acid, 50%	C	N	Cottonseed oil	R	R	Hydrofluoric acid, 100%	N	N
Benzoic acid	R	R	Cresylic acid, 50%	N	N	Hydrocyanic acid	–	–
Black liquor–paper	R	C	Crude oil	R	R	Hydrogen peroxide, 50%	N	N
Bleach, 12.5% active chlorine	C	N	Cyclohexane	R	N	Hydrogen peroxide, 90%	N	N
Bleach, 5.5% active chlorine	C	N	Cyclohexanol	R	N	Hydrogen sulfide, dry	R	R
Borax	R	R	Cyclohexanone	–	–	Hydrazine	N	N
Boric acid	R	R	Diesel fuels	R	N	Hypochlorous acid, 10%	N	N
Brine	R	N	Diethyl amine	N	N	Jet fuels, JP 4 and JP5	R	N
Bromic acid, <50%	N	N	Diethyl phthalate	R	C	Kerosene	R	N

R = Generally resistant N = Generally not resistant C = Less resistant than "R" but still suitable for some conditions

UP TO TEMPERATURE, °F			UP TO TEMPERATURE, °F			UP TO TEMPERATURE, °F		
EPOXY CONDUIT			EPOXY CONDUIT			EPOXY CONDUIT		
CHEMICAL	120°	210°	CHEMICAL	120°	210°	CHEMICAL	120°	210°
Lauric acid	R	R	Perchloric acid, 10%	R	C	Tannic acid	R	R
Lauryl chloride	R	R	Perchloric acid, 70%	R	C	Tartaric acid	R	R
Lauryl sulfate	R	R	Perchloroethylene	R	C	Tetrachloroethane	C	N
Lead salts	R	R	Petroleum, sour	R	R	Tetrahydrofuran	N	N
Linoleic acid	R	N	Petroleum, refined	R	R	Thionyl chloride	N	N
Linseed oil	R	R	Phenol, 88%	N	N	Thread cutting oil	R	N
Lithium salts	R	R	Phenylcarbinol	N	N	Terpineol	R	R
Lubricating oils	R	N	Phenylhydrazine	N	N	Toluene	C	N
Machine oil	R	N	Phosphoric acid	C	R	Tributyl phosphate	R	N
Magnesium salts	R	R	Phosphorous, yellow	N	N	Tricresyl phosphate	R	N
Maleic acid	R	R	Phosphorous, red	N	N	Trichloroacetic acid	C	C
Manganese sulfate	R	R	Phosphorous trichloride	N	N	Trichloroethylene	N	N
Mercuric salts	R	R	Phthalic acid	R	R	Triethanolamine	R	N
Mercury	R	R	Potassium salts, aq.	R	R	Triethylamine	C	N
Methane	R	R	Potassium permanganate, 25%	C	C	Turpentine	R	N
Methyl acetate	N	N	Propane	R	R	Urea, 50%	R	N
Methyl bromide (gas)	N	N	Propylene dichloride	N	N	Urine	R	N
Methyl cellosolve	-	-	Propylene glycol	R	R	Vaseline	R	R
Methyl chloride	N	N	Propylene oxide	N	N	Vegetable oils	R	R
Methyl chloroform	N	N	Pyridine	N	N	Vinegar	R	R
Methyl cyclohexanone	N	N	Rayon coagulating bath	R	N	Vinyl acetate	N	N
Methyl methacrylate	N	N	Sea water	R	R	Water, distilled	C	N
Methylene bromide	N	N	Salicylic acid	R	N	Water, fresh	R	N
Methylene chloride	N	N	Sewage, residential	C	N	Water, mine	R	N
Methylene iodide	N	N	Silicic acid	R	R	Water, salt	R	N
Milk	R	R	Silicone oil	R	R	Water, tap	R	N
Mineral oil	R	R	Silver salts	R	R	Whiskey	R	N
Molasses	R	N	Soaps	R	R	Wines	R	C
Monochlorozenzene	N	N	Sodium hydroxide	N	N	Xylene	C	N
Monoethanolamine	N	N	Sodium salts, aq. Except	R	C	Zinc salts	R	R
Motor oil	R	R	Sodium chlorite, 10%	R	N			
Naphtha	R	N	Sodium chlorate	R	R			
Naphthalene	R	R	Sodium dichromate, acid	R	R			
Nickel salts	R	R	Stannic chloride	R	R			
Nitric acid, 0 to 20%	N	N	Stannous chloride	R	R			
Nitric acid, 21 to 100%	N	N	Stearic acid	R	R			
Nitric acid, fuming	N	N	Sulfite liquor	R	C			
Nitrobenzene	N	N	Sulfur	R	N			
Nitrous acid	R	N	Sugars, aq.	R	R			
Oleic acid	R	R	Sulfur dioxide, dry	R	R			
Oleum	N	N	Sulfur dioxide, wet	C	C			
Olive oil	R	R	Sulfur trioxide, gas, dry	R	R			
Oxalic acid	R	R	Sulfur trioxide, gas, wet	N	N			
Ozone, gas, 5%	C	N	Sulfuric acid, < 26%	R	N			
Palmitic acid, 10%	R	R	Sulfuric acid, 26 to 80%	C	N			
Palmitic acid, 70%	R	R	Sulfuric acid, 81 to 100%	N	N			
Paraffin	R	R	Sulfuric acid, 10%	R	N			

R = Generally resistant N = Generally not resistant C = Less resistant than "R" but still suitable for some conditions

- Temperatures represent standard test conditions and are not minimums or maximums. Champion Duct products may be acceptable at other temperatures for some chemicals, but should be tested to determine specific suitability.
- The recommendations or suggestions contained in this table are made without guarantee or representation as to results. We suggest that you evaluate these recommendations and suggestions in your own laboratory or field trial prior to use.