



Industrial Plastics, Inc.



ENGINEERING HANDBOOK
For Industrial Plastic Piping Systems

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Harrington's corporate office in Chino, CA



MATERIAL DESCRIPTION

POLYVINYL

PVC (POLYVINYL CHLORIDE) has a relatively high tensile strength and modulus of elasticity and therefore is stronger and more rigid than most other thermoplastics. The maximum service temperature is 140°F for Type 1. PVC has excellent chemical resistance to a wide range of corrosive fluids, but may be damaged by ketones, aromatics, and some chlorinated hydrocarbons. It has proved an excellent material for process piping (liquids and slurries), water service, and industrial and laboratory chemical waste drainage. Joining methods are solvent welding, threading (Schedule 80 only), or flanging.

CPVC (CHLORINATED POLYVINYL CHLORIDE) is particularly useful for handling corrosive fluids at temperatures up to 210°F. In chemical resistance, it is comparable to PVC. It weighs about one-sixth as much as copper, will not sustain combustion (self-extinguishing), and has low thermal conductivity. Suggested uses include process piping for hot, corrosive liquids; hot and cold water lines in office buildings and residences; and similar applications above the temperature range of PVC. CPVC pipe may be joined by solvent welding, threading, or flanging.

POLYOLEFINS

POLYPROPYLENE (HOMOPOLYMER) is the lightest thermoplastic piping material, yet it has considerable strength, outstanding chemical resistance, and may be used at temperatures up to 180°F in drainage applications. Polypropylene is an excellent material for laboratory and industrial drainage piping where mixtures of acids, bases, and solvents are involved. It has found wide application in the petroleum industry where its resistance to sulfur-bearing compounds is particularly useful in salt water disposal line, chill water loops, and demineralized water. Joining methods are coil fusion and socket heat welding.

COPOLYMER POLYPROPYLENE is a copolymer of propylene and polybutylene. It is made of high molecular weight copolymer polypropylene and possesses excellent dielectric and insulating properties because of its structure as a non-polar hydrocarbon polymer. It combines high chemical resistance with toughness and strength at operating temperatures from freezing to 200°F. It has excellent abrasion resistance and good elasticity, and is joined by butt and socket fusion.

POLYETHYLENE, although its mechanical strength is comparatively low, polyethylene exhibits very good chemical resistance and is generally satisfactory when used at temperatures below 120°F. Types I and II (low and medium density) polyethylene are used frequently in tanks, tubing, and piping. Polyethylene is excellent for abrasive slurries. It is generally joined by butt fusion.

FLUOROPOLYMERS

PVDF (POLYVINYLIDENE FLUORIDE) is a strong, tough, and abrasion-resistant fluoroplastic material. It resists distortion and retains most of its strength to 280°F. As well as being ideally suited to handle wet and dry chlorine,

bromine, and other halogens, it also withstands most acids, bases, and organic solvents. PVDF is not recommended for strong caustics. It is most widely recognized as the material of choice for high purity piping such as deionized water. PVDF is joined by thermal butt, socket, or electrofusion.

HALAR is a durable copolymer of ethylene and chlorofluoroethylene with excellent resistance to a wide variety of strong acids, chlorine, solvents, and aqueous caustics. Halar has excellent abrasion resistance, electric properties, low permeability, temperature capabilities from cryogenic to 340°F, and radiation resistance. Halar has excellent application for high purity hydrogen peroxide and is joined by thermal butt fusion.

TEFLON

There are three members of the Teflon family of resins.

PTFE TEFLON is the original Teflon resin developed by DuPont in 1938. This fluoropolymer offers the most unique and useful characteristics of all plastic materials. Products made from this resin handle liquids or gases up to 500°F. The unique properties of this resin prohibit extrusion or injection molding by conventional methods. When melted PTFE does not flow like other thermoplastics and it must be shaped initially by techniques similar to powder metallurgy. Normally PTFE is an opaque white material. Once sintered it is machined to the desired part.

FEP TEFLON was also invented by DuPont and became a commercial product in 1960. FEP is a true thermoplastic that can be melt-extruded and fabricated by conventional methods. This allows for more flexibility in manufacturing. The dielectric properties and chemical resistance are similar to other Teflons, but the temperature limits are -65°F to a maximum of 300°F. FEP has a glossy surface and is transparent in thin sections. It eventually becomes translucent as thickness increases. FEP Teflon is the most transparent of the three Teflons. It is widely used for its high ultraviolet light transmitting ability.

Caution: While the Teflon resin family has great mechanical properties and excellent temperature resistance, care must be taken when selecting the proper method of connections for your piping system. Generally, Teflon threaded connections will handle pressures to 120 PSIG. Loose ferrule connections are limited to 60 PSIG at ambient temperatures. Teflon loses its ability to bear a load at elevated temperatures quicker than other thermoplastics. When working with the PTFE products shown in this catalog external ambient temperatures ranging from -60°F to 250°F (-51°C to 121°C) may be handled safely. Fluid or gas temperatures inside the product should be limited to -60 to 400°F (-51°C to 204°C) unless otherwise noted. Always use extreme care when working with chemicals at elevated temperatures.

MATERIAL DESCRIPTION

PFA TEFLON, a close cousin of PTFE, was introduced in 1972. It has excellent melt-processability and properties rivaling or exceeding those of PTFE Teflon. PFA permits conventional thermoplastic molding and extrusion processing at high rates and also has higher mechanical strength at elevated temperatures to 500°F. Premium grade PFA Teflon offers superior stress and crack resistance with good flex-life in tubing. It is generally not as permeable as PTFE.

DURAPLUS

ABS (ACRYLONITRILE-BUTADIENE-STYRENE)

There are many possibilities for polymer properties by combining these resins. For our purposes we will limit it to two products. One is the less expensive ABS resin used in drain, waste, and vent applications. The other resin for more stringent industrial applications has a different combination of the three polymers that make up the copolymer. The Duraplus product is made from this copolymer and has outstanding impact resistance even at low temperatures. The product is very tough and abrasion resistant. Temperature range is 40°F to 176°F.

RYTON (PPS) POLYPHENYLENE SULFIDE remains quite stable during both long and short term exposure to high temperatures. The high tensile strength and flexural modulus typical of PPS compounds, decrease with an increase in temperature. PPS is also highly resistant to chemical attack. Relatively few chemicals react to this material even at high temperatures. Its broad range of chemical resistance is second only to that of Teflon (PTFE). Ryton is used primarily for precision pump parts.

ELASTOMERS

VITON (FLUOROCARBON) is inherently compatible with a broad spectrum of chemicals. Because of this extensive chemical compatibility which spans considerable concentration and temperature ranges, Viton has gained wide acceptance as a sealing for valves, pumps, and instrumentation. Viton can be used in most applications involving mineral acids, salt solutions, chlorinated hydrocarbons, and petroleum oils.

EPDM (EPT) is a terpolymer elastomer made from ethylene-propylene diene monomer. EPDM has good abrasion and tear resistance and offers excellent chemical resistance to a variety of acids and alkalis. It is susceptible to attack by oils and is not recommended for applications involving petroleum oils, strong acids, or strong alkalis.

HYTREL is a multipurpose polyester elastomer similar to vulcanized thermoset rubber. Its chemical resistance is comparable to Neoprene, Buna-N and EPDM; however, it is a tougher material and does not require fabric reinforcement as do the other three materials. Temperature limits are -10°F minimum to 190°F maximum. This material is used primarily for pump diaphragms.

THERMOSETS

FIBERGLASS REINFORCED PLASTICS (FRP) including epoxy, polyester, and vinylester have become a highly valuable process engineering material for process piping.

FRP has been accepted by many industries because it offers the following significant advantages:

- (a) moderate initial cost and low maintenance;
- (b) broad range of chemical resistance;
- (c) high strength-to-weight ratio;
- (d) ease of fabrication and flexibility of design;
- (e) good electrical insulation properties.

EPOXY pipe and fittings have been used extensively by a wide variety of industries since 1960. It has good chemical resistance and excellent temperatures to pressure properties (to 300°F). Epoxy has been used extensively for fuel piping and steam condensate return lines.

POLYESTER pipe and fittings have been used by the industry since 1963. It has a proven resistance to most strong acids and oxidizing materials. It can be used in applications up to 200°F. Polyester is noted for its strength in both piping and structural shapes.

VINYLESTER resin systems are recommended for most chlorinated mixtures as well as caustic and oxidizing acids up to 200°F. Vinylester for most service has superior chemical resistance to epoxy or polyester.

NYLONS are synthetic polymers that contain an amide group. Their key characteristics are: (a) excellent resistance and low permeation to fuels, oils, and organic solvent, including aliphatic, aromatic, and halogenated hydrocarbons, esters, and ketones; (b) outstanding resistance to fatigue and repeated impact; and (c) wide temperature range from -30°F to 250°F.

Caution: Acids will cause softening, loss of strength, rigidity, and eventual failure.

POLYURETHANES

There are essentially two types of polyurethanes: polyester based and polyether based. Both are used for tubing applications.

POLYESTER based is the toughest of the two, having greater resistance to oil and chemicals. It does not harden when used with most oils, gasoline, and solvents. Polyurethane is extremely resistant to abrasives making it ideal for slurries, solids and granular material transfer. Temperature limit is 170°F.

Caution: Polyester based polyurethanes may be subject to hydrolysis under certain conditions, high relative humidity at elevated temperatures, aerated water, fungi, and bacteria. Where these potentials exist, we recommend polyether-based polyurethane.

POLYETHER-based polyurethane possesses better low temperature properties, resilience and resistance to hydrolytic degradation than the polyester previously discussed.

MATERIAL DESCRIPTION

Accelerated testing indicates that polyether-based polyurethanes have superior hydrolytic stability as compared to polyester based material. Made with no plasticizers and with a low level of extractables, polyether is ideal for high purity work. It will not contaminate laboratory samples and is totally non-toxic to cell cultures. Compared with PVC tubing, polyurethanes have superior chemical resistance to fuels, oils, and some solvents. Its excellent tensile strength and toughness make it suitable for full vacuums. This tubing can withstand temperatures from -94°F to 200°F.

PTBP

Polybutylene terephthalate is a little known specialty material belonging to the polyimide group; It has excellent mechanical properties and good mechanical stress properties under corrosive environments. PTBP is used mainly for valve actuators, and bonnet assemblies.



INDUSTRY STANDARDS

The standards referenced herein, like all other standards, are of necessity minimum requirements. It should be recognized that two different plastic resin materials of the same kind, type, and grade will not exhibit identical physical and chemical properties. Therefore, the plastic pipe purchaser is advised to obtain specific values or requirements from the resin supplier to assure the best application of the material not covered by industry specifications; this suggestion assumes paramount importance.

ANSI

American National Standards Institute, Inc.
655 15th St. N.W.
300 Metropolitan Square
Washington, DC 20005
Phone (202) 639-4090

ANSI PRESSURE CLASSES

ANSI Class 125 means 175 PSIG at 100°F
 ANSI Class 150 means 285 PSIG at 100°F
 ANSI Class 300 means 740 PSIG at 100°F
 ANSI A119.2 - 1963
 ANSI B72.2 - 1967
 ANSI B31.8 - 1968
 ANSI Z21.30 - 1969

The following ASTM standards have been accepted by ANSI and assigned the following designations.

Table 1

ANSI Designation	ASTM Designation	ANSI Designation	ASTM Designation
B72.1	D 2239	B 72.11	D 2412
B72.2	D 2241	B 72.12	D 2446
B72.3	D 2282	B 72.13	D 2447
B72.4	D 1503	B 72.16	D 2564
B72.5	D 1527	B 72.17	D 2657
B72.6	D 1598	B 72.18	D 2661
B72.7	D 1785	B 72.19	D 2662
B72.8	D 2104	B 72.20	D 2672
B72.9	D 2152	B 72.22	D 2740
B72.10	D 2153	B 72.23	D 2235

ASTM

American Society of Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103

Plastic Pipe Specifications:

D	1785	Polyvinyl chloride (PVC) plastic pipe, schedules 40, 80, and 120
F	441	Chlorinated poly (vinyl chloride)(CPVC) plastic pipe, schedules 40 and 80
D	2241	Polyvinyl chloride (PVC) plastic pipe (SD - PR)
D	2513	Thermoplastic gas pressure pipe, tubing and fittings
D	2665	PVC plastic drain, waste, and vent pipe and fittings
D	2672	Bell-ended PVC pipe

D	2729	PVC sewer pipe and fittings
D	2846	Chlorinated (CPVC) plastic hot water distribution system
D	2949	3" thin wall PVC plastic drain, waste, and vent pipe and fittings
D	3034	Type PSM PVC sewer pipe and fittings

Plastic Pipe Fittings Specifications:

D	2464	Threaded PVC plastic pipe fittings, Schedule 80
F	437	Threaded chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 80
D	2466	Socket-type PVC plastic type fittings, Schedule 40
D	2467	Socket-type PVC plastic type fittings, Schedule 80
F	439	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings Schedule 80
D	3036	PVC plastic pipe lined couplings, socket type

Plastic Pipe Solvent Cement Specifications

D	2564	Solvent cements for PVC plastic pipe and fittings
F	493	CPVC solvent cement

Plastic Lined Steel Piping Specifications:

ASTM A-587	Standard specification for electric-welded low carbon steel pipe for the chemical industry
ASTM A-53	Standard specification for pipe, steel, black and hot-dipped, zinc-coated, welded and seamless
ASTM A-105	Standard specification for forgings, carbon steel, for piping components
ASTM A-125	Standard specification for steel springs, helical, heat-treated
ASTM A-126	Standard specifications for gray iron castings for valves, flanges, and pipe fittings
ASTM A-395	Standard specification for ferritic ductile iron pressure retaining castings for use at elevated temperatures
ASTM A-216	Standard specification for carbon steel castings suitable for fusion welding for high temperature service
ASTM A-234	Standard specification for piping fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ANSI B-16.1	Cast iron pipe flanges and flanged fittings Class 25, 125, 150, 250 and 800
ANSI B-16.42	Ductile iron pipe flanges and flanged fittings Class 150 and 300

INDUSTRY STANDARDS

ANSI B-16.5	Steel pipe flanges and flanged fittings Class 150, 300, 400, 600, 900, 1500 and 2500
A-587	Standard specification for electric-welded low carbon steel pipe for the chemical industry
A-53	Standard specification for pipe, steel black and hot-dipped, zinc-coated, welded and seamless
A-105	Standard specification for forgings, carbon steel, for piping components
A-125	Standard specification for steel springs, helical, heat-treated
A-126-73	Standard specification for gray iron castings for valves, flanges, and pipe fittings
A-395-77	Standard specification for ferritic ductile iron pressure retaining castings for use at elevated temperatures
A-216-77	Standard specification for carbon steel castings suitable for fusion welding for high temperature service

Methods of Test Specifications:

D	256	Test for impact resistance of plastics and electrical insulating materials
D	543	Test for resistance of plastics to chemical reagents
D	570	Test for water absorption of plastics
D	618	Conditioning plastics and electrical insulating materials for testing
D	621	Tests for deformation of plastics under load
D	635	Test for flammability of self-supporting plastics
D	638	Test for tensile properties of plastics
D	648	Test for deflection temperature of plastics under load
D	671	Tests for repeated flexural stress of plastics
D	757	Test for flammability of plastics, self-extinguishing type
D	790	Test for flexural properties of plastics
D	883	Nomenclature relating to plastics

D	1180	Test for bursting strength of round, rigid plastic tubing
D	1598	Test for time to failure of plastic pipe under long-term hydrostatic pressure
D	1599	Test for short-time rupture strength of plastic pipe, tubing and fittings
D	2122	Determining dimensions of thermoplastic pipe and fittings
D	2152	Test for quality of extruded PVC pipe by acetone immersion
D	2412	Test for external loading properties of plastic pipe by parallel-plate loading
D	2444	Test for impact resistance of thermoplastic pipe and fittings by means of a tup (falling weight)
D	2837	Obtaining hydrostatic design basis thermoplastic pipe materials
D	2924	Test for external pressure resistance of plastic pipe

RECOMMENDED PRACTICES

D	2153	Calculating stress in plastic pipe under internal pressure
D	2321	Underground installation of flexible thermoplastic sewer pipe
D	2657	Heat joining of thermoplastic pipe and fittings
D	2749	Standard definitions of terms relating to plastic pipe fittings
D	2774	Underground installation of thermoplastic pressure pipe
D	2855	Making solvent cemented joints with PVC pipe and fittings

ASTM STANDARDS FOR PLASTIC MATERIALS REFERENCED IN PLASTIC PIPE, FITTINGS, AND CEMENT STANDARDS

D	1784	PVC compounds and CPVC compounds
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BOCA

Building Officials Conference of America
1313 East 60th Street
Chicago, Illinois 60637

BOCA Basic Plumbing Code

INDUSTRY STANDARDS

Table 2

Group	Commercial Standard or Product Standard	ASTM Standard or Tentative Specification
A	PS10	D2104
B	PS11	D2238
C	PS12	D2447
D	PS18	D1527
E	PS19	D2282
F	PS21	D1785
G	PS22	D2241
H	CS228	D2852
I	CS270	D2661
J	CS272	D2665

COMMERCIAL AND PRODUCT STANDARDS

Supt. of Documents
U.S. Government Printing Office
Washington, DC 20402

CS 272	PVC-DWV pipe and fittings
PS 21	PVC plastic pipe (Schedules 40, 80, 120) supersedes CS 207-60
PS 22	PVC plastic pipe (SDR) supersedes CS 256

CSA

Canadian Standards Association
178 Rexdale Boulevard
Rexdale, Ontario, Canada

B	137.0	Defines general requirements and methods of testing for thermoplastic pressure pipe
B	137.3	Rigid polyvinyl chloride (PVC) pipe for pressure applications
B	137.4	Thermoplastic piping systems for gas service
B	137.14	Recommended practice for the installation of thermoplastic piping for gas service
B	181.2	Polyvinyl chloride drain, waste, and vent pipe and pipe fittings
B	181.12	Recommended practice for the installation of PVC drain, waste, and vent pipe fittings
B	182.1	Plastic drain and sewer pipe and pipe fittings for use underground
B	182.11	Recommended practice for the installation of plastic drain and sewer pipe and pipe fittings

DEPARTMENT OF AGRICULTURE

U.S. Department of Agriculture
Soil Conservation Service
Washington, DC 20250

SCS National Engineering Handbook, Section 2, Part 1, Engineering Practice Standards

SCS432-D High pressure underground plastic irrigation pipelines

SCS432-E Low head underground plastic irrigation pipelines

DEPARTMENT OF DEFENSE MILITARY STANDARDS

Commanding Officer
Naval Publications and Forms Center
5108 Tabor Avenue
Philadelphia, Pennsylvania 19120

MIL-A-22010A(1) Adhesive solvent-type, polyvinyl chloride amendment

MIL-C-23571A(YD) Conduit and conduit fittings, plastic, rigid

MIL-P-14529B Pipe, extruded, thermoplastic

MIL-P-19119B(1) Pipe, plastic, rigid, unplasticized, high impact, polyvinyl chloride

MIL-P-22011A Pipe fittings, plastic, rigid, high impact, polyvinyl chloride, (PVC) and poly 1, 2 dichlorethylene

MIL-P-28584A Pipe and pipe fittings, glass fiber reinforced plastic for condensate return lines

MIL-P-29206 Pipe and pipe fittings glass fiber reinforced plastic for liquid petroleum lines

DOT - OTS

Department of Transportation, Hazardous Materials Regulation Board, Office of Pipeline Safety, Title 49, Docket OPS-3 and amendments, Part 192. Transportation of Natural Gas and Other Gas by Pipeline: Minimum Federal Safety Standards, Federal Register, Vol, 35, No. 161, Wednesday, August 19, 1980. Amendments to date are 192-1, Vol. 35, No. 205, Wednesday, October 21, 1970; 19-2, Vol. 35, No. 220, Wednesday, November 11, 1970; and 192-3, Vol. 35, No. 223, Tuesday, November 17, 1970.

FEDERAL SPECIFICATIONS

Specifications Activity
Printed Materials Supply Division
Building 197, Naval Weapons Plant
Washington, DC 20407

L-P-320a Pipe and fittings, plastic (PVC, drain, waste, and vent)

L-P-1036(1) Plastic rod, solid, plastic tubes and tubing, heavy walled; polyvinyl chloride

INDUSTRY STANDARDS

FHA

**Architectural Standards Division
Federal Housing Administration
Washington, DC 20412**

- FHA UM-41 PVC plastic pipe and fittings for domestic water service
- FHA UM-49 ABS and PVC plastic drainage and vent pipe and fittings, FHA 4550.49
- FHA UM-53a Polyvinyl chloride plastic drainage, waste and vent pipe and fittings
- FHA MR-562 Rigid chlorinated polyvinyl chloride (CPVC) hi/temp water pipe and fittings
- FHA MR-563 PVC plastic drainage and vent pipe and fittings
- FHA Minimum Property standards interim revision No. 31

IAPMO

**International Association of Plumbing and Mechanical Officials
5032 Alhambra Avenue
Los Angeles, California 90032**

Uniform Plumbing Code

- IAPMO IS8 Solvent cemented PVC pipe for water service and yard piping
- IAPMO IS9 PVC drain, waste, and vent pipe and fittings
- IAPMO IS10 Polyvinyl chloride (PVC) natural gas yard piping
- IAPMO PS27 Supplemental standard to ASTM D2665; polyvinyl chloride (PVC) plastic drain, waste, and vent pipe and fittings

(NOTE: IS = installation standard; PS = property standard)

NSF

**National Sanitation Foundation
School of Public Health
University of Michigan
Ann Arbor, Michigan 48106**

NSF
Standard No. 14: Thermoplastic Materials, Pipe, Fittings, Valves, Traps, and Joining Materials

NSF
Seal of Approval: Listing of Plastic Materials, Pipe, Fittings, and Appurtenances for Potable Water and Waste Water (NSF Testing Laboratory).

NSPI

**National Swimming Pool Institute
2000 K Street, N.W.
Washington, DC 20006**

T.R.-19 The Role of Corrosion-Resistant Materials in Swimming Pools, Part D, The Role of Plastics in Swimming Pools.

PHCC

**National Association of Plumbing-Heating-Cooling Contractors
1016 20th Street, N.W.
Washington, DC 20036
National Standard Plumbing Code**

SBCC

**Southern Building Code Congress
1166 Brown-Marx Building
Birmingham, Alabama 35203
SBCC Southern Standard Plumbing Code**

SIA

**Sprinkler Irrigation Association
1028 Connecticut Avenue, N.W.
Washington, DC 20036
Minimum Standards for Irrigation Equipment**

WUC

**Western Underground Committee, W.H. Foote
Los Angeles Department of Water and Power
P.O. Box 111
Los Angeles, California 90054
Interim Specification 3.1: Plastic Conduit and Fittings**

UL

**Underwriters Laboratories, Inc.
207 East Ohio Street
Chicago, Illinois 60611
UL 651 Rigid Nonmetallic Conduit (September 1968)
UL 514 Outlet Boxes and Fittings (March 1951 with Amendments of 22-228-67)**



INDUSTRY STANDARDS

NEMA

National Electrical Manufacturers' Association
 2101 "L" St. N.W.
 Washington, DC 20037

		Type 4X	Watertight, Dusttight and Corrosion-Resistant - Indoor and Outdoor: This type has same provisions as Type 4 and, in addition, is corrosion-resistant.
Type 1	General Purpose - Indoor: This enclosure is intended for use indoors, primarily to prevent accidental contact of personnel with the enclosed equipment in areas where unusual service conditions do not exist. In addition, they provide protection against falling dirt.	Type 5	Superseded by Type 12 for Control Apparatus.
		Type 6	Submersible, Watertight, Dusttight, and Sleet (Ice) Resistant - Indoor and Outdoor: Type 6 enclosures are intended for use indoors and outdoors where occasional submersion is encountered, such as in quarries, mines, and man-holes. They are required to protect equipment against a static head of water of 6 feet for 30 minutes and against dust, splashing or external condensation of non-corrosive liquids, falling or hose directed lint and seepage. They are not sleet (ice) proof.
Type 2	Dripproof - Indoor: Type 2 dripproof enclosures are for use indoors to protect the enclosed equipment against falling non-corrosive liquids and dirt. These enclosures are suitable for applications where condensation may be severe such as encountered in cooling rooms and laundries.		
Type 3	Dusttight, Raintight, Sleet (Ice) Resistant Outdoor: Type 3 enclosures are intended for use outdoors to protect the enclosed equipment against windblown dust and water. They are not sleet (ice) proof.	Type 7	Class I, Group A, B, C, and D-Indoor Hazardous Locations - Air-Break Equipment: Type 7 enclosures are intended for use indoors, in the atmospheres and locations defined as Class 1 and Group A, B, C or D in the National Electrical Code. Enclosures must be designed as specified in Underwriters' Laboratories, Inc. "Industrial Control Equipment for Use in Hazardous locations," UL 698. Class I locations are those in which flammable gases or vapors may be present in explosive or ignitable amounts. The group letters A, B, C, and D designate the content of the hazardous atmosphere under Class 1 as follows:
Type 3R	Rainproof and Sleet (Ice) Resistant Outdoor: Type 3R enclosures are intended for use outdoors to protect the enclosed equipment against rain and meet the requirements of Underwriters Laboratories Inc., Publication No. UL 508, applying to "Rainproof Enclosures." They are not dust, snow, or sleet (ice) proof.		Group A Atmospheres containing acetylene.
Type 3S	Dusttight, Raintight, and Sleet (Ice) Proof-Outdoor: Type 3S enclosures are intended for use outdoors to protect the enclosed equipment against windblown dust and water and to provide for its operation when the enclosure is covered by external ice or sleet. These enclosures do not protect the enclosed equipment against malfunction resulting from internal icing.		Group B Atmospheres containing hydrogen or gases or vapors of equivalent hazards such as manufactured gas.
Type 4	Watertight and Dusttight - Indoor and Outdoor: This type is for use indoors or outdoors to protect the enclosed equipment against splashing and seepage of water or streams of water from any direction. It is sleet-resistant but not sleet-proof.		Group C Atmospheres containing ethyl ether vapors, ethylene, or cyclopropane.
			Group D Atmospheres containing gasoline, hexane, naphtha, benzene, butane, propane, alcohols, acetone, lacquer solvent vapors and natural gas.

INDUSTRY STANDARDS

<p>Type 8</p>	<p>Class I, Group A, B, C or D - Indoor Hazardous Locations Oil-immersed Equipment: These enclosures are intended for indoor use under the same class and group designations as Type 7, but are also subject to immersion in oil.</p>	<p>Type 10</p>	<p>Bureau of Mines: Enclosures under Type 10 must meet requirements of Schedule 2G (1968) of the Bureau of Mines, U.S. Department of the Interior, for equipment to be used in mines with atmospheres containing methane or natural gas, with or without coal dust.</p>
<p>Type 9</p>	<p>Class II, Group E, F and G - Indoor Hazardous Locations - Air-Break Equipment: Type 9 enclosures are intended for use indoors in the atmospheres defined as Class II and Group E, F, or G in the National Electrical Code. These enclosures shall prevent the ingress of explosive amounts of hazardous dust. If gaskets are used, they shall be mechanically attached and of a non-combustible, nondeteriorating, verminproof material. These enclosures shall be designed in accordance with the requirements of Underwriters' Laboratories, Inc. Publication No. UL 698. Class II locations are those in which combustible dust may be present in explosive or ignitable amounts. The group letter E, F, and G designate the content of the hazardous atmosphere as follows:</p> <p>Group E Atmosphere containing metal dusts, including aluminum, magnesium, and their commercial alloys.</p> <p>Group F Atmospheres containing carbon black, coal, or coke dust.</p> <p>Group G Atmospheres containing flour, starch, and grain dust.</p>	<p>Type 11</p>	<p>Corrosion-Resistant and Dripproof-Oil-Immersed - Indoor: Type 11 enclosures are corrosion-resistant and are intended for use indoors to protect the enclosed equipment against dripping, seepage, and external condensation of corrosive liquids. In addition, they protect the enclosed equipment against the corrosive effects of fumes and gases by providing for immersion of the equipment in oil.</p>
		<p>Type 12</p>	<p>Industrial Use - Dusttight and Driptight - Indoor: Type 12 enclosures are intended for use indoors to protect the enclosed equipment against fibers, flyings, lint, dust and dirt, and light splashing, seepage, dripping and external condensation of non-corrosive liquids.</p>
		<p>Type 13</p>	<p>Oiltight and Dusttight - Indoor: Type 13 enclosures are intended for use indoors primarily to house pilot devices such as limit switches, foot switches, pushbuttons, selector switches, pilot lights, etc., and to protect these devices against lint and dust, seepage, external condensation, and spraying of water, oil or coolant. They have oil-resistant gaskets.</p>

HAZARDOUS (CLASSIFIED) LOCATIONS IN ACCORDANCE WITH FACTORY MUTUAL ENGINEERING CORP.

The National Electrical Code and the Canadian Electrical Code divide hazardous locations into three "classes" according to the nature of the hazard: Class I, Class II, and Class III. The locations in each of these classes are further divided by "divisions" according to the degree of the hazard.

Class I, Division 1 locations are those in which flammable gases or vapors are or may be present in sufficient quantities to produce an ignitable mixture (continuously, intermittently, or periodically).

Class I, Division 2 locations are those in which hazardous mixtures may frequently exist due to leakage or maintenance repair.

Class I, Division 3 are those in which the breakdown of equipment may release concentration of flammable gases or vapors which could cause simultaneous failure of electrical equipment.

For purposes of testing, classification and approval of electrical equipment atmospheric mixtures are classified in seven groups (A through G) depending on the kind of material involved.

Class II locations are classified as hazardous because of the presence of combustible dusts.

Class III locations are hazardous because of the presence of combustible fibers or flyings in textile processes.

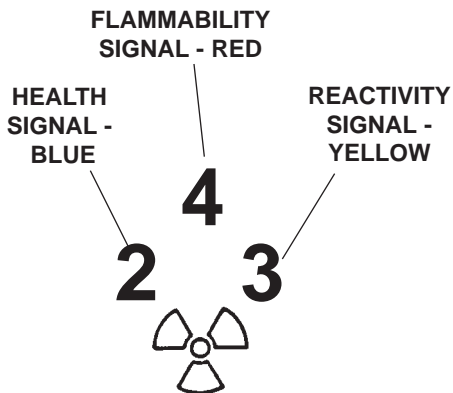
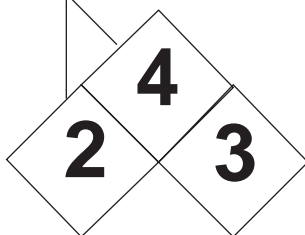
There are similar divisions and groups for Class II and Class III as those described for Class I. For specifics or further details contact Harrington's Technical Services department.

INDUSTRY STANDARDS HAZARDOUS MATERIAL SIGNALS

Hazardous Material Signals based on the National Fire Protection Association Code number 704M and Federal Standard 313. This system provides for identification of hazards to employees and to outside emergency personnel. The numerical and symbolized system shown here are the

standards used for the purpose of safeguarding the lives of those who are concerned with fires occurring in an industrial plant or storage location where the fire hazards of material may not be readily apparent.

ADHESIVE-BACKED PLASTIC BACKGROUND PIECES - ONE NEEDED FOR EACH NUMERAL, THREE NEEDED FOR EACH COMPLETE SIGNAL



WHITE PAINTED BACKGROUND, WHITE PAPER OR CARD STOCK

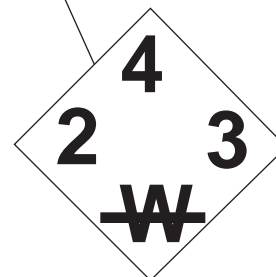


Figure 1. For use where specified color background is used with numerals of contrasting colors.

Figure 2. For use where a white background is necessary.

Figure 3. For use where a white background is used with painted numerals, or for use when the signal is in the form of sign or placard.

Table 4 - ARRANGEMENT AND ORDER OF SIGNALS - OPTIONAL FORM OF APPLICATION

DISTANCE AT WHICH SIGNALS MUST BE LEGIBLE	MINIMUM SIZE OF SIGNALS REQUIRED
50 FEET	1"
75 FEET	2"
100 FEET	3"
200 FEET	4"
300 FEET	6"

NOTE:

This shows the correct spatial arrangement and order of signals used for identification of materials by hazard.

IDENTIFICATION OF MATERIALS BY HAZARD SIGNAL ARRANGEMENT

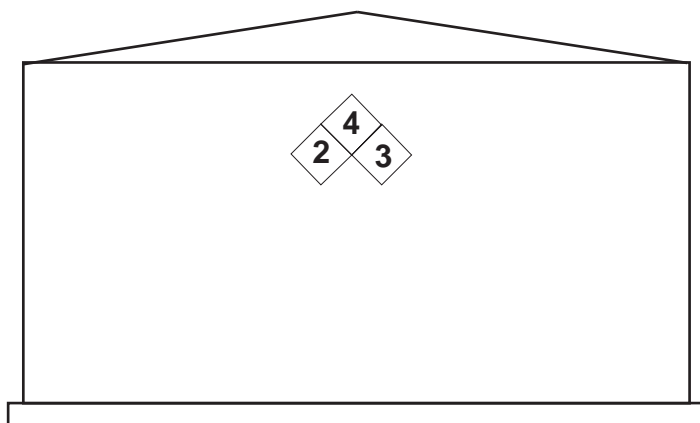


Figure 4. Storage Tank

This is a system for the identification of hazards to life and health of people in the prevention and control of fires and explosions in the manufacture and storage of materials.

The basis for identification are the physical properties and characteristics of materials that are known or can be determined by standard methods. Technical terms, expressions, trade names, etc., are purposely avoided as this system is concerned only with the identification of the involved hazard from the standpoint of safety.

The explanatory material on this page is to assist users of these standards, particularly the person who assigns the degree of hazard in each category.

INDUSTRY STANDARDS

Table 5 IDENTIFICATION OF THE FIRE AND HEALTH HAZARDS OF MATERIALS

IDENTIFICATION OF HEALTH HAZARDS COLOR CODE: BLUE		IDENTIFICATION OF FLAMMABILITY COLOR CODE: RED		IDENTIFICATION OF REACTIVITY COLOR CODE: YELLOW	
SIGNAL	TYPE OF POSSIBLE INJURY	SIGNAL	SUSCEPTIBILITY OF MATERIALS TO BURNING	SIGNAL	SUSCEPTIBILITY TO RELEASE OF ENERGY
4	Materials which on very short exposure could cause death or major residual injury even though prompt medical treatment were given.	4	Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily.	4	Materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
3	Materials which on short exposure could cause serious, temporary or residual injury even though prompt medical treatment were given.	3	Liquids and solids that can be ignited under almost all ambient temperature conditions.	3	Materials which in themselves are capable of detonation or of explosive reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water.
2	Material which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.	2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.	2	Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. Also materials which may react violently with water or which may form potentially explosive mixtures with water.
1	Materials which on exposure would cause irritation but only minor residual injury, even if no treatment is given.	1	Materials that must be preheated before ignition can occur.	1	Materials which, in themselves, are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently.
0	Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.	0	Materials that will not burn.	0	Materials, which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.

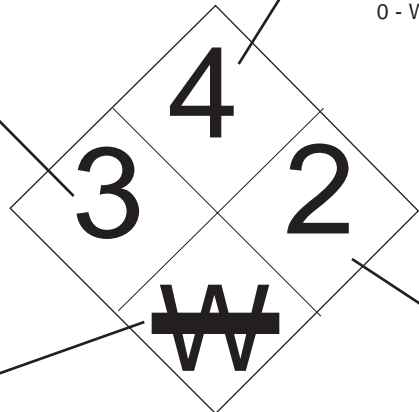
INDUSTRIAL STANDARDS

HEALTH HAZARD
 4 - DEADLY
 3 - EXTREME DANGER
 2 - HAZARDOUS
 1 - SLIGHTLY HAZARDOUS
 0 - NORMAL MATERIAL

**FIRE HAZARD
 FLASH POINTS**
 4 - BELOW 73°F
 3 - BELOW 100°F
 2 - BELOW 200°F
 1 - ABOVE 200°F
 0 - WILL NOT BURN

SPECIFIC HAZARD
 Oxidizer OXY
 Acid ACID
 Alkali ALK
 Corrosive COR
 Use NO WATER ~~W~~
 Radiation Hazard ☼

REACTIVITY
 4 - MAY DETONATE
 3 - SHOCK AND HEAT MAY DETONATE
 2 - VIOLENT CHEMICAL CHANGE
 1 - UNSTABLE IF HEATED
 0 - STABLE



INDUSTRY STANDARDS

Government regulatory agencies

DEPARTMENT OF COMMERCE

National Institute
of Standards and Technology
Public and Business Affairs Div.
Building 101, Room A903
Gaithersburg, MD 20889
Ph#: 301/975-2762
Fax: 301/926-1630

The National Institute of Standards and Technology (NIST) focuses on tasks vital to the country's technology infrastructure that neither industry nor the government can do separately.

NIST works to promote U.S. economic growth by working with industry to develop and apply technology, measurements, and standards.

Part of the Commerce Department's Technology Administration, NIST has four major programs that reflect U.S. industry's diversity and multiple needs. These programs include the Advanced Technology Program; Manufacturing Extension Partnership; Laboratory Research and Services; and the Baldrige National Quality Program.

DEPARTMENT OF ENERGY

Consumer Affairs
1000 Independence Avenue SW
Washington, DC 20585
Ph#: 202/586-5373
Fax: 202/586-0539

The Department of Energy is entrusted to contribute to the welfare of the nation by providing the technical information and scientific and educational foundation for technology, policy, and institutional leadership necessary to achieve efficiency in energy used, diversity in energy sources, a more productive and competitive economy, improved environmental quality, and a secure national defense.

DEPARTMENT OF THE INTERIOR

1849 C Street NW
Washington, DC 20240
Ph#: 202/208-3100
Fax: 202/208-6950

As the nation's principal conservation agency, the Department of the Interior's responsibilities include: encouraging and providing appropriate management, preservation and operation of the nation's public lands and natural resources; developing and using resources in an environmentally sound manner; carrying out related scientific research and investigations in support of these objectives; and carrying out trust responsibilities of the U.S. government with respect to American Indians and Alaska Natives.

It manages more than 440 million acres of federal lands.

DEPARTMENT OF LABOR

Office of Information and Public Affairs
200 Constitution Avenue, NW
Washington, DC 20210
Ph#: 202/219-7316
Fax: 202/219-8699

The Department of Labor's principal mission is to help working people and those seeking work.

The department's information and other services, particularly in job training and labor law enforcement, benefit and affect many other groups, including employers, business organizations, civil rights groups and government agencies at all levels as well as the academic community.

DEPARTMENT OF TRANSPORTATION

Office of Public Affairs
400 Seventh Street SW, Room 10414
Washington, DC 20590
Ph#: 202/366-4570
Fax: 202/366-6337

The Department of Transportation ensures the safety of all forms of transportation; protects the interests of consumers; conducts planning and research for the future; and helps cities and states meet their local transportation needs.

The Department of Transportation is composed of 10 operating administrations, including the Federal Aviation Administration; the Federal Highway Administration; the Federal Railroad Administration; the Federal Transit Administration; the National Highway Traffic Safety Administration; the Maritime Administration; the St. Lawrence Seaway Development Corp.; the U.S. Coast Guard; the Research and Special Programs Administration; and the Bureau of Transportation Statistics.

DEPARTMENT OF THE TREASURY

Bureau of Alcohol, Tobacco and
Firearms
Liaison and Public Information
650 Massachusetts Avenue NW
Room 8290
Washington, DC 20226
Ph#: 202/927-8500
Fax: 202/927-8112

The Bureau of Alcohol, Tobacco and Firearms (ATF) is an agency of the U.S. Department of the Treasury.

ATF's responsibilities are law enforcement; regulation of the alcohol, tobacco, firearms and explosives industries; and ensuring the collection of taxes on alcohol, tobacco, and firearms.

ATF's mission is to curb the illegal traffic in and criminal use of firearms; to assist federal, state and local law enforcement agencies in reducing crime and violence; to investigate violations of federal explosive laws; to regulate the alcohol, tobacco, firearms and explosives industries; to assure the collection of all alcohol, tobacco and firearm tax revenues; and to suppress commercial bribery, consumer deception, and other prohibited trade practices in the alcoholic beverage industry.

ENVIRONMENTAL PROTECTION AGENCY

Communication, Education and Public Affairs
401 M Street SW
Washington, DC 20460
Ph#: 202/260-2090 Public Information Center
Mail Code 3404
Ph#: 202/260-2080
Fax: 202/260-6257
Chemical Control
401 M St. SW
Washington DC 20460
Ph#: 202/260-3749
Fax: 202/260-8168

Chemical Emergency Preparedness and Prevention 401 M St. SW Washington, DC 20460 Ph#: 202/260-8600 Fax: 202/260-7906

The Environmental Protection Agency (EPA) is an independent agency in the executive branch of the U.S. government. EPA controls pollution through a variety of activities, which includes research, monitoring, standards setting, and enforcement.

The Environmental Protection Agency supports research and antipollution efforts by state and local governments as well as by public service institutions and universities.

INDUSTRY STANDARDS

Government regulatory agencies

FEDERAL AVIATION ADMINISTRATION

800 Independence Avenue, SW
Washington, DC 20591
Ph#: 800/FAA-SURE
FAA Consumer Hotline

The Federal Aviation Administration (FAA) provides a safe, secure and efficient global aerospace system that contributes to national security and the promotion of U.S. aerospace.

As the leading authority in the international aerospace community, FAA is responsive to the dynamic nature of customer needs, economic conditions and environmental concerns.

FOOD AND DRUG ADMINISTRATION Office of Public Affairs
Public Health Service Department of Health & Human Services
5600 Fishers Lane (HFI-40)
Rockville, MD 20857
Ph#: 301/443-3170
Consumer Affairs

The Food and Drug Administration (FDA) works to protect, promote, and enhance the health of the American people by ensuring that foods are safe, wholesome, and sanitary; human and veterinary drugs, biological products and medical devices are safe and effective; cosmetics are safe; electronic products that emit radiation are safe; regulated products are honestly, accurately, and informatively represented; these products are in compliance with the law and the FDA regulations; and non-compliance is identified and corrected and any unsafe and unlawful products are removed from the marketplace.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

300 E Street SW
Washington, DC 20546
Ph#: 202/358-0000
Fax: 202/358-3251

The National Aeronautics and Space Administration explores, uses and enables the development of space for human enterprise; advances scientific knowledge and understanding of the Earth, the solar system and universe; uses the environment of space for research; and researches, develops, verifies and transfers advanced aeronautics, space and related technologies.

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Public Affairs
200 Independence Avenue SW
Washington, DC 20201
Ph#: 202/260-8519
Fax: 202/260-1898

The National Institute for Occupational Safety and Health (NIOSH) was established by the Occupational Safety and Health Act of 1970. NIOSH is part of the Centers for Disease Control and Prevention and is the federal institute responsible for conducting research and making recommendations for the prevention of work-related illnesses and injuries.

The Institute's responsibilities include: investigating potentially hazardous working conditions as requested by employers or employees; evaluating hazards in the workplace; creating and disseminating methods for preventing disease, injury, and disability; conducting research and providing scientifically valid recommendations for protecting workers; and providing education and training to individuals preparing for or actively working in the field of occupational safety and health.

NIOSH identifies the causes of work related diseases and injuries and the potential hazards of new work technologies and practices. It determines new ways to protect workers from chemicals, machinery, and hazardous working conditions.

NATIONAL TRANSPORTATION SAFETY BOARD

490 L'Enfant Plaza SW
Washington, DC 20594
Ph#: 202/382-6600

The National Transportation Safety Board is an independent federal accident investigation agency that also promotes transportation safety.

The board conducts safety studies; maintains official U.S. census of aviation accidents; evaluates the effectiveness of government agencies involved in transportation safety; evaluates the safeguards used in the transportation of hazardous materials; and evaluates the effectiveness of emergency responses to hazardous material accidents.

NUCLEAR REGULATORY COMMISSION

Office of Public Affairs
Washington, DC 20555
Ph#: 301/415-8200
Fax: 301/415-2234

The Nuclear Regulatory Commission regulates the civilian uses of nuclear materials in the United States to protect the public health and safety, the environment, and the common defense and security.

The mission is accomplished through licensing of nuclear facilities and the possession, use and disposal of nuclear materials; the development and implementation of requirements governing licensed activities; and inspection and enforcement to assure compliance.

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Office of Information and Consumer Affairs
200 Constitution Avenue NW, Room N3647
Washington, DC 20210
Ph#: 202/2198151
Fax: 202/219-5986

The Occupational Safety and Health Administration (OSHA) sets and enforces workplace safety and health standards with a goal of ensuring safe and healthful working conditions for all Americans.

OSHA issues standards and rules for safe and healthful working conditions, tools, equipment, facilities, and processes.

OCCUPATIONAL SAFETY AND HEALTH REVIEW COMMISSION

Office of Public Information
One Lafayette Center
1120 20th Street, NW, Ninth Floor
Washington, DC 20036-3419
Ph#: 202/606-5398
Fax: 202/606-5050

The Occupational Safety and Health Review Commission is an independent federal agency that serves as a court to provide decisions in workplace safety and health disputes arising between employers and the Occupational Safety and Health Administration in the department of labor.

U.S. COAST GUARD

Hazard Materials Standards Branch
2100 Second Street SW
Washington, DC 20593-0001
Ph#: 202/267-2970
Fax: 202/267-4816

The U.S. Coast Guard is the United States' primary maritime law enforcement agency as well as a federal regulatory agency and one of the armed forces.

The U.S. Coast Guard duties include aids to navigation; defense operations; maritime pollution preparedness and response; domestic and international ice breaking operations in support of commerce and science; maritime law enforcement; marine inspection and licensing; port safety and security; and search and rescue.

INDUSTRY STANDARDS

Chemical Industry Trade Associations

ADHESIVES MANUFACTURERS ASSOCIATION

1200 19th Street NW, Suite 300
Washington, DC 20036
Ph#: 202/857-1127
Fax: 202/857-1115

The Adhesives Manufacturers Association (AMA) is a national organization comprised of major U.S. companies engaged in the manufacturing, marketing, and selling of formulated adhesives or formulated adhesives coatings to the industrial marketplace. Associate members supply raw materials to the industry.

AIR & WASTE MANAGEMENT ASSOCIATION

1 Gateway Center, 3rd Floor
Pittsburgh, PA 15222
Ph#: 412/232-3444
Fax: 412/232-3450
Membership Department

The Air & Waste Management Association is a non-profit, technical and educational organization with 17,000 members in 58 countries. Founded in 1907, the association provides a neutral forum in which all viewpoints of an environmental issue (technical, scientific, economic, social, political, and health-related) receive equal consideration. The association serves its members and the public by promoting environmental responsibility and providing technical and managerial leadership in the fields of air and waste management.

AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS (AAEE)

130 Holiday Court, Suite 100
Indianapolis, MD 21401
Ph#: 301/261-8958 (Washington, DC)

This organization certifies environmental engineers.

AMERICAN BOILER MANUFACTURERS ASSOCIATION

950 N. Glebe Road, Suite 160
Arlington, VA 22203
Ph#: 703/522-7350
Fax: 703/522-2665

The mission of the American Boiler Manufacturers Association is to improve services to the public; to be proactive with government in matters affecting the industry; to promote safe, economical, and environmentally friendly services of the industry; and to carry out other activities recognized as lawful for such organizations.

THE AMERICAN CERAMIC SOCIETY

P.O. Box 6136
Westerville, OH 43086-6136
Ph#: 614/890-4700
Fax: 614/899-6109
Customer Service: 614/794-5890

The American Ceramic Society is the headquarters for the professional organization for ceramic engineers.

AMERICAN CHEMICAL SOCIETY (ACS)

1155 Sixteenth Street NW
Washington, DC 20036
Ph#: 202/872-4600
Fax: 202/872-6337

ACS has 149,000 members. The members are chemists, chemical engineers, or people who have degrees in related fields.

AMERICAN COKE AND COAL CHEMICALS INSTITUTE

1255 23rd Street NW
Washington, DC 20037
Ph#: 202/452-1140
Fax: 202/466-4949

The ACCI's mission is to represent the interests of the coke and coal chemicals industry by communicating positions to legislative and regulatory officials, cooperating with all government agencies having jurisdiction over the industry, providing a forum for the exchange of information, and discussion of problems and promoting the use of coke and its byproducts in the marketplace.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

Kemper Woods Center
1330 Kemper Meadow Drive, Suite 600
Cincinnati, OH 45240
Ph#: 513/742-2020
Fax 513/742-3355

The ACGIH is an organization of more than 5,500 industrial hygienists and occupational health and safety professionals devoted to the technical and administrative aspects of worker health and safety.

AMERICAN CROP PROTECTION ASSOCIATION

1156 15th Street NW, Suite 400
Washington, DC 20005
Ph#: 202/872-3869
Fax: 202/463-0474

ACPA is the trade association for the manufacturers and formulators/distributors representing virtually all of the active ingredients manufactured, distributed, and sold in the United States for agricultural uses, including herbicides, insecticides, and fungicides.

AMERICAN INSTITUTE OF MINING, METALLURGICAL AND PETROLEUM ENGINEERS (AIME)

345 E. 47th Street
New York, NY 10017
Ph#: 212/705-7695
Fax: 212/371-9622

AIME serves as the unifying forum for the Member Societies, which include the Society for Mining, Metallurgy and Exploration; The Minerals, Metals & Materials Society; Iron and Steel Society; Society of Petroleum Engineers; and the AIME Institute Headquarters.

AMERICAN NATIONAL STANDARDS INSTITUTE, INC.

(ANSI) 11 W. 42nd Street, 13th Floor
New York, NY 10036
Ph#: 212/642-4900
Fax: 212/302-1286
The Sales Department

ANSI is an approval entity in the United States for the voluntary standards effort.

AMERICAN PETROLEUM INSTITUTE (API)

1220 L Street NW
Washington, DC 20005
Ph#: 202/682-8000
Fax: 202/682-8232

The American Petroleum Institute (API) is the U.S. petroleum industry's primary trade association. API provides public policy development and advocacy, research, and technical services to enhance the ability of the petroleum industry to meet its mission.

AMERICAN SOCIETY OF BREWING CHEMISTS

3340 Pilot Knob Road
St. Paul, MN 55121
Ph#: 612/454-7250
Fax: 612/454-0766
Member Services Representative

A non-profit organization that publishes scientific books and journals.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONING ENGINEERS (ASHRAE)

1791 Tullie Circle NE
Atlanta, GA 30329
Ph#: 404/636-8400
Fax: 404/321-5478
Customer Service: 800/527-4723

ASHRAE is an engineering society whose members are engineers specializing in heating, refrigerating, and air conditioning. It serves members through meetings and publications.

INDUSTRY STANDARDS

Chemical Industry Trade Associations

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

345 E 47th Street
New York, NY 10017-2392
Ph#: 212/705-7722
Fax: 212/705-7674
Member Services

This organization provides classes and networking, and also serves its members by providing information about technology and solutions to the problems of an increasingly technological society.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

1711 Arlington Lane
P.O. Box 28518
Columbus, OH 43228-0518
Ph#: 614/274-6003
Fax: 614/274-6899

A non-profit organization that has 10,000 members worldwide. It sells technical books as well as providing testing for certification for non-destructive testing. This organization also publishes a monthly magazine.

AMERICAN SOCIETY FOR QUALITY CONTROL (ASQC)

P.O. Box 3005
Milwaukee, WI 53201-3005
Ph#: 414/272-8575
Fax: 414/272-1734
Customer Service: 800/248-1946

This organization facilitates continuous improvement and increased customer service by identifying, communicating, and promoting the use of quality concepts and technology. The ASQC carries out a variety of professional, educational, and informational programs.

AMERICAN SOCIETY OF SAFETY ENGINEERS

1800 E. Oakton
Des Plaines, IL 60018-2187
Ph#: 847/699-2929
Membership Department, extensions 231, 228, or 254
Fax: 847/296-3769

This is the oldest and largest organization servicing safety engineers. It has more than 32,000 members and 139 local chapters. The society provides safety education seminars, technical publications, and a monthly magazine among other services.

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

100 Barr Harbor Drive
W. Conshohocken, PA 19428
Ph#: 610/832-9500
Fax: 610/832-9555
Membership Department

This non-profit organization deals with 132 different committees, and provides materials and tests different standards.

CHEMICAL MANUFACTURERS ASSOCIATION (CMA)

1300 Wilson Boulevard
Arlington, VA 22209
Ph#: 703/741-5000
Fax: 703/741-6095

CMA is one of the oldest trade associations in North America. The CMA is also the focal point for the chemical industry's collective action on legislative, regulatory, and legal matters at the international, national, state and local levels.

CHLORINE INSTITUTE

2001 L Street NW #506
Washington, DC 20036
Ph#: 202/775-2790
Fax: 202/223-7225

This organization supports the chloralkaline industry and serves as a public service for safety and health.

COMPOSITES FABRICATORS ASSOCIATION

8201 Greensboro Drive, Suite 300
McLean, VA 22102
Ph#: 703/610-9000
Fax: 703/610-9005

The Composites Fabricators Association provides educational services including seminars, video training tapes, publications, a monthly technical magazine, and an annual convention. It offers free technical, government, and regulatory service to its members.

COSMETIC, TOILETRY AND FRAGRANCE ASSOCIATION

1101 17th Street NW, Suite 300
Washington, DC 200364702
Ph#: 202/331-1770
Fax: 202/331-1969

The Cosmetic, Toiletry and Fragrance Association is the leading trade association for the personal care product industry, representing the majority of U.S. personal care product sales. The industry trade association was founded in 1894.

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY

492 Norristown Road
Blue Bell, PA 19422
Ph#: 610/940-0291
Fax: 610/940-0292

This is a trade association for the paint industry.

HAZARDOUS MATERIALS ADVISORY COUNCIL

1101 Vermont Avenue NW, Suite 301
Washington, DC 20005-3521
Ph#: 202/289-4550
Fax: 202/289-4074

Incorporated in 1978, the Hazardous Materials Advisory Council (HMAC) is an international, non-profit organization devoted to promoting regulatory compliance and safety in the transportation of hazardous materials, substances, and wastes.

ISA

P.O. Box 12277
67 Alexander Drive
Research Triangle Park, NC 27709
Ph#: 919/549-8411
Fax: 919/549-8288
Brian Duckett, Meetings Manager

ISA develops standards for the instrumentation and control field.

METAL FINISHING SUPPLIERS' ASSOCIATION

801 N. Cass Avenue, Suite 300
Westmont, IL 60559
Ph#: 708/887-0797
Fax: 708/887-0799

MFSA is an organization representing 175 member companies who are suppliers of equipment, chemicals, and services to the metal finishing industry.

NACE INTERNATIONAL

National Association of Corrosion Engineers
P.O. Box 218340
Houston, TX 77218-8340
Ph#: 713/492-0535
Fax: 713/492-8254

This organization provides a number of services to its members: the selling of books, publications, magazines, classes, seminars and symposiums are among some of those services.

NATIONAL ASSOCIATION OF CHEMICAL RECYCLERS

1900 M. Street NW, Suite 750
Washington, DC 20036
Ph#: 202/296-1725
Fax: 202/296-2530

INDUSTRY STANDARDS

Chemical Industry Trade Associations

NATIONAL ASSOCIATION OF PRINTING INK MANUFACTURERS, INC. (NAPIM)

Heights Plaza, 777 Terrace Avenue
Hasbrouck Heights, NJ 07604
Ph#: 201/288-9454
Fax: 201/288-9453

The National Association of Printing Ink Manufacturers is a trade association whose purpose it is to represent the printing ink industry in the United States and to provide direction to management in the areas of environmental issues, business management, government regulations, and regulatory compliance.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

1 Batterymarch Park
Quincy, MA 02269-9101
Ph#: 617/770-3000
Fax: 617/770-0700
Member Services

Fire protection standards and manuals. Services and interpretation of standards are available to members only.

PHARMACEUTICAL RESEARCH AND MANUFACTURERS OF AMERICA

1100 Fifteenth Street NW, Suite 900
Washington, DC 20005
Ph#: 202/845-3400
Fax: 202/835-3414

The Pharmaceutical Research and Manufacturers of America (PhRMA) represents the country's largest research based pharmaceutical and biotechnology companies. Investing nearly \$16 billion a year in discovering and developing new medicines. PhRMA companies are the source of nearly all new drug discoveries worldwide.

PROCESS EQUIPMENT MANUFACTURERS' ASSOCIATION

111 Park Place
Falls Church, VA 22046-4513
Ph#: 703/538-1796
Fax: 703/241-5603

The Process Equipment Manufacturers' Association is an organization of firms and corporations engaged in the manufacture of process equipment such as agitators, mixers, crushing, grinding and screening equipment, vacuum and pressure filters, centrifuges, furnaces, kilns, dryers, sedimentation and classification devices, and waste treatment equipment.

PULP CHEMICALS ASSOCIATION, INC

15 Technology Parkway South
Norcross, GA 30092
Ph#: 770/446-1290
Fax: 770/446-1487

The Pulp Chemicals Association Inc. is an international trade association serving the common goals of its membership. Any person, firm or corporation who manufactures chemical products derived from the pulp and forest products industries is eligible for membership.

RUBBER MANUFACTURERS ASSOCIATION

1400 K Street NW, Suite 900
Washington, DC 20005
Ph#: 202/682-4800
Fax: 202/682-4854

The Rubber Manufacturers Association is a trade association representing the rubber and tire industry in North America.

SOAP AND DETERGENT ASSOCIATION

475 Park Avenue, S.
New York, NY 10016
Ph#: 212/725-1262
Fax: 212/213-0685

This is a national, non-profit trade association that represents the manufacturers of soaps and detergents.

SOCIETY FOR THE ADVANCEMENT OF MATERIAL AND PROCESS ENGINEERING (SAMPE)

P.O. Box 2459
Covina, CA 91722
Ph#: 818/33-0616
Fax: 818/332-8929

SAMPE is a global, member-governed, volunteer, not-for-profit organization, which supplies information on advanced state-of-the-art materials and process opportunities for career development within the materials and process industries.

SOCIETY OF PLASTICS ENGINEERS

14 Fairfield Drive
Brookfield, CT 06804-0403
Ph#: 203/775-0471
Fax: 203/775-8490

This society deals with education, holds seminars and conferences, and produces magazines and journals. Membership of 37,500 worldwide individuals in all areas of the plastics industry, in 70 countries.

THE SOCIETY OF THE PLASTICS INDUSTRY INC.

1275 K Street NW, Suite 400
Washington, DC 20005
Ph#: 202/371-5200
Fax: 202/371-1022

VALVE MANUFACTURERS ASSOCIATION OF AMERICA (VMA)

1050 17th Street NW, Suite 280
Washington, DC 20036
Ph#: 202/331-8105
Fax: 202/296-0378

WANER ENVIRONMENT FEDERATION

601 Wythe Street
Alexandria, VA 22314-1994
Ph#: 703/684-2400
Fax: 703/684-2450
Member Services



CHEMICAL RESISTANCE GUIDE

The chemical resistance data provided here on the following pages has been assembled from a wide variety of sources in our industry. This information is based on practical field experience and actual laboratory testing conducted by the manufacturers of various plastic resins and finished products. Keep in mind that this information should only be used as a guideline for recommendations and not a guarantee of chemical resistance. Some performance variations may be noticed between homopolymers and copolymers as well as emulsion and suspension type resins of the same general type. In addition, actual service conditions including temperature, concentration, and contaminant's will affect variances in chemical resistance.

In assembling the chemical resistance data presented here, several sources were checked. When conflicts were uncovered, we took a conservative approach and used the lower of two or more ratings. In addition, special consideration was given to the material as supplied by a particular vendor; i.e., our polyethylene ratings are based on information provided by tank manufacturers rather than pipe suppliers. This was done primarily because of the volume of tanks supplied as compared to polyethylene pipe.

In an attempt to make the recommendations more meaningful, we have given the maximum recommended use temperature for each plastic and elastomer in the specific chemicals listed. Lacking complete data in many cases we did leave those in question as blanks. Where a material is unsuitable for a specific chemical an "X" is used.

Metals are listed as:

- A = Excellent
- B = Good, minor effect
- C = Fair, needs further tests
- X = Unsuitable

To the best of our knowledge, the information contained in this publication is accurate. However, we do not assume any liability whatsoever for the accuracy or completeness of such information. Moreover, there is a need to reduce human exposure to many materials to the lowest physical limits in view of possible long term adverse effects. To the extent that any hazards may have been mentioned in this publication, we neither suggest nor guarantee that such hazards are the only ones which exist. Final determination of the suitability of any information or product for the use contemplated by any user, the manner of that use and whether there is any infringement of patents, is the sole responsibility of the user. We recommend that anyone intending to rely on any recommendation or use any equipment, processing technique, or material mentioned in this publication should satisfy themselves as to such suitability, and that they meet all applicable safety and health standards. We strongly recommend the user seek and adhere to manufacturers' or suppliers' current instructions for handling each material they use.

USE OF THE CHEMICAL RESISTANCE TABLES

The aggressive agents are classified alphabetically according to their most common designation. Further descriptions include trivial or common names as trade names.

If several concentrations are given for a particular material, the physical data, in general, relates to the pure product that is 100% concentration.

In listing the maximum use temperature for each plastic type in a given chemical, it can in general be assumed that the resistance will be no worse at lower temperatures.

HOW TO SELECT THE CORRECT MATERIAL:

1. Locate the specific chemical in the system or found in the surrounding atmosphere using the alphabetical chart of chemicals.
2. Select the material with a maximum use temperature that matches or exceeds the need. The Harrington philosophy has always been to suggest the least costly material that will do the job.

3. Where a material or elastomer appears to be marginal compared to the requirements, we encourage a call to our technical service group.

EXAMPLES:

1. Methylene chloride: in the tables PVDF, Halar, or Teflon are the only materials suitable. Carbon steel works well for chlorinated hydrocarbons of this sort and that would be our choice unless there was another reason to justify the higher cost of the PVDF, Teflon or Halar.
2. Sodium hypochlorite, 15% at 100°F, PVC is good to 140°F and is the least expensive of the materials available.
3. For nitric acid 40% ambient temperature, the tables recommend either CPVC or polypropylene at 73°F. In most cases CPVC will be the economical choice. Note that PVDF is rated for higher temperature use.

NOTE: The ratings shown for carbon and ceramic pump seals are approximate. Please contact your local Harrington service center for a recommendation on your specific application.

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CHEMICAL	FORMULAS	PLASTIC										ELASTOMER					SEAL	METAL								
		APPROX. SP.GRAVITY @ 100% CONC.	PVC	CPVC	POLYETHYLENE-CROSS LINKED (PEXL)	POLYETHYLENE FLUORIDE (PEF)	POLYETHYLENE (PE)	DURAPLUS ABS	RYTON	HALAR	PEEK	TEFLON	EPOXY	VINYLESTER	POLYSULFONE	VITON	EPDM	BUNA N (NITRILE)	NEOPRENE	CARBON	CERAMIC	304 STAINLESS STEEL	316 STAINLESS STEEL	TITANIUM	HASTELLOY C	
Acetaldehyde	CH ₃ CHO	-	-	X	X	100	120	X	X	X	200	-	-	350	150	X	X	100	200	X	X	A	A	A	A	A
Acetaldehyde, Aqueous	-	40	-	X	X	100	120	X	X	-	200	-	-	350	150	X	X	100	200	X	X	A	A	A	A	A
Acetamide	CH ₃ CONH ₂	-	-	-	-	100	73	150	-	-	-	-	-	-	-	-	200	200	X	100	-	A	B	A	-	
Acetate Solvents, Crude	-	-	-	X	X	-	78	-	-	X	-	-	-	350	-	-	-	X	X	X	A	A	B	A	-	
Acetate Solvents, Pure	-	-	-	X	X	-	X	-	-	X	-	-	-	350	-	-	-	X	X	X	-	-	B	A	-	
Acetic Acid*	CH ₃ COOH	5	-	140	140	200	140	X	140	68	200	250	-	350	150	200	-	X	200	100	-	-	-	A	A	
Acetic Acid*	CH ₃ COOH	10	-	140	140	200	140	X	140	68	200	250	-	350	150	200	-	180	200	X	X	-	-	A	A	
Acetic Acid*	CH ₃ COOH	20	-	140	140	200	140	X	140	X	200	250	-	350	X	200	-	180	200	X	X	-	-	A	A	
Acetic Acid*	CH ₃ COOH	30	-	140	140	200	140	X	140	X	200	250	-	350	-	100	-	180	200	-	-	-	-	A	A	
Acetic Acid*	CH ₃ COOH	50	-	100	100	200	100	X	140	X	200	250	-	350	X	100	-	180	200	X	X	-	-	A	A	
Acetic Acid*	CH ₃ COOH	60	-	73	73	150	100	X	140	X	200	-	-	350	X	X	-	180	100	X	X	-	-	A	A	
Acetic Acid*	CH ₃ COOH	80	-	X	X	140	73	X	70	X	200	212	-	350	X	X	-	180	100	X	X	-	-	A	A	
Acetic Acid*, Glacial	CH ₃ COOH	100	1.0	110	110	180	180	X	70	X	200	212	300	350	X	X	-	X	73	X	X	A	A	A	A	
Acetic Anhydride	(CH ₃ CO) ₂ O	-	5	X	X	73	90	X	X	X	200	73	-	-	X	X	-	X	200	X	X	A	A	-	-	
Acetic Ether (See Ethyl Acetate)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Acetol (Hydroxy 2 Propanone)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	
Acetone	CH ₃ COCH ₃	-	-	X	X	-	-	-	-	-	200	150	-	-	-	-	-	-	-	-	-	-	-	A	A	
Acetonitrile (Methyl Cyanide)	CH ₃ CN	-	-	X	X	X	150	X	X	X	200	212	-	400	X	X	-	X	-	X	X	-	-	A	A	
Acetophenone	C ₆ H ₅ COCH ₃	-	0.8	X	X	150	200	-	-	X	200	121	-	400	120	X	-	X	-	X	-	-	A	A	B	
Acetyl Acetone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Acetyl Benzene	C ₆ H ₅ COCH ₃	-	-	X	X	73	73	-	-	X	-	-	-	-	X	X	-	X	-	X	X	-	-	A	-	
Acetyl Bromide	-	-	1.0	X	X	-	-	-	-	X	-	-	-	-	X	X	-	X	-	X	X	-	-	A	-	
Acetyl Chloride (dry)	C ₆ H ₅ COCH ₃	-	3	-	-	-	100	X	X	X	200	150	-	-	X	X	-	X	-	-	-	-	-	A	-	
Acetyl Oxide	CH ₃ COBr	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Acetyl Propane	CH ₃ COCL	-	-	X	X	130	100	-	-	X	-	-	-	200	-	-	-	X	-	X	X	-	-	A	A	
Acetylene	(CH ₃ CO) ₂ O	-	-	100	100	-	200	-	-	-	200	150	-	-	-	-	-	-	-	-	-	-	A	A	B	
Acetylene Dichloride	CLHC:CHLC	-	-	X	X	-	X	-	-	X	-	-	-	300	-	-	-	150	-	-	-	-	-	-	-	
Acetylene Tetrachloride	(CHCL ₂) ₂	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Acid Mine Water	-	-	-	100	150	150	250	-	-	-	200	-	-	350	-	-	-	-	-	-	-	-	-	-	-	
Acrylic Acid	CH ₂ CHCOOH	-	-	X	X	X	100	X	X	X	-	212	-	170	X	X	-	-	-	-	-	-	-	-	-	
Acrylic Emulsions*	-	-	-	-	-	-	-	X	70	-	-	-	-	-	-	-	-	X	X	X	X	-	-	A	-	
Acrylonitrile	H ₂ CCHCN	-	-	X	X	73	100	140	140	X	-	73	-	350	100	X	-	250	200	160	180	A	A	B	B	
Adipic Acid Aqueous	-	-	-	140	180	100	250	140	140	-	-	150	-	350	-	-	-	-	-	-	-	-	-	A	A	
Alcohol (See Ethyl Alcohol)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alcohol, Allyl	-	-	-	80	80	140	200	100	140	X	-	-	-	250	200	100	-	200	70	100	180	-	-	A	-	
Alcohol, Amyl	C ₅ H ₁₁ OH	-	-	100	100	170	250	140	140	X	200	250	-	400	200	100	-	190	200	140	140	-	-	A	-	
Alcohol, Benzyl	C ₆ H ₅ CH ₂ OH	-	-	X	X	140	180	-	-	X	-	250	-	-	-	-	-	140	X	140	X	-	-	A	-	
Alcohol, Butyl	-	-	-	140	180	180	240	140	140	X	200	250	-	250	200	100	-	100	180	140	140	-	-	A	-	
Alcohol, Diacetone	-	-	-	X	-	73	73	-	-	X	-	150	-	350	-	-	-	X	70	X	-	-	-	A	-	
Alcohol, Ether	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alcohol, Ethyl	C ₂ H ₅ OH	-	-	140	*	180	750	140	140	X	-	250	-	300	180	-	-	170	170	170	200	A	A	A	-	
Alcohol, Hexyl	-	-	-	100	70	70	-	-	-	X	-	73	-	-	-	-	-	160	X	70	70	A	A	A	-	
Alcohol, Isobutyl	(CH ₃) ₂ CHCH ₂ OH	-	-	-	-	-	250	-	-	X	-	-	-	300	180	100	-	140	140	70	70	A	A	A	-	
Alcohol, Isopropyl	(CH ₃) ₂ CHOH	-	-	140	*	150	230	140	140	X	-	250	-	300	180	100	-	200	140	70	200	A	A	A	-	
Alcohol, Methyl	CH ₃ OH	-	-	140	150	150	230	140	140	X	-	250	-	300	150	-	-	100	100	140	140	A	A	A	-	
Alcohol, Octyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alcohol, Polyvinyl	-	-	-	140	180	180	250	-	-	68	-	-	-	280	150	100	-	210	100	-	-	-	-	A	-	
Alcohol, Propargyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	-	
Alkanes	-	-	-	140	100	100	250	-	-	-	-	-	-	300	-	-	-	210	X	X	X	-	-	A	-	
Alkazene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Allyl Aldehyde	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Allyl Bromide	C ₃ H ₅ Br	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Allyl Chloride	C ₃ H ₅ CL	-	-	X	X	100	200	100	-	X	-	250	-	350	-	-	-	100	X	X	X	-	-	A	-	
Alum (See Aluminum Sulfate)	AL ₂ (SO ₄) ₃	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

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