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12

MATERIAL DEVELOPMENT STUDY FOR A HAZARDOUS CHEMICAL PROTECTIVE CLOTHING OUTFIT

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16. Abstract

Expansion of a data base for protection of personnel engaged in handling accidentally discharged hazardous chemicals was the program objective. This involved assigning levels of protection, reviewing available protective equipment and material chemical compatibility, developing requirements and conducting a test program. A CHRIS listing of 985 chemicals reviewed showed 403 chemicals in the category that personnel be equipped with a sealed suit. Other categories assigned were nonsealed suit, fire suit, and in some instances only gloves and goggles for those chemicals which were innocuous. Literature review was used to establish a test plan. Test results showed that butyl rubber was 38% acceptable and polycarbonate 60% acceptable relative to 403 chemicals. There were 45 chemicals in which levels of protection were not assigned. These were placed into the category of future R&D. Other future R&D studies resulted from chemicals which could not be adequately decontaminated by a detergent-cold water wash in addition to those chemicals found incompatible with butyl rubber and polycarbonate.

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METRIC CONVERSION FACTORS

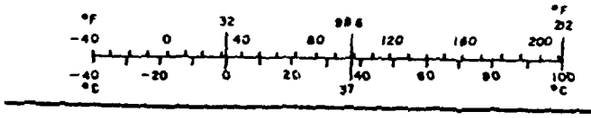
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

The U.S. Coast Guard has a mandate to respond to discharges of hazardous chemicals into or near the waters of the United States. Appropriate protective gear is required for the Strike Team personnel in order to cope with the toxicity and other hazardous properties of these discharges.

The Chemical Hazards Response Information System Manual (CHRIS) lists 985 chemicals which might be discharged into inland or coastal waterways. The manual provides the On-Scene Coordinator or other officials with some of the information necessary to properly respond to discharges of hazardous chemicals. The primary objectives of this program were to determine the levels of protection required for each of the chemicals and to develop guidelines for the personal protective equipment which might be required for Strike Team personnel.

It was obvious, at the inception of the program, that levels of protection could not be assigned for many of the chemicals due to lack of toxicological information. Further, it was determined that compatibility data for materials commonly used in protective ensembles, specifically butyl rubber and polycarbonate, did not exist.

Levels of protection were established by reviewing each of the 985 chemicals on the CHRIS list, referring to current information. Clothing requirements and respiratory protection were determined for each case where possible. Many of these required judgments based on good practice, chemical toxicity, expected exposure conditions, etc. Toxicity data was not available for 45 chemicals. For these, a level of protection was not established and they were placed into a future R&D category.

Protective clothing ensembles are available commercially, and the Coast Guard has acquired a Hazardous Chemical Protective Clothing Outfit (HCPCO). However, the levels of protection required for specific chemicals given in the CHRIS list have not been addressed in a correlated fashion. The ideal material which is totally compatible with all of the chemicals is not available - none of the materials used in manufacture of protective equipment has such compatibility. Requirements for use of a fully sealed

suit include: maximum wear time of two hours; 20 hours resistance to chemical damage (represents 10 wear cycles and decontaminaton); 10 year shelf life; ambient temperature of -30°C to 40°C; no UV or ozone degradation; be impermeable to 100% chemical contact. Materials of suit construction should also be relatively inexpensive and easy to fabricate. Decontamination should not degrade future performance.

Studies of information on suit materials compatibility of the 985 chemicals on the CHRIS list were confined to butyl rubber and polycarbonate, since these are the materials in the existing HCPCO ensemble. Of these chemicals, 403 were considered to require a fully sealed suit: 45 chemicals showed insufficient data for a decision and 15 chemicals are pyrophoric. Of the 403 chemicals requiring a sealed suit, it was found that sufficient data was not available on 113 chemicals for the polycarbonate chemical resistance, and 377 for the butyl rubber.

A materials compatibility program to demonstrate physical damage and penetration of materials by chemicals in question was performed. Decontamination effectiveness and degradation of protection by repeated decontamination were studied. In these tests, any detectable permeation of the test chemical through the butyl rubber on a continuous 20 hour penetration test was cause for failure. Additionally, failure during 10 contamination/decontamination cycles was cause for rejection. Seams were also studied and found to be difficult to decontaminate, but were basically as resistant as the parent butyl suit material.

As a result of this program and the best information available in the literature, polycarbonate was found to be compatible with 241 chemicals and incompatible with 119 chemicals; no assignment could be made for the remaining 43 chemicals. Butyl rubber was found to be compatible with 155 chemicals and incompatible with 187 chemicals; no assignment could be made for the remaining 61 chemicals.

FINAL REPORT

on

MATERIAL DEVELOPMENT STUDY FOR A
HAZARDOUS CHEMICAL PROTECTIVE CLOTHING OUTFIT

1.0 INTRODUCTION

This report summarizes a study performed for the U.S. Coast Guard to broaden the data base on protective clothing required for Strike Team personnel. These personnel must deal with accidental discharges of hazardous chemicals into or near waters of the United States and various degrees of protection must be provided depending upon the specific chemical spill.

Work centered around the evaluation of butyl rubber and polycarbonate materials used in the Hazardous Chemical Protective Clothing Outfit (HCPCO), a sealed suit ensemble. Although some chemical compatibility data for butyl rubber and polycarbonate exists in the literature, data is limited on 985 chemicals of concern in regard to chemical compatibility and the degree of protection afforded. Chemical compatibility data in the literature applied primarily to engineering systems information, e.g., gasketing material, O-rings and so on, and translating it in the context of personnel protection is a different matter. This is because data on permeation and ability to decontaminate are even less known.

The project proceeded by completing succeeding task assignments. These were as follows:

Task I - Levels of Protection. The objective of this task was to provide information on the type of personnel protection that will be necessary for each of the 985 hazardous chemicals in CHRIS. Potential sources for personnel protection outfits were to be provided. The output of this task provided input into Task V (Material Compatibility Testing) and Task VI (Future R&D Effort). An Interim Report was prepared on Task I results.

Task II - Define Requirements. The objective of this task was to establish parameters which must be met for candidate materials so that they are suitable for use in a hazardous personnel protective outfit. Part of the task was to provide candidate materials and selection rationale. This task served as a basis for evaluation of candidate materials and, in this respect, was supplementary to the development of the test program plan.

Task III - Testing Program. The objective of this task was to devise a test plan based upon information generated in Tasks I

and II. Task V, Material Compatibility of Testing, was conducted according to the Task III test program plan.

Task IV - Interim Report. This task summarized the results of Task II (Define Requirements) and Task III (Testing Program). Approval of the Task IV Interim Report was required before proceeding with Task V, Material Compatibility Testing.

Task V - Material Compatibility Testing. The preceding task provided the guidelines for conducting Task V. The objective of Task V was to collect quantitative data on chemical resistance of butyl rubber and polycarbonate used in the HCPCO suit. Output of this task is factored into Task VI, Future R&D Efforts.

Task VI - Future R&D Efforts. The objective this task is to recommend alternatives to butyl rubber and polycarbonate used in the HCPCO which do not provide suitable protection with some chemicals. Additional studies needed to further define levels of protection and to recommend protective garments are suggested as part of this task.

Task VII - Final Report. This task summarizes the work conducted in Task I through Task VI.

2.0 STUDY SUMMARY

The results of Task I through Task IV have been presented in Interim Reports. Task I, Levels of Protection, was given in Interim Report MSAR 79-36. Task II, Define Requirements, was presented in Interim Report MSAR 79-45. Task III, Testing Program, was given in Interim Report MSAR 79-52. Task IV was a report summarizing Tasks II and III. Task VII, this report, constitutes primarily work conducted in Task V, Material Compatibility Testing, and Task VI, Future R&D Efforts, as well as summarizing work performed in the other tasks.

2.1 Levels of Protection - Task I

The Coast Guard is responsible for dealing with spills of 985 hazardous chemicals. Safety equipment and levels of protection have been described to some extent in CHRIS Volumes I, II, III (1978). The basic objective of this task was to determine the degree of protection required as a function of the physical, chemical and toxicological characteristics of each of the 985 chemicals. Levels of protection along with other available pertinent information are given in Appendix A.

In establishing levels of protection, it was assumed that a worst case condition would exist at the spill site. Members of the strike cleanup team could be exposed to high and unknown air concentrations of the spilled chemical. Leaking rail cars, trucks or barges could result in direct contamination of the skin with large quantities of the chemical. Members of the crew could be required to enter contaminated waterways to erect dikes or dams and thus be exposed directly to high levels of the contaminant. Since exposure levels are incident dependent, and cannot be predicted, maximum levels of protection are recommended for the initial entry to the area by the members of the strike team. Once the severity and associated hazards of the spill have been identified, a lower level of protection could be used.

Basic premises made to evaluate potential hazards posed by hazardous chemical spills to recommend protective clothing and respiratory equipment were:

1. Guidelines used to evaluate the hazard should cover all modes of entry into the body and should be based upon acute exposures.

2. The recommended protective equipment should be classified into three basic categories to minimize stocking, storing and logistic problems.

In this task, the basic source of information was Sax's ranking of hazard levels ranging from 3, a severe hazard to 0, the least hazard. These values are based on acute exposures and not on chronic exposures. Effects of exposure relate to inhalation, percutaneous (skin absorption) and skin irritation hazards.

An inhalation hazard of 3 and a skin irritant of 3 constituted rationale for use of a sealed suit for any chemical whether liquid, solid, or gaseous state. Where a 3 appears under respiratory hazard, the use of an air line supply or complete respiratory support without recourse to ambient atmosphere at the point of the spill is dictated.

This leaves the middle ground of a 2 categorization where some judgment is required. A 1 category in either contact, percutaneous or respiratory effects can be handled by individual items of protection other than the fully encapsulating sealed suit.

2.1.1 Rationale for Establishing Levels of Protection

There are a number of sources which can provide guidelines for selection of protection levels. References 1-9 given in the Bibliography were the primary references used.

Threshold Limit Values, Short Term Exposure Limits and Excursion Limits have been developed to provide a safe environment for workers who may be exposed to toxic contaminants during a normal routine work cycle. These values are useful in maintaining healthful work environments, and in some cases provide relative toxicity data among various classes of contaminants. Concentrations at or below the recommended TLV and STEL require no protective equipment; in the case of massive hazardous chemical spills, it must be assumed that the ambient air concentration of the contaminant will exceed these values. Thus, TLV, STEL and EL values offer limited information on required levels of protection for concentrations exceeding these values.

Threshold Limit Values define chronic exposure levels where the worker is exposed to low concentrations for long periods of time. In the case of a hazardous chemical spill, the members of a Strike Team would likely suffer acute exposures of exceptionally high concentrations of hazard chemicals. In addition, the TLV's indicate those chemicals which may find their way into the body through the percutaneous route but they do not necessarily identify those that may be tissue irritants.

These limitations dictated the need for an alternate procedure for establishing levels of protection. Sax's Dangerous Properties of Industrial Materials provides a Toxic

Hazard Rating Code with information on both acute and chronic effects and assigns ratings based on the mode of action or entry, i.e., inhalation, ingestion, skin absorption and irritation.

The rationale used for establishing required levels of protection is based on the hazard rating code of Sax:

0 NONE:	(a) No harm under any conditions; (b) Harmful only under unusual conditions or overwhelming dosage.
1 SLIGHT:	Causes readily reversible changes which disappear after end of exposure.
2 MODERATE:	May involve both irreversible and reversible changes not severe enough to cause death or permanent injury.
3 HIGH:	May cause death or permanent injury after very short exposure to small quantities.
U UNKNOWN:	No information on humans considered valid by authors.

These are applied to the routes of entry to the body, and the resultant effect such as:

Acute Local	Acute Systemic
Irritant	Ingestion
Ingestion	Inhalation
Inhalation	Skin Absorption

Table 1 lists the guidelines used in selecting protective equipment based upon toxicity rating, mode of entry, and physical form of the chemical. If a chemical is a carcinogen, a sealed suit was recommended. If a chemical has a 0 rating or is innocuous, it is recommended that strike team personnel wear standard safety equipment including hard hats, safety glasses, gloves, and steel-toed footwear in observance of good safety practices.

2.1.1.1 Respiratory Protection

The first concern is respiratory protection, since this is the most likely exposure route, and is generally the most critical. Guides to selection of type and degree of respiratory protection equipment developed are presented in Tables 2,3 and 4.

TABLE 1 - GUIDELINES FOR SELECTION OF PERSONAL PROTECTION EQUIPMENT

Toxicity Rating	Mode of Entry	Response: Gas & Liquids — Respiratory	Gas & Liquids — Clothing	Solids — Respiratory	Solids — Clothing
0	Inhalation	None required	None required	None required	None required
	Skin Absorption	"	"	"	"
	Irritation	"	"	"	"
1	Inhalation	Chemical filter[2]	----	Particulate	-----
	Skin Absorption	-----	Nonsealed	----	Nonsealed
	Irritation	-----	Nonsealed	----	Nonsealed
2	Inhalation	Chemical filter or air supply[2]	----	Particulate & chemical filter	-----
	Skin Absorption	-----	-----	-----	-----
	Irritation	-----	Nonsealed	-----	Nonsealed
		-----	Nonsealed	-----	Nonsealed
3	Inhalation	Air supply[3]	-----	Air supply[3]	-----
	Skin Absorption	-----	FES[1]	-----	FES[1]
	Irritation	-----	FES[1]	-----	FES[1]

[1] Fully encapsulating sealed suit indicates need for air supply

[2] Contaminants in gaseous form at STP indicates need for air supply

[3] Carcinogens indicate need for air supply

TABLE 2 - SELECTION OF RESPIRATORS FOR EMERGENCY OR SHORT-TERM USE ON THE BASIS OF HAZARD AND EXPECTED CONCENTRATION (Particulates)

Toxicity	Expected Concentrations of Particulate Matter (Dusts, Fumes and Mists)			
	Two to five times TLV	Five to twenty times TLV	Above twenty times TLV	Oxygen deficient, emergency, highly corrosive
Low	Respirator not usually needed	Filter	Filter or air-line respirator	Where exposure is to extremely corrosive dusts or to dusts in an oxygen deficient atmosphere, a self-contained air or oxygen respirator must be used.
Moderate or High (toxicity no greater than lead)	Filter	Filter or air-line respirator	Air-line or self-contained air or oxygen	
Extremely High (toxicity greater than lead)	Filter or air-line respirator	Air-line respirator	Self-contained air or oxygen	

NOTES:

(1) TLV refers to the Threshold Limit Values for a number of substances published by the American Conference of Governmental Industrial Hygienists (Sections 1, 12).

(2) See Sections 1 and 2 for a discussion of toxicity ratings and their relation to TLV's.

(3) Expected concentrations of particulate matter have been shown only as multiples of the threshold limit values. Where these values are not available, the following concentrations may be used as a guide:

	Mineral Dusts	Other Dusts, Fumes, and Mists
2 to 5 (TLV)	up to 50 mppcf*	Up to 0.5 milligrams per cubic meter
5 to 20 (TLV)	50 to 1000 mppcf*	0.5 to 10 milligrams per cubic meter
Above 20 (TLV)	above 1000 mppcf*	Above 10 milligrams per cubic meter

(4) When unavoidable conditions necessitate using respirators for longer periods (above 1 hour), use equipment in a higher protective category than shown above.

(5) Subject to limitations (Table 2.1), hose-type respirators may be used in place of air line.

* Mppcf = millions of particles per cubic foot.

From Sax, N.I., Dangerous Properties of Industrial Materials, Fifth Edition, p. 47, Van Nostrand Reinhold Company, New York (1979).

TABLE 3 - PROTECTION FACTOR FORMULA (12)

$$\text{protection factor (PF)} = \frac{\text{ambient air concentration}}{\text{concentration inside facepiece or enclosure}}$$

Protection Factor	Respirator Efficiency (%)	Facepiece Penetration (%)	Selection Guide for Maximum Use Concentration (× TLV)
5	80	20	5
10	90	10	10
20	95	5	20
50	98	2	50
100	99	1	100
200	99.5	0.5	200
500	99.8	0.2	500
1,000	99.9	0.1	1,000
2,000	99.95	0.05	2,000
5,000	99.98	0.02	5,000
10,000	99.99	0.01	10,000

From Patty's Industrial Hygiene and Toxicology, Vol. 1, 3rd Revised Edition, p. 1035, John Wiley & Sons, New York (1978)

TABLE 4 - RESPIRATORY PROTECTION FACTORS (12)

Type Respirator	Facepiece[b] Pressure	Protection Factor
I. Air purifying		
A. Particulate[c] removing		
Single-use,[d] dust[e]	–	5
Quarter mask, dust[f]	–	5
Half mask, dust[f]	–	10
Half or quarter mask, high efficiency[h]	–	10
Half or quarter mask, fume[g]	–	10
Full facepiece, high efficiency	–	50
Powered, high efficiency, all enclosures	+	1,000
Powered, dust or fume, all enclosures	+	—[i]
B. Gas and vapor removing[j]		10
Half mask	–	50
Full facepiece	–	
II. Atmosphere supplying		
A. Supplied air		
Demand, half mask	–	10
Demand, full facepiece	–	50
Hose mask without blower, full facepiece	–	50
Pressure demand, half mask[k]	+	1,000
Pressure demand, full facepiece[l]	+	2,000
Hose mask with blower, full facepiece	–	50
Continuous flow, half mask[k]	+	1,000
Continuous flow, full facepiece[l]	+	2,000
Continuous flow, hood, helmet, or suit[m]	+	2,000
B. Self contained breathing apparatus (SCBA)		
Open circuit, demand, full facepiece	–	50[n]
Open circuit, pressure demand full facepiece	+	10,000
Closed circuit, oxygen tank-type, full facepiece	–	50
III. Combination respirator		
A. Any combination of air-purifying and atmosphere-supplying respirator	Use minimum protection factor listed above for type of mode of operation.	
B. Any combination of supplied-air respirator and an SCBA		

Exception: Combination supplied-air respirators, in pressure demand or other positive pressure mode, with an auxiliary self-contained air supply, and a full facepiece, should use the PF for pressure demand SCBA.

[a] The overall protection afforded by a given respirator design (and mode of operation) may be defined in terms of its protection factor (PF). The PF is a measure of the degree of protection afforded by a respirator, defined as the ratio of the concentration of contaminant in the ambient atmosphere to that inside the enclosure (usually inside the facepiece) under conditions of use. Respirators should be selected so that the concentration inhaled by the wearer will not exceed the

From Patty's Industrial Hygiene and Toxicology, Vol. 1, 3rd Revised Edition, p. 1036, John Wiley & Sons, New York (1978)

TABLE 4 (continued)

appropriate limit. The recommended respirator PFs are selection and use guides, and should only be used when the employer has established a minimal acceptable respirator program as defined in Section 3 of the ANSI Z88.2-1969 Standard.

[a] In addition to facepieces, this includes any type of enclosure or covering of the wearer's breathing zone, such as supplied-air hoods, helmets, or suits.

[c] Includes dusts, mists, and fumes only. Does not apply when gases or vapors are absorbed on particulates and may be volatilized or for particulates volatile at room temperature. Example: Coke oven emissions.

[d] Any single-use dust respirator (with or without valve) not specifically tested against a specified contaminant.

[e] Single-use dust respirators have been tested against asbestos and cotton dust and could be assigned a PF of 10 for these particulates.

[f] Dust filter refers to a dust respirator approved by the silica dust test and includes media of all types, that is, both nondegradable mechanical-type media and degradable resinimpregnated wool felt or combination wool-synthetic felt media.

[g] Fume filter refers to a fume respirator approved by the lead fume test. All types of media are included.

[h] High efficiency filter refers to a high efficiency particulate respirator. The filter must be at least 99.97 percent efficient against 0.3 μm DOP to be approved.

[i] To be assigned, based on dust or fume filter efficiency for specific contaminant.

[j] For gases and vapors, a PF should be assigned only when published test data indicate that the cartridge or canister has adequate sorbent efficienty and service life for a specific gas or vapor. In addition, the PF should not be applied in gas or vapor concentrations that are (1) immediately dangerous to life, (2) above the lower explosive limit, and (3) cause eye irritation when using a half mask.

[k] A positive pressure supplied-air respirator equipped with a half-mask facepiece may not be as stable on the face as a full facepiece. Therefore, the PF recommended is half that for a similar device equipped with a full facepiece.

[l] A positive pressure supplied-air respirator equipped with a full facepiece provides eye protection but is not approved for use in atmospheres immediately dangerous to life. It is recognized that the facepiece leakage, when a positive pressure is maintained, should be the same as an SCBA operated in the positive pressure mode. However, to emphasize that it basically is not for emergency use, the PF is limited to 2000.

[m] The design of the supplied-air hood, suit, or helmet (with a minimum of 170 liters/min of air) may determine its overall efficiency and protection. For example, when working with the arms over the head, some hoods draw the contaminant into the hood breathing zone. This may be overcome by wearing a short hood under a coat or overalls. Other limitations specified by the approval agency must be considered before using in certain types of atmospheres.

[n] The SCBA operated in the positive pressure mode has been tested on a selected 31-man panel and the facepiece leakage recorded as $\leq$0.01 percent penetration. Therefore, a PF of 10,000+ is recommended. At this time, the lower limit of detection 0.01 percent does not warrant listing a higher number. A positive pressure SCBA for an unknown concentration is recommended. This is consistent with the 10,000+ that is listed. It is essential to have an emergency device for use in unknown concentrations. A combination supplied-air respirator in pressure demand or other positive pressure mode, with auxiliary self-contained air supply, is also recommended for use in unknown concentrations of contaminants immediately dangerous to life. Other limitations, such as skin absorption of HCN or tritium, must be considered.

Guidelines for selection of respirators for emergency or short-term use have been based on relative toxicity factors and expected concentrations (Table 5). Protection factors have been developed based on respiratory cartridge efficiency, ambient air concentration and facepiece characteristics (Tables 3-4).

Numerous problems exist in formulating recommendations for Strike Team personnel exposed to gaseous and liquid chemical spills. These include:

1. The logistics problems involved in storing and maintaining a variety of respiratory canisters and facepiece ensembles.

2. The unknown and perhaps variable air concentrations existing in the area of the spill.

3. Lack of information on specific canisters which can be used for many of the 985 chemicals.

4. Variable canister lifetimes depending upon the type and concentration of chemical.

Respiratory protection against solid, nonvolatile chemical spills is more easily defined and requires basically a high efficiency particulate filter cartridge; solids with moderate vapor pressures could require a combination particulate-chemical canister.

2.1.1.2 Protective Clothing

Types of protective clothing classifications can be considered to be:

1. Whole body fully encapsulating sealed suits

2. Whole body nonsealed suits

3. Partial body clothing items

An example of a whole body encapsulating sealed suit is the Hazardous Chemical Protective Clothing Outfit, HCPCO (POTMC Army designation). This suit is made of butyl rubber with a polycarbonate fishbowl helmet. This suit provides full body protection for dealing with those chemicals which require whole body protection. Because it is fully sealed, an environmental control unit is used with the suit to provide the wearer with respiratory air and cooling.

TABLE 5 - SELECTION OF RESPIRATORS FOR EMERGENCY OR SHORT-TERM USE ON THE BASIS OF HAZARD AND EXPECTED CONCENTRATION (Gases and Vapors)

Toxicity	Expected Concentrations of Gases or Vapors			
	Two to five times TLV or up to 1000 ppm	Five to ten times TLV or 1000–5000 ppm	Above ten times TLV or 5000–20,000 ppm	Oxygen deficiency, emergency or above 20,000 ppm
Low	No respirator, or chemical cartridge needed	Canister gas mask	Canister gas mask or air-line respirator	Self-contained air or oxygen
Moderate	Chemical cartridge	Canister gas mask or air-line respirator	Air-line or self-contained air or oxygen	Self-contained air or oxygen
High	Canister gas mask	Air-line respirator	Self-contained air or oxygen	Self-contained air or oxygen

NOTES:
(1) TLV refers to the Threshold Limit Values for a number of substances published by the American Conference of Governmental Industrial Hygienists (see Section 1 and section 12).
(2) See Sections 1 and 2 for a discussion of toxicity ratings and their relation to TLV.
(3) When unavoidable conditions necessitate using respirators for longer periods (above 1 hour), use equipment in a higher protective category than shown above.
(4) Subject to limitiations (Table 2.1), hose-type respirators may be used in place of air line.

From Sax, N.I., Dangerous Properties of Industrial Materials, Fifth Edition, p. 47, Van Nostrand Reinhold Company, New York (1979).

Part of this task effort was to list those chemicals which require a whole body encapsulating sealed suit (HCPCO). A majority of the chemicals will require protective clothing less sophisticated than the HCPCO type suit and in some cases no special protective clothing at all.

Advisement of types of protective clothing available other than whole body encapsulating sealed suits was a part of Task I work goals.

Protective clothing manufacturers were contacted to obtain clothing and chemical compatibility data. A list of organizations surveyed is given in Table 6. Appendix B lists the specific types of protective devices available from suppliers.

Some chemical compatibility information is available in protective clothing equipment brochures but is limited in the number of chemicals. Chemical compatibility data for clothing materials is presented only as a guideline and the manufacturer does not guarantee any specific chemical compatibility/clothing performance. Protective clothing manufacturers will provide sample swatches and advise that those interested in their protective clothing products conduct testing and evaluation themselves. Complete compatibility data on all 985 chemicals listed in CHRIS was not obtainable from manufacturers data sources and therefore testing was required in many cases.

Types of protective clothing items include gloves, boots, aprons, hoods, coveralls, pants, jackets, coats, one and two piece suit combinations as well as whole body encapsulating sealed suits. The majority of protective clothing is polyvinyl chloride coated on nylon or cotton fabric material. Rubber and urethane fabric materials are also available. TYVEK (duPont trademark) is a lightweight polyethylene fabric material which is low cost and generally used for throw-away type protective apparel. Butyl rubber protective clothing garments are top of line in cost. Unfavorable cost and manufacturing problems have detracted from Teflon as a protective clothing material although it would be the most chemical resistant of all materials.

2.1.2 Summary and Conclusions

The 985 chemicals were reviewed and levels of protection were established based on Sax's Toxic Hazard Rating. It had been estimated initially that perhaps 100 of the chemicals would require a full encapsulating garment. The rationale used in this study indicated that 403 chemicals may require a fully encapsulating sealed suit with an air supply.

Information is available on the compatibility of many of the chemicals with the standard butyl rubber-polycarbonate

TABLE 6 - REFERRAL LIST

(Protective Clothing)

ORGANIZATION

1. Clever Maid Uniform Company
2. Singer Safety Products Company
3. Boss Manufacturing Company, Ind. Division
4. Clark, David, Company, Inc.
5. Advance Glove Manufacturing Company
6. Star Glove Company
7. Shaffer Products
8. Texier, H. Glove Company, Inc.
9. Colonial Uniform Manufacturing Corporation
10. Loveline Industries, Inc.
11. Fyrepel Products, Inc.
12. Fabohi(Inc.
13. Plastimayd Corporation
14. Wheeler Protective Apparel, Inc.
15. Titan Abrasive Systems, Inc.
16. Guardian Safety Equipment Company
17. Norton Company Safety Products Division
18. Encon Manufacturing Company
19. Mine Safety Appliances Company
20. East Wind Industries
21. Army Research Center
22. DuPont de Nemours & Company
23. Arrowhead Products, Division Federal Mogul
24. International Latex Corporation
25. Rich Industries (Snyder Manufacturing Company)
26. Standard Safety and Equipment Company
27. Edmont-Wilson Division, Bechton Dickinson & Company
28. JOMAC Products, Inc.
29. Plymouth Rubber Company

encapsulating suit. However, the information is not complete and compatibility tests were required for those cases where compatibility was not known.

In summary, of the 985 chemicals reviewed, it was concluded that 403 chemicals would require a fully sealed suit. There were 44 chemicals in which a decision could not be made and these are given in Table 7. Fifteen chemicals are pyrophoric requiring a fire suit; these are listed in Table 8.

Appendix C lists the 403 chemicals in the test program which are discussed later in this report.

2.2 Requirements - Task II

Requirements given herein apply to clothing material sought to provide head and body protection to personnel who will encounter chemicals of all types of reactivity groups.

The list of requirements for candidate materials is given in Table 9.

2.2.1 Service Time

Time period within a fully sealed suit shall be a maximum of two (2) hours based upon the physiological impact of wearing the suit.

First level requirement for candidate material shall be twenty (20) hours chemical resistance time. This requires that the candidate material be exposed for a twenty (20) hour contact time without damage and represents ten (10) wear cycles and associated decontamination.

A secondary protection level requirement for the candidate material shall have a chemical resistance service time of two (2) hours. This represents the absolute minimum wear time for a single use duty during which no catastrophic degradation of material is permissible to jeopardize personnel welfare.

Because of associated cost, a multiple wear cycle material is desired over a single wear cycle material. However, a single wear cycle material should be given consideration as an acceptable alternative.

2.2.2 Shelf Life

Candidate material shall have a shelf life period of ten (10) years when properly stored to prevent premature aging. Chemical resistance and durability properties during its shelf life period shall not be affected.

TABLE 7 - CHEMICALS WITH UNASSIGNED LEVELS OF PROTECTION

CHRIS Code	Chemical Name	State
AEA	n-Aminoethylethanolamine	L
ALS	Ammonium Lauryl Sulfate	L
AMT	Ammonium Thiocyanate	S
AMY	n-Amyl Chloride	L
BZP	Benzophenone	S
BBP	Benzyl n-Butyl Phthalate	L
BZO	Benzyl Dimethyl-Octa-Decyl Ammonium Chloride	L
BMA	Benzyltrimethyl Ammonium Chloride	L
BDO	1,3-Butanediol	L
BUD	1,4-Butenediol	L
CPH	Camphene	S
CLS	Caprolactum Solution	L
CAR	Carene	L
CRN	p-Chlorotoluene	L
COS	Cobalt Sulfamate(ous)	-
CGE	Cresyl Glycidyl Ether	S
DES	2,4-D Esters	L
DBZ	n-Decylbenzene	L
DIC	Dicamba	S
DSD	Dodecylsulfate, Diethanolamine Salt	L
DSM	Dodecylsulfate, Magnesium Salt	L
DDS	Dodecylsulfate, Sodium Salt	S
DST	Dodecylsulfate, Triethanolamine Salt	L
DAI	Dodecyclbenzene Sulfonic Acid,Isopropanolamine Salt	S
EHP	Ethoxydihydropyran	L
EBR	Ethylbutyrate	L
ETN	Ethylnitrite	L/G
IPC	Isopropyl Percarbonate	S
MCP	Methylcyclopentane	L
MPA	Monoisopropanolamine	L
OET	Octyl Epoxy Tallate	L
ORS	Oil Misc., Resin	L
ORD	Oil Misc., Road	L
ORN	Oil Misc., Rosin	L
OSP	Oil Misc., Sperm	L
OCF	Oil Misc., Clarified	L
PPB	Phosphorous,Black	S
SAS	Silver Aklyl Sulfates	S
SFL	Sulfolane	L
TRN	Thorium Nitrate	S
UDB	n-Undecylbenzene	L
URA	Uranyl Acetate	S
VEE	Vinyl Ethyl Ether	L/G
ZDP	Zinc Dialkyldithiophosphate	L

TABLE 8 - PYROPHORIC CHEMICAL LIST

(Fire Suit)

CHRIS Code	Chemical Name	State
CRE	Calcium Resinate	S
DBR	Decaborane	S
DEZ	Diethyl Zinc	L
DMZ	Dimethyl Zinc	L
EAD	Ethylaluminum Dichloride	L
EAS	Ethylaluminum Sesquichloride	L
NKC	Nickel Carbonyl	L
PTB	Pentaborane	L
PPR	Phosphorous, Red	S
PPW	Phosphorous, White	S
PTM	Potassium, Metallic	S
SDU	Sodium, Metallic	S
SZA	Sodium Azide	S
TIA	Triisobutylaluminum	L
TAL	Triethylaluminum	L

TABLE 9 - MATERIAL REQUIREMENT SUMMARY

Paragraph	Item	Requirement
2.2.1	Service Time	
	Wear Time	2 hours
	Chemical Service Time	
	Primary level	20 hours
	No. wear cycles	10
	Secondary level	2 hours
	No. wear cycles	1
2.2.2	Shelf Life	10 years
2.2.3	Ambient Work Conditions	
	Pressure	1 Atmosphere (Air with no contaminant to 100% contaminant
	Temperature	-30°C (-22°F) to 40°C (104°F)
	Humidity	Up to 100% and water contact
	Sunlight	No UV or O_3 degradation
	Fungus	Will not support mold growth
2.2.4	Temperature Characteristics	
	Operational and storage temperatures, -30°C (-22°F) to 70°C (158°F) range	Noncracking, tackiness, stiffening, flaking or separation
2.2.5	Durability	Meet physical properties per MIL-C-12189E, Table 1
2.2.6	Odor	No offensive odors
2.2.7	Toxicity	No inherent toxicity hazard
2.2.8	Fabrication Methods	Sewed, glued, heat bonded impulse heated, sonic bonded, radio frequency bonded or other method to provide leak tight joints Capable of bonding to other acceptable materials Field and factory repairable

TABLE 9 - MATERIAL REQUIREMENT SUMMARY (cont.)

Paragraph	Item	Requirement
2.2.9	Workmanship	Material conforms to quality and grade per these requirements
2.2.10	Support and Maintenance	Provide data and procedure to sanitize, leak check, seal, repair, inspection, optical quality, storage- record keeping
2.2.11	Decontamination	Material does not degrade from decontamination procedures
2.2.12	Material and Production Cost	
	Material Cost Range	$10-$50 per square yard Variable depending upon garment material
2.2.13	Chemical Compatibility	
	(985 CHRIS List Chemicals)	100% compatibility desired
2.2.14	Other Requirements	Impermeable Fire retardant Static electricity free
2.2.15	Intended Use	Protective garment

2.2.3 Ambient Work Conditions

Candidate materials shall be capable of exposure to contaminated air with contaminant concentrations ranging from 0 to 100%. Candidate materials must be able to withstand a temperature range of -30°C (-22°F) to 40°C (104°F), a humidity of 100% and water content, have no ultraviolet light or ozone degradation and be fungus resistant.

2.2.4 Temperature Characteristics

Over a temperature range of -30°C (-22°F) to 40°C (104°F) ambient work conditions and storage conditions of -30°C (-22°F) to 70°C (158°F), material shall not exhibit cracking, become tacky, exhibit stiffening, flaking or separation from these temperature extremes.

2.2.5 Durability

Candidate material shall be resistant to abrasion, scuffing and tearing. Physical property data for butyl rubber per MIL-C-12189E, Table 9 shall apply as a material durability requirement.

2.2.6 Odor

Candidate material shall not have an offensive odor.

2.2.7 Toxicity

Candidate material shall not in itself present a toxicity hazard.

2.2.8 Fabrication Methods

Candidate materials shall possess suitable fabrication characteristics. Material for body protective garments shall be sufficiently flexible so as not to impede body movement.

Candidate material shall be capable of beirg fabricated to produce leak-free seams by sealing, sewing, gluing, heat bonding, impulse heating, sonic bonding, radio-frequency bonding, and other methods. Bonding to other acceptable materials as well as to itself is also desirable.

It is required that material be capable of repair in the field for minor tears or at the fabricator shop for more major tears to salvage the protective ensemble.

2.2.9 Workmanship

Finished material shall conform to the quality and grade of product established by these requirements.

2.2.10 Support and Maintenance

Support and maintenance procedures shall be required for proper care of protective clothing materials. Information shall be provided on:

1. sanitizing after use
2. leak checking
3. leak sealing
4. major and minor repairs
5. inspection for chemical attack
6. checking optical quality of transparent materials
7. storage
8. record keeping

Material requirements are based upon appropriate care: storage in uncreased condition, prompt decontamination and sanitization, proper inspection and repairs.

2.2.11 Decontamination

Candidate material shall be capable of being decontaminated to recondition for additional service. Decontamination procedures might include, in addition to others, such procedures as:

1. Water wash or flush.
2. Water wash with detergent.
3. Wash with neutralizing agent.
4. Wash or wipe with appropriate solvents.
5. Brushing or other means of removing contaminants.

Decontamination procedures shall be based upon consideration that contaminants might be solids or liquid residual. Decontamination shall be considered to apply to both external and internal surfaces. Decontamination shall not deteriorate material for additional wear cycles.

2.2.12 Material and Production Costs

Material unit cost and fabrication cost data shall be supplied. Cost level shall be considered for making analysis of

the material's suitability in relation to the Coast Guard's purposes and use. Material costs in the range of $3.50 per square yard are typical of protective clothing materials; cost for special runs may be in the range of $10 per square yard. Material costs generally are minor costs of the total cost; fabrication and quality control costs are the major cost. Material scrap shall be in the range of 7-10% so that material costs do not become a greater portion of total cost. A material cost of $20 per square yard shall not be considered excessive if service life compared to $10 per square yard is more than doubled. Based upon material unit cost range of $3.50 to $20 per square yard, material costs per ensemble shall be in the range of $20 to $120.

It is recognized that fabrication costs will depend primarily upon specific requirements for the suit. The magnitude of the costs will depend upon any special research, development and engineering time to develop a protective suit. Furthermore, protective clothing ensembles manufactured to applicable MIL specifications and to specific design features entail greater cost. Cost targets cannot be established until a final selection is made of garment requirements for each of the chemicals.

2.2.13 Material Chemical Compatibility Data

Data shall be provided on the number and types of chemicals which the candidate material is compatible with so assessment of its applicability can be made. Preliminary evaluation of the candidate material may be judged on basis of chemical reactivity groups, however some exceptions are likely to be found within a reactivity group. Comparison of each of the 985 chemicals given in the CHRIS list against the candidate material shall be made. Data shall consist of the percent compatible with the chemicals and a listing of those which are not and a list for those for which information is not available.

As an example, a data search indicated butyl rubber was compatible with about 70% of the chemicals:

No. compatible	685
No. incompatible	119
No. unknown	111
TOTAL	985

For polycarbonate, the compatibility was approximately 56%:

No. compatible	553
No. incompatible	153
No. unknown	279
TOTAL	985

2.2.14 Other Requirements

Candidate materials shall be impermeable, fire retardant, and not exhibit static electricity properties.

2.2.15 Intended Use

Candidate materials shall be fabricated for assembly of a protective garment. This protective garment shall be used by Coast Guard Strike Team personnel in cleanup operations that include 985 CHRIS list chemicals.

2.3 Testing Program (Plan) - Task III

Levels of protection investigated during Task I indicated 403 chemicals required a sealed suit out of 985 chemicals involved. An additional 15 chemicals were pyrophoric and were assigned to a fire suit. Another 44 chemicals were indeterminate and a level of protection was unassigned. The remaining 523 chemicals were assigned levels of protection of an unsealed suit or use of standard safety equipment; i.e., gloves, goggles, hard hats and steel-toed footwear.

Of the 403 chemicals requiring sealed suits, 327 were specified by use of Sax's Toxic Hazard Rating and the remaining 76 chemicals were determined by other standards and best judgments. A total of 403 chemicals were candidates for the Material Compatibility Testing, Task V.

A program plan was devised with the objective to assign a performance rating for each of the 403 chemicals of interest.

In general, a Performance Rating Guide for chemicals requiring a sealed suit would evolve from the evaluation of available literature compatibility and the outcome of extensive tests conducted at MSAR. There were, however, several overriding factors which prevented the straightforward application of published data. The developmental process used to generate performance ratings is detailed below and is summarized in Figures 1 and 2.

2.3.1 Applicability of Literature Data

Numerous materials selection guides have been published detailing the compatibility of certain plastics and rubbers with various chemicals. Unfortunately, the basis for this information is unclear or not revealed. Realistically, it would have been impractical to ignore this extensive data source in its entirety. As a result, guidelines were developed to distinguish the type data which could be accepted at face value. The following rationale concerning published literature compatibility data was used.

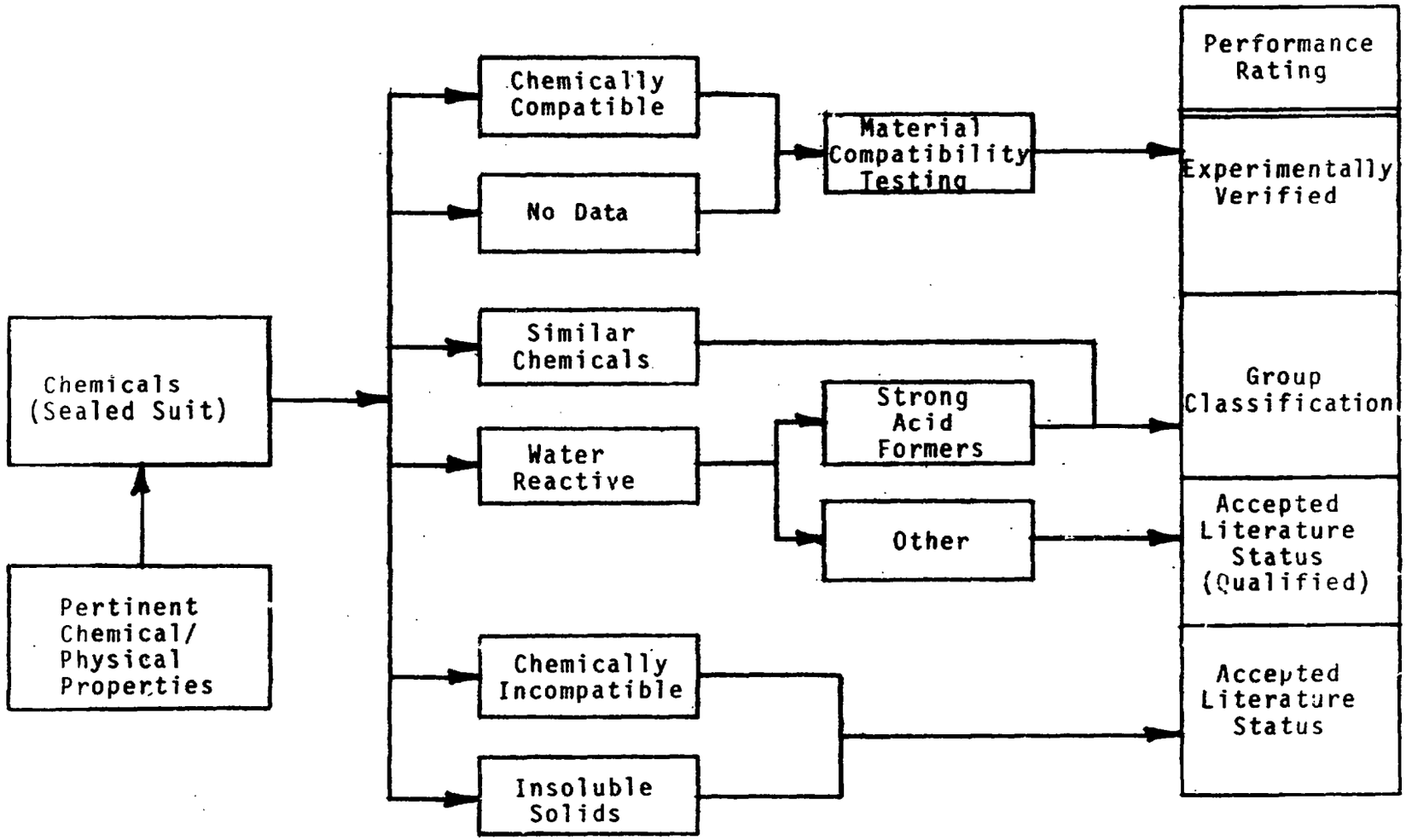


FIGURE 1 - BUTYL RUBBER PERFORMANCE RATING EVALUATION PLAN

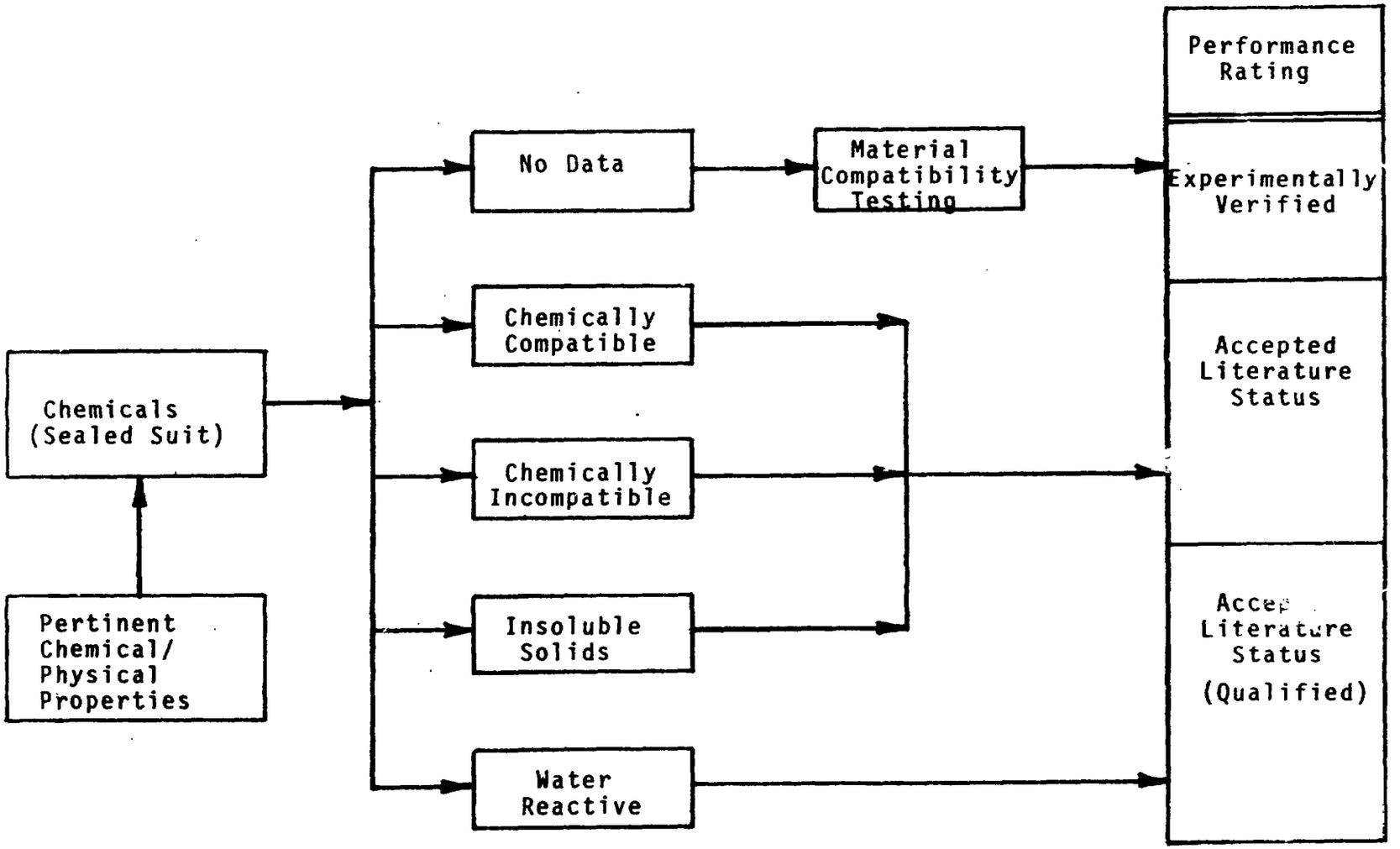


FIGURE 2 - POLYCARBONATE PERFORMANCE RATING EVALUATION PLAN

2.3.1.1 Polycarbonate

The literature findings (compatible or noncompatible) were used without further consideration. It was concluded that valid and applicable type testing have been performed. Key test factors such as resistance to fogging, softening, discoloration, etc., would undoubtedly have been included in these tests. Testing at MSAR was limited therefore only to those chemicals for which no data could be uncovered. Over 100 chemicals fell into "no data" classification and were subsequently tested at MSAR.

2.3.1.2 Butyl Rubber

A literature finding of "incompatible" or "unsatisfactory" of the chemical with butyl rubber was accepted as an unacceptable rating. It was confidently anticipated that the application of more extensive and rigorous testing would only confirm this data. On the other hand, a literature rating of "compatible" was not accepted because of the uncertainty of the test methods and the increased requirements demanded of a protective sealed suit, e.g., penetration data.

In addition to the shortcomings of the published data, there were other factors which were inherent in the chemicals themselves which influences the methods of generating a final rating guide. Three distinct classes of chemicals were singled out and treated separately, i.e., water reactive, insoluble solids and similar group classifications.

2.3.2 Water Reactive Chemicals

It was concluded that literature information concerning chemicals that could react with water applied only to the unreacted chemical, whereas mixtures of uncertain composition would exist in the field. Detailed laboratory studies of these chemicals were not undertaken partly because the field composition would be situation dependent. Performance Rating Guides for water reactive chemicals were generated in the following manner.

2.3.2.1 Polycarbonate

The accepted chemical compatibility literature findings were retained, however the rating would be qualified by noting that it applied only to the unreacted chemical.

2.3.2.2 Butyl Rubber

Specialized laboratory tests eventually showed that reactive chemicals which yielded strong acid decomposition products would eventually prove harmful to butyl rubber. This class of reactive chemicals was categorically given a "Fail" rating.

The literature data was retained for chemicals yielding lesser reactive materials. In this latter case, the rating was qualified and limited to the unreacted chemical.

The subject of water reactive chemicals and their effects on butyl rubber is detailed in a later section.

2.3.3 Insoluble Solids

No tests were scheduled on solid chemicals which were found to be insoluble in water. It was concluded that this general class of chemical could only penetrate the protective ensemble via mechanical defects such as holes, tears, faulty seams, etc. However, the possibility persisted that these chemicals could still chemically attack butyl and polycarbonate. The literature findings were subsequently adopted with no qualifications.

2.3.4 Similar/Group Classification

The overall plan provided for the classification of certain chemicals based on their close chemical relationship. In the event that chemicals could not be evaluated either experimentally or on the basis of literature data, such chemicals should be assigned a rating based on chemical similarity. The number of chemicals assigned a rating on this basis would be held to a minimum and the rating would only be assigned where proven or obvious trends existed.

2.3.5 Material Test Sequence

The overall evaluation plans shown in Figure 1 and 2 provide for a laboratory study to assess the compatibility of the chemical with butyl rubber and polycarbonate. The laboratory test program was limited to chemicals whose assigned literature rating was unknown and/or unaccepted. A Performance Rating Guide for these chemicals was generated by subjecting butyl rubber and polycarbonate to the chemicals in a series of selected and related tests. The laboratory test sequence is shown in Figure 3.

The selected time frames for these tests were 3 hours and 20 hours. A 3-hour time limit was intended to safely simulate a single mission in which the duration of exposure would be limited to about 2 hours. The 20-hour time frame for testing evolved from the consideration that the protective ensemble would be used for at least ten 2-hour periods. In this case, a 20-hour continuous exposure to the chemical was comparable or safely in excess of the demand posed by multi-short term use. The 20-hour test was not rigorously equated to 10 missions although this is implied. A brief description of the individual tests is described next. A detailed discussion of the experimental program is included in Section 3.0.

2.3.5.1 Swatch Test

All chemicals selected to be tested were routed initially through a basic compatibility test. The intended purpose was to immediately eliminate chemicals which grossly attacked the test specimens. The duration of the test was 20 hours in which the specimens of polycarbonate and butyl rubber were maintained completely submerged (liquid) or engulfed (gas) by the chemical.

The test specimens were examined after 3-hour contact and again after 20 hours. Quantitative data which were recorded were weight and dimensional changes and any visually apparent indications of attack; i.e., cracking, blistering, tackiness, discoloration, fogging, etc. Special physical property testing was performed on the butyl specimen following the 20-hour contact. These tests were limited to the measurement of tensile and tear strength (warp direction).

A greater than 10% change in weight and/or physical properties was selected as a fail criterion. Chemicals found to attack the test specimen within 3 hours were assigned a failed rating. Chemicals passing 3 hours but failing in 20 hours were retained in the test program, as shown in Figure 3 for concentration versus time testing.

2.3.5.2 Penetration Test (Butyl Rubber)

Chemicals advancing beyond the Swatch Test were subjected to penetration or permeation tests, which was the heart of the test program. The penetration test was limited to butyl rubber. Specimens of butyl rubber were contained in specially designed cells with the test chemical applied to the outer, thicker coated side. Clean air continuously purged the underside and suitable analytical techniques were used to measure the extent of penetration. Penetration by the nonvolatile inorganics was determined by swabbing the underside of the butyl specimen. The extent of penetration was measured at the end of 3 hours and/or at 20 hours.

The established fail criterion for the penetration test was the presence of positive signs of penetration. The criterion, which basically is dependent upon the sensitivity or detection limits of the analytical methods, was preferred over the general approach of establishing an allowable safe limit. The latter approach would have involved making uncertain toxiological decisions especially in instances where TLV type information was not available.

On the basis of the above, chemicals penetrating the butyl rubber within 3 hours were eliminated from further testing.

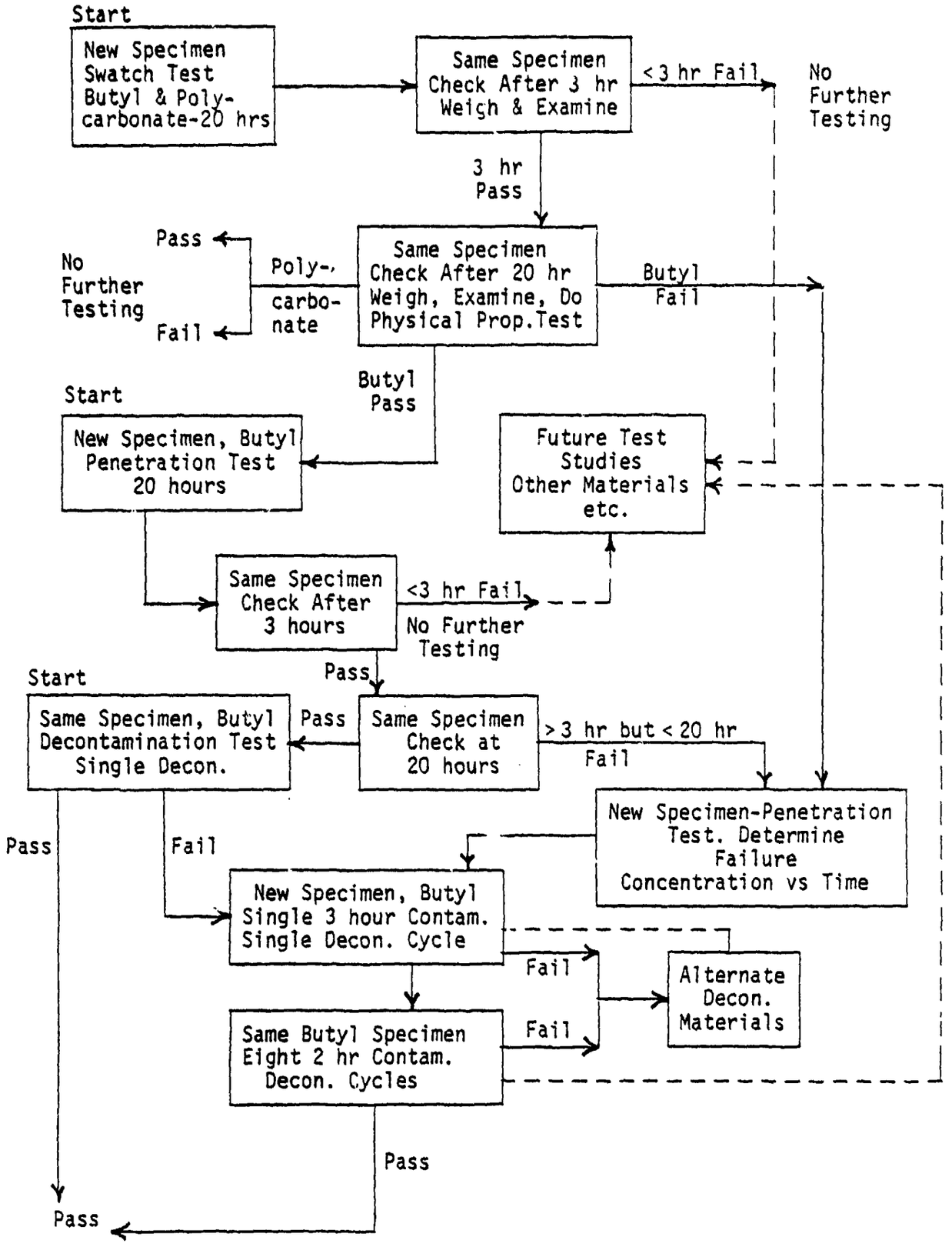


FIGURE 3 - MATERIAL COMPATIBILITY TESTING SEQUENCE

As is shown in Figure 3, chemicals breaking through the specimen between 3 and 20 hours were subjected to a concentration versus time test to determine service time. Chemicals passing the 20-hour test advanced to the Single Decon Test.

2.3.5.3 Single Decon Test

Butyl rubber specimens which passed the 20-hour penetration test were given a single decon test. A single decon test consisted of a cold water wash with 1% detergent. The specimen was then checked for decontaminating effectiveness. Any detection of the chemical (see paragraph 2.3.5.2 agove) on the butyl rubber represented a fail status. When butyl rubber specimens exposed for 20 hours failed the single decon test, a multi-decon test cycle was instituted.

Polycarbonate is impermeable, hence any degradation of the material is a surface phenomenon. During compatibility testing, the surface of the polycarbonate specimen was decontaminated with a cold water-1% detergent solution prior to post weighing of the specimen. The surface of the polycarbonate was adequately decontaminated by this procedure.

2.3.5.4 Multi-Decon Cycle Test

The multi-decon cycle test was limited to butyl rubber specimens. The objective of this test was to determine the ability to decontaminate when the butyl rubber was exposed to the chemical for shorter 2-3 hour time periods. Test sequence was planned upon initially exposing the butyl rubber for a 3-hour period followed by a decon with water and detergent as was similarly done in the single decon test. Any detection of the chemical represented a fail with no further testing conducted.

If no detection was made after the initial 3-hour exposure, eight 2-hour exposures with decontamination washes made between the 2-hour exposures was followed. After the last 2-hour exposure period, any detection of the chemical resulted in a fail and no further testing was done. Failure resulted in assignment into the category of future R&D studies with alternative decontaminating agents.

2.3.5.5 Concentration vs Time Tests

If a butyl specimen failed after 20-hour expsoure in the swatch or penetration test, it became scheduled for a concentration versus time test. The objective of this test was to determine at what period of time between three and 20 hours the butyl rubber failed. This test required monitoring between the three and 20-hour priod whereas monitoring in the penetration test was conducted at the end of the 3-hour period and the 20-hour

period only. Although it was scheduled that a new butyl rubber specimen be given a 3-hour exposure and decon after conducting the concentration versus time test, this test sequence was not conducted because it was deemed that the chemical had indeed penetrated to the degree that a decontamination problem existed.

2.4 Interim Report - Task IV

MSAR Reports 79-45 and 79-52 were issued in fulfillment of Task IV. Additional comments to MSAR 79-52 were prepared on Task III in a report issued 13 June 1979 and adopted as outlined in 2.3 above.

2.5 Material Compatibility Testing - Task V

Results of material compatibility testing and evaluation are given in Appendix C (test performance rating column). The sealed suit requirement was assigned to 403 chemicals as determined from Levels of Protection, Task I study. Using the Test Program Plan (Test III) as the testing guide, resulted in conducting tests with approximately 235 chemicals. Approximately 163 chemicals were not tested. On a mutually inclusive basis of having no data for either butyl rubber or polycarbonate, 39 of these chemicals were considered for future R&D study (see Section 5.0). Approximately 129 chemicals were not tested but given test performance rating. Rationale used was based upon chemical compatibility data and information pertaining to similar chemical reactivity, water reactivity, insolubility, properties and the like.

2.5.1 Swatch Test Results

Testing was conducted for butyl rubber and polycarbonate against those chemicals where no chemical compatibility data was available. Approximately 113 chemicals were classified for this test. The purpose of this test was to immediately screen out those chemicals which were obviously incompatible with butyl rubber. Figure 4 is a breakdown of the swatch test results. Failure rate was found to be about 60% for butyl rubber and 50% for polycarbonate for those selective chemicals scheduled in this test. Chemicals which passed (40% butyl rubber) went into the penetration test. No additional tests were conducted with polycarbonate.

2.5.2 Penetration Test Results

Penetration tests were conducted with butyl rubber only. This test applied to those chemicals which were classified as being compatible either from available information or from passing the swatch test. The purpose of this test was to further establish resistance of butyl rubber to penetration since little or no data was available for the majority of chemicals, regarding penetration properties.

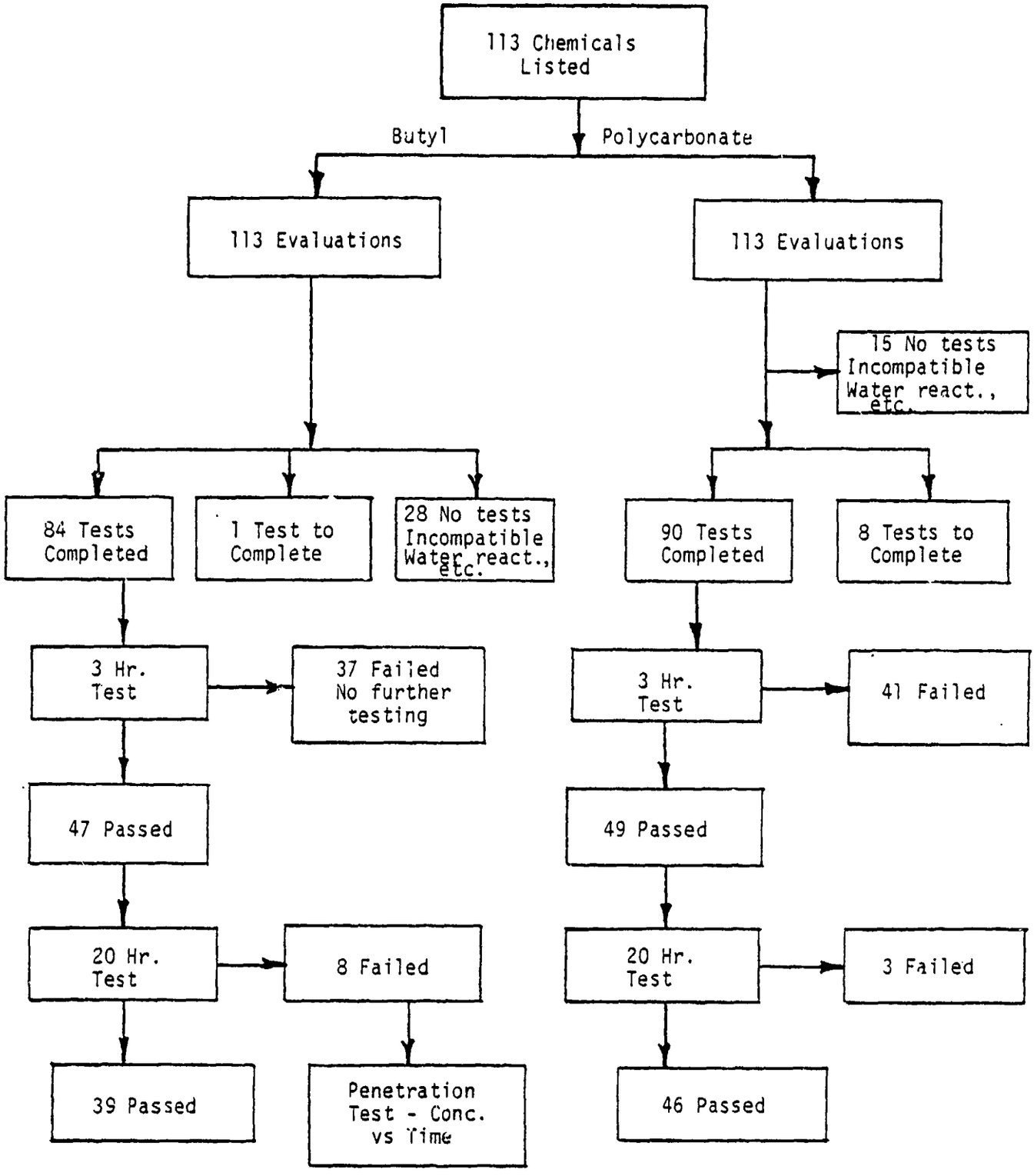


FIGURE 4 - SWATCH TEST DATA BREAKDOWN

Approximately 192 chemicals were used in conducting the penetration test. Basis for failing was any detection of the chemical. Figure 5 summarizes the penetration/decon test results. Approximately 60% passed the 20-hour penetration test. About 35% failed in 3 hours and about 5% failed after 20 hours. There were several cases where butyl rubber was found to be incompatible as evidenced by obvious attack. Chemicals which passed the penetration test were given a single decon test to further confirm test performance rating. Those which failed in 3 hours were considered basically not suitable. Those which failed between 3 and 20 hours were given the concentration versus time test.

2.5.3 Single Decon Test Results

If no penetration was detected after 20 hours of exposure to the chemical, a single decon test (cold water-1% detergent solution) was conducted. A breakdown of results from this test is shown in Figure 5. Approximately 66% passed the single decon test and were given a pass (acceptable) performance rating. The 34% which failed were given the multi-decon test.

2.5.4 Multi-Decon Test Results

The single decon test, which was performed after 20 hours of continuous exposure to the chemical, uncovered a number of chemicals in which decontamination could be a problem. These chemicals were subsequently examined in the multi-decon test which consisted of a series of short term contamination/decontamination cycles. Residual contamination was evaluated after an initial 3-hour exposure and again after a series of eight 2-hour exposures. Decontamination was performed after each exposure.

There were 26 chemicals investigated in the multi-decon test and Table 10 shows the breakdown of test results. Table 11 shows those chemicals which failed and were assigned to future R&D work for alternate decontamination studies. About 45% of the chemicals passed the first 3-hour exposure and 55% failed. Of the chemicals which entered the eight 2-hour portion of the test, a total of 30% passed and 70% failed.

2.5.5 Concentration vs Time Test Results

Swatch test and penetration test results determined the number of concentration versus time tests to conduct based upon failure between 3 and 20 hours. The purpose of this test was to determine the approximate time before breakthrough of the chemical. Appendix C (see table test performance rating column) lists service time/range and no special tabulation of this data is given since there was not a large number of tests conducted.

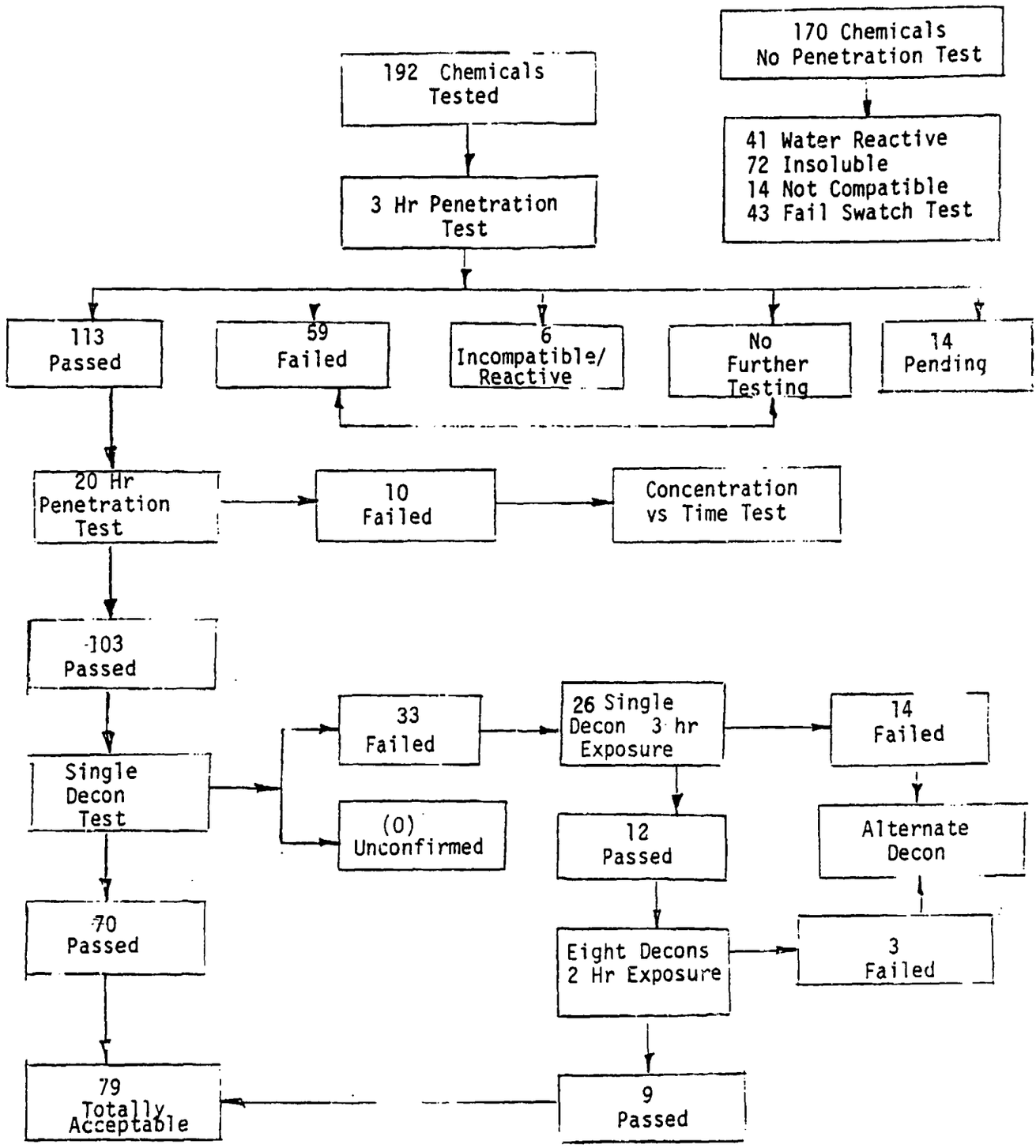


FIGURE 5 - BREAKDOWN OF PENETRATION/DECON TESTS - BUTYL RUBBER

TABLE 10 - DECON CYCLE TEST RESULTS FOR BUTYL RUBBER

CHRIS Code	Chemical Name	Single 3-hour Exposure & Decon	Eight 2-hour Exposures & Decon Cycles*
ARL	Acrolein	Failed, 1 ppm	--
ACR	Acrylic Acid	Passed	Failed, 0.2 ppm
ANL	Aniline	Passed	Failed, 0.5 ppm
BZN	Benzonitrile	Failed, 0.52 ppm	--
BZM	Benzylamine	Passed	Passed
CCT	Creosote	Failed, strong odor	--
DEP	Dl-(Ethylhexyl)Phosphoric Acid	Passed	Failed, 0.7 ppm
DDW	2,5 Dimethyl Hexane Dihydroperoxide, Wet	Passed	Passed**
DMH	1,1-Dimethyl Hydrazine	Failed, 0.8 ppm	--
DSF	Dimethyl Sulfate	Passed	Passed** (0.06 ppm)
DIQ	Diquat	Passed	Passed**
EPC	Epichlorohydrin	Failed, 0.6 ppm	--
GCM	Glycidyl Metacrylate	Passed	Passed
IPP	Isopropylamine	Passed	Passed**
MLT	Malathion	Failed, not detected but strong odor	--
MTA	Methylacrine	Passed	Passed**
MAA	Methyl Amyl Alcohol	Failed, 0.4 ppm	--
MAN	n-Methylaniline	Failed, 0.6 ppm	--
MIC	Methyl Isobutyl Carbinol	Failed, 0.8 ppm	--
NTB	Nitrobenzene	Failed, 0.8 ppm	--
NPP	2-Nitropropane	Failed, 0.3 ppm	--
PHD	Phosdrin	Passed	Passed**
PII	Propyleneimine, Inhibited	Failed, not detected but strong odor	--
TTP	Tetraethylenepentamine	Passed	Passed
XYL	2,4 Xylenol	Failed, not detected but strong odor	--
HDS	Hydrogen Sulfide	Failed	--

*Each cycle consists of 2 hr exposure to chemical followed by a cold water detergent one minute wash, then examined after the eighth cycle for residual contamination.
**Slight odor.

TABLE 11- CHEMICALS REQUIRING ALTERNATE DECON INVESTIGATION

CHRIS Code	Chemical Name
ARL	Acrolein
ACR	Acrylic Acid
ANL	Aniline
BZN	Benzonitrile
CCT	Creosote, Coal Tar
DEP	Di-(Ethyl Hexyl) Phosphoric Acid
DMH	1,1-Dimethyl Hydrazine
EPC	Epichlorohydrin
MLT	Malathion
MAA	Methyl Amyl Alcohol
MAN	n-Methylaniline
MIC	Methyl Isobutyl Carbinol
NTB	Nitrobenzene
NPP	2-Nitropropane
PII	Propyleneimine, Inhibited
XYL	2,4-Xylenol

2.5.6 Seam Test Results

Purpose of the seam test was to provide additional information regarding seam design (Table 12). Chemicals tested were based on a selective method and most of the chemicals tested were those which passed the penetration/single decon tests. These tests pointed up that edge effects presented by the seam areas in fabrication of the HCPCO suit can hold up the chemical to a greater degree than smooth fabric presenting no seam edge effects. In regard to penetration,this test verified penetration results obtained with the fabric and also served to show that the seam design and construction was sound.

TABLE 12- BUTYL SEAM TEST RESULTS

CHRIS Code	Chemical Name	Penetration 3 hr	Penetration 20 hr	Single Decon
AAC	Acetic Acid	Pass	Pass	Pass
ACY	Acetone Cyanohydrin	Pass	Pass	Fail (3.2 ppm)
AAM	Acrylamide	Pass	Pass	Pass
ANL	Aniline	Pass	Pass	Fail (8.2 ppm)
CHN	Cyclohexanol	Pass	Pass	Fail (1.4 ppm) Some blistering on adhesive
NTT	p-Nitrotoluene	Pass	Pass	Fail (2.2 ppm)
PHN	Phenol	Pass	Pass	Pass
CBN	4-Chlorobutrylnitric	Pass	Pass	Fail (20 ppm) Some blistering on adhesive
HDZ	Hydrazine	Pass	Pass	Pass

3.0 EXPERIMENTAL

The following sections detail the laboratory methods and equipment used to evaluate those chemicals requiring sealed suits. The actual selection of the test methods was strongly influenced by the need to cope with an extremely large number of widely varying chemicals.

3.1 Chemical Sources

The bulk of the chemicals used in the test program were obtained from chemical supply houses. The purity of the chemicals was technical grade or better (>90%) and were used without further purification.

Specialty chemicals including formuations such as agricultural chemicals were obtained from a manufacturer listed in CHRIS for that specific chemical. In cases where the chemical was available in a number of different formulations, the manufacturer was requested to recommend the material most likely to be encountered "outside the fence". The most abundant type of chemicals belonging to the class are the agricultural chemicals; fungicides, herbicides, etc. In most cases, a single working ingredient was found to be available in a number of formulations; i.e., a water wettable powder, an emulsion, or as a solution in an organic solvent. The most common solvents or vehicles used in these preparations are kerosene, xylene, and toluene and all three are incompatible with butyl rubber. Toluene, for example, was examined briefly and was found to dissolve in butyl rubber to the extent of about 0.8 g/g (80% pickup).

CHRIS list chemicals requiring a fully sealed suit and marketed in solvents known to adversely affect butyl or polycarbonate were categorically assigned a "Fail" in the performance rating. These chemicals are identified in Appendix C by the insert "liquid formulation" adjacent to the chemical name.

3.2 Swatch Test

A swatch test was the initial test conducted when chemical resistance data was not available for polycarbonate and butyl rubber. It consisted of exposing polycarbonate and butyl rubber specimens to the chemical and making inspection after a 3-hour and 20-hour period. Overall, one of the primary functions of the swatch test was to eliminate as early as possible the chemicals which grossly attacked the butyl and/or polycarbonate. Specimens were tested in separate containers so that the polycarbonate and butyl rubber specimens were observed individually with chemicals that were liquid or soluble solids dissolved in water. For gases, the specimens were placed in a cell through which the test gas was passed, as described in 3.3.1.

After three hours, the specimens were removed and examined for weight change, dimensional change, or obvious visual damage. This inspection was performed again after 20 hours; and in the case with butyl rubber, additional measurements were made to observe the change in tensile and tear properties in the warp direction of the fabric. A change of 10% in quantitative measurements, obvious visual damage or deterioration was used as fail criteria and no further testing was conducted. Only swatch tests were conducted with polycarbonate. Butyl ubber which passed the swatch test was then given subsequent penetration, single decon, etc. tests.

3.2.1 Polycarbonate Swatch Test Specimens

Polycarbonate used in the test was Lexan sheet Grade 9034 material. Size of the specimens was 1 1/4 inch wide x 3 1/2 inch long x 1/6 inch thick. The specimens weighed approximately 5 grams (see Figure 6).

3.2.2 Butyl Rubber Swatch Test Specimens

Butyl rubber per MIL-C-12189E obtained from Plymouth Rubber Company was used in all tests in this study. This material is heavyw ight (11.0 to 13.5 ounces/square yard). Two specimens 3 inches wide x 6 inches long were cut for each test. After 20 hours of exposure to the chemical, one of the butyl specimens was given a 2-inch long slit and used to measure tear strength and the other one to measure the tensile strength in the warp direction (see Figure 6). The butyl rubber specimens weighed about 4.7 grams. Relative change in tensile and tear strength was obtained by comparing the exposed specimen to specimens which had not been exposed to the chemical.

3.2.3 Swatch Test Data

Results of the swatch tests are given in Appendix C. Data collected was as follows:

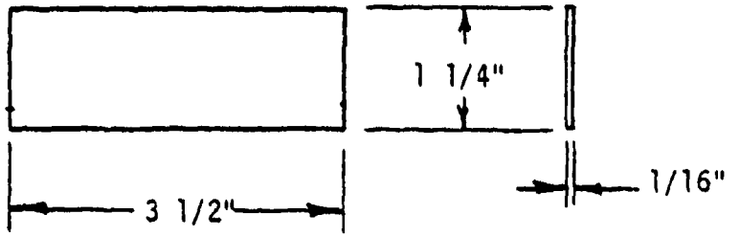
W_i = Initial weight - polycarbonate and butyl rubber

W_3 = Weight after 3 hours - polycarbonate and butyl rubber

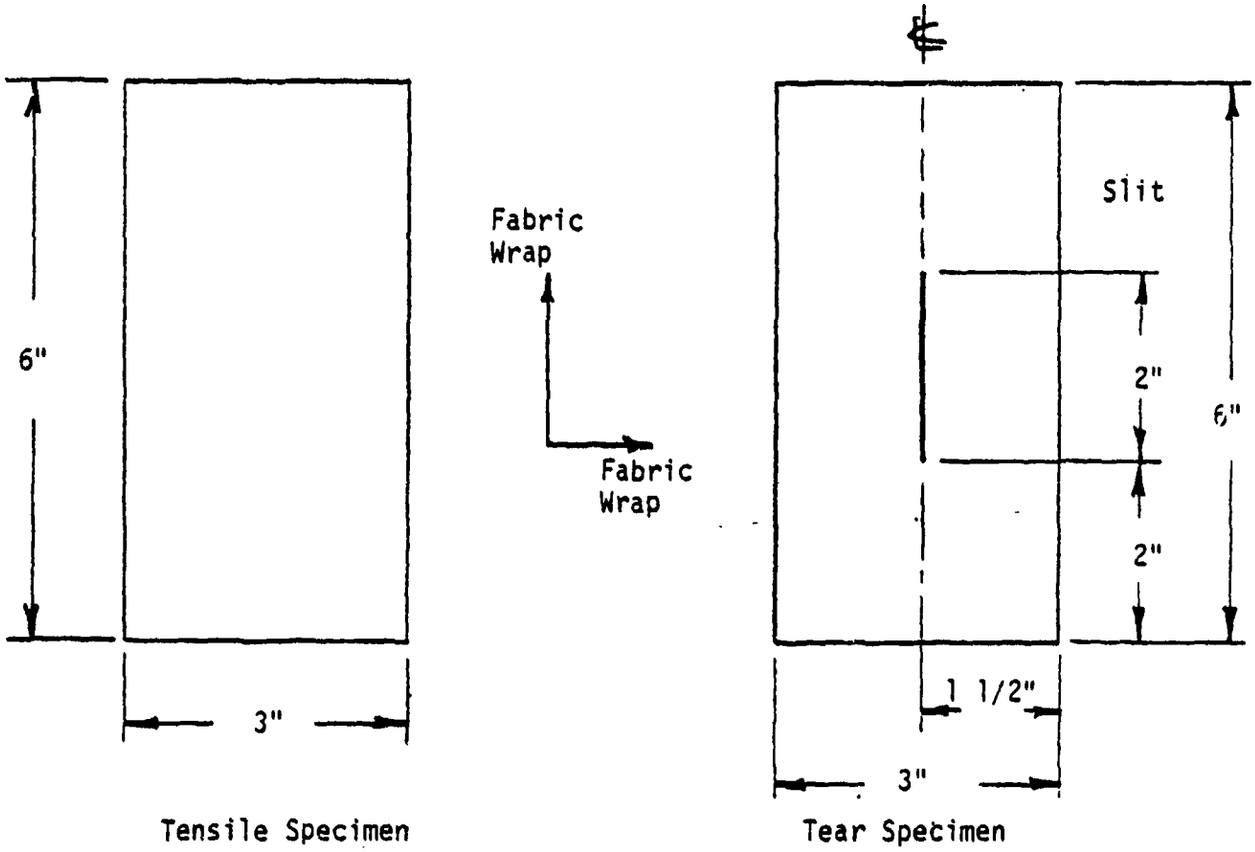
W_{20} = Weight after 20 hours - polycarbonate and butyl rubber

$Tens_b$ = Tensile strength - butyl rubber, unexposed blank

$Tens_{20}$ = Tensile strength after 20 hours - butyl rubber



Polycarbonate Test Specimen
(Lexan Sheet Grade 9034)



Tensile Specimen

Tear Specimen

Butyl Rubber (MIL-C-12189E) Test Specimens
(Heavy Weight 11.0 to 13.5 oz/sq yd)

FIGURE 6 - SWATCH TEST SPECIMENS

$Tear_b$ = Tear strength - butyl rubber, unexposed blank

$Tear_{20}$ = Tear strength after 20 hours - butyl rubber

Equations representing property changes were:

$$\text{Weight change (3 hrs)} = \frac{W_3 - W_i}{W_i} \times 100 = \% \text{ weight change}$$

$$\text{Weight change (20 hrs)} = \frac{W_{20} - W_i}{W_i} \times 100 = \% \text{ weight change}$$

$$\text{Tensile strength change (20 hrs)} = \frac{Tens_{20} - Tens_b}{Tens_b} \times 100 = \% \text{ Tensile Strength Change}$$

$$\text{Tear strength change (20 hrs)} = \frac{Tear_{20} - Tear_b}{Tear_b} \times 100 = \% \text{ Tear Strength Change}$$

3.2.4 Swatch Test Instrumentation

Instruments used for swatch test evaluations were:

1. Weight - Scale
   Mettler Model No. H31ARH
2. Strength Properties - Tensile and Tear
   Instron Model 1135 Universal Testing Instrument
   [Set at Separation Speed of 31.7 cm/min (12.5 in./min) 225 kg (500 lb) load cell]

3.3 Penetration Test

The design of the penetration cell is shown in Figure 7. A number of modifications of this basic design were used in order to cope with the various chemicals. Figure 8 shows a manifold arrangement of cells which permitted four similar tests to be conducted simultaneously. In general, test chemical was applied to one side of the butyl specimen and the subsequent penetrant removed from the underside by an air sweep or by washing.

3.3.1 Cell Design and Modifications

The basic cell was constructed of stainless steel and with the exception of the fittings all components were obtained from a single manufacturer. The design was adopted predominantly because it was simple, easy to operate and was sufficiently flexible to accommodate the wide assortment of different chemicals.

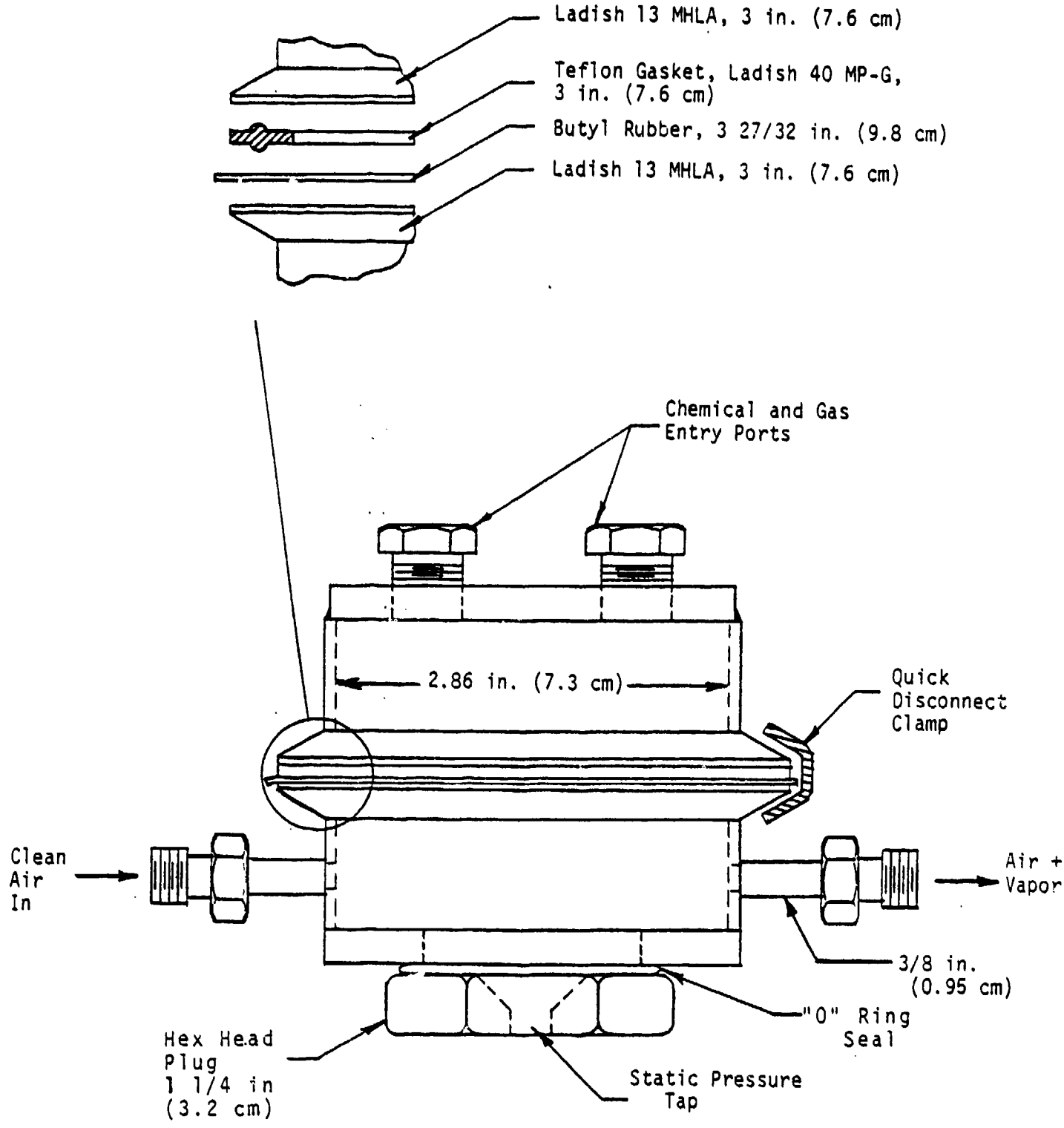


FIGURE 7 - PENETRATION CELL

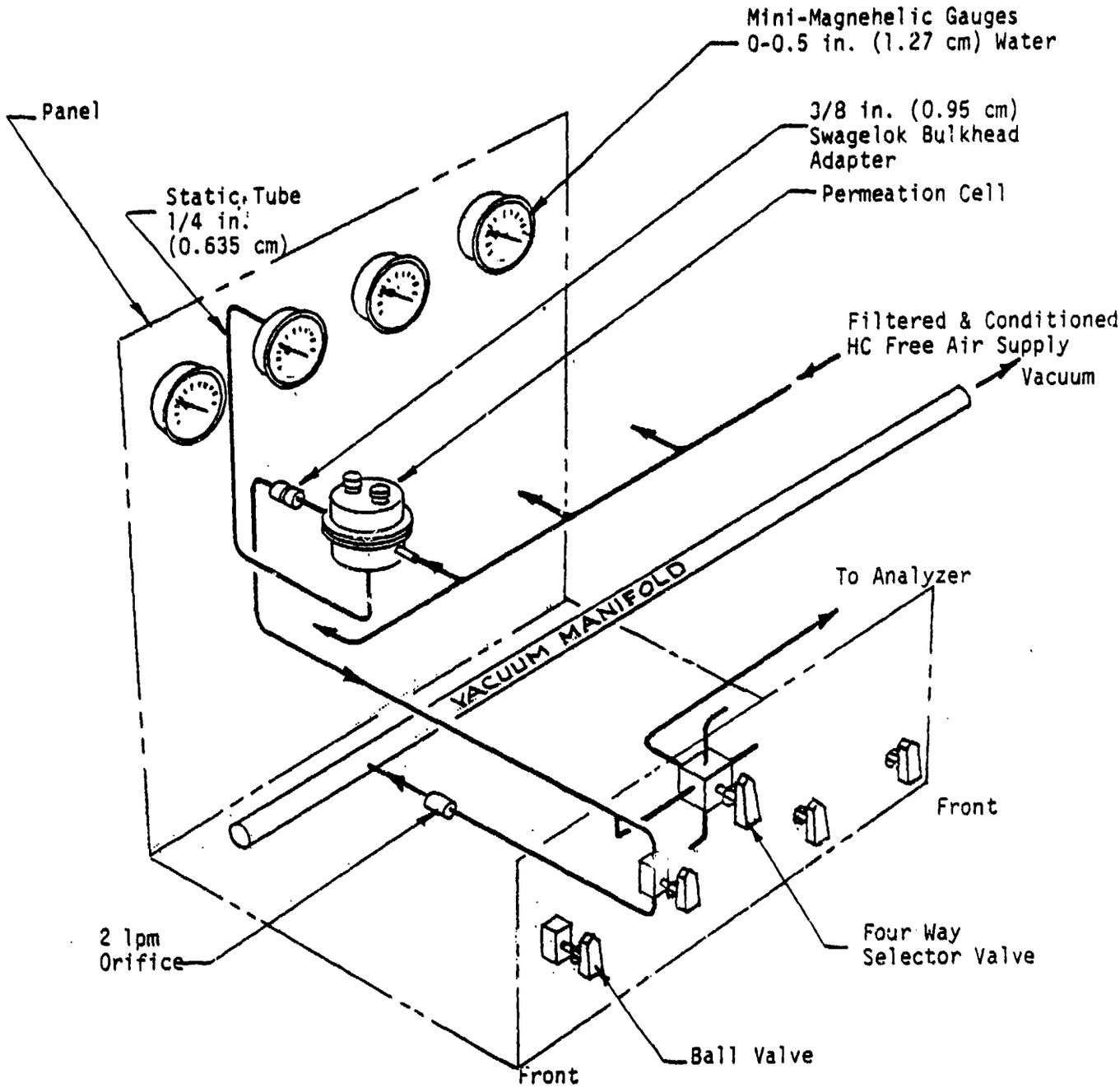


FIGURE 8 - PENETRATION TEST PANEL SCHEMATIC

As is shown in Figure 7, the cell consisted of two similar halves separated by a Teflon "O" ring.

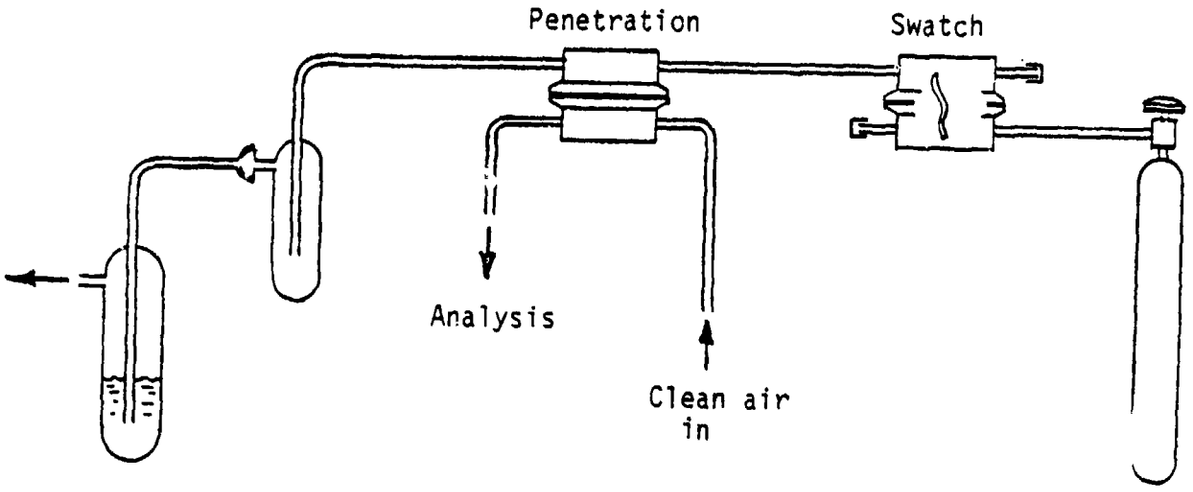
The slightly oversized butyl rubber test specimen was placed directly on the lower flanged cell unit with the "O" ring directly on top. The two halves of the cell were secured by a quick-disconnect clamp.

Leak tightness was assured by the action of the "O" ring which was compressed into corresponding slots cut into the flanges of each half end. The "O" ring when forced into the bottom slot stretched the butyl rubber slightly resulting in the production of a slight strain. When secured in place, the butyl rubber was pulled sufficiently tight to be wrinkle free. The strain on the butyl rubber was not measured but was consistent for all tests. The chemically exposed surface was 41.2 sq cm (6.42 sq in.).

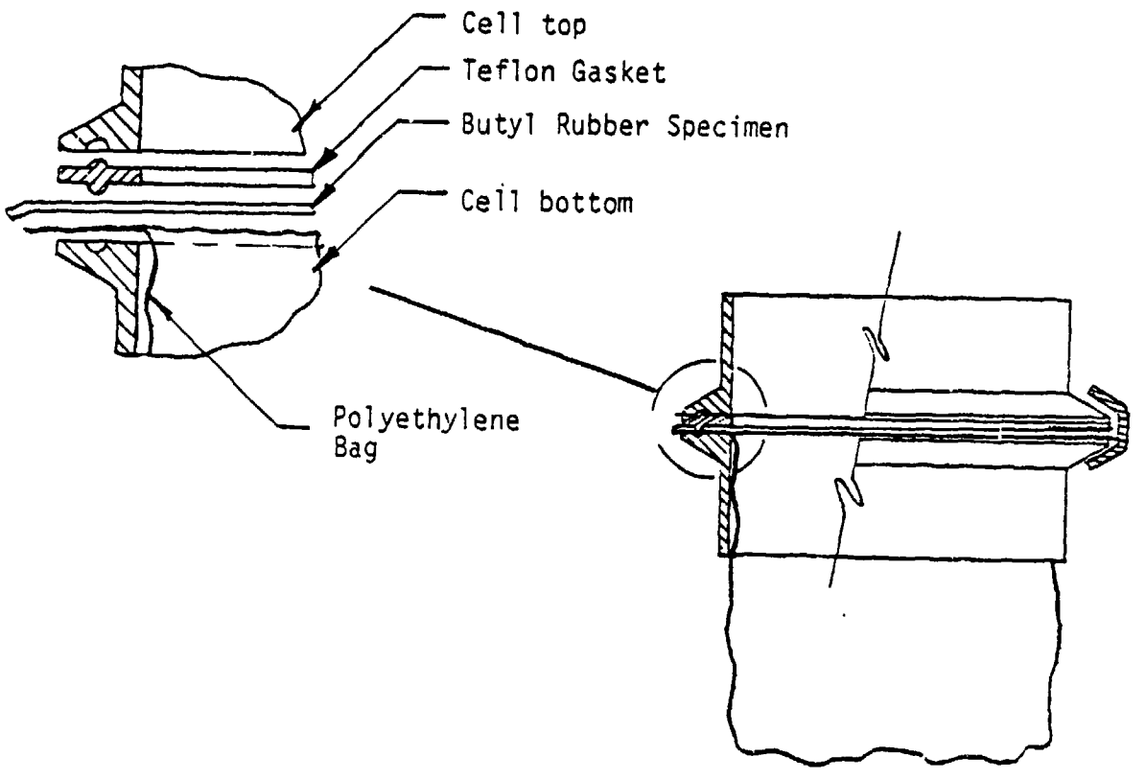
The cell used in studying the penetration from gases consisted of combining two of the lower half cell units shown in Figure 7. An overall gas test system is shown in Figure 9(a). The particular arrangement was employed in cases where only limited supply of the test gas was available. In this case, several tests were conducted at the same time in order to conserve challenge chemical. Tests with gases were conducted with a continuous flow of test gas passing above the butyl specimen. Flow of test gas was usually 1 to 5 cc/min.

Figure 9(b) shows the design of the cell used to study penetration of inorganic materials, specifically penetrant chemicals which might become contaminated by laboratory or other extraneous contaminants. As is noted in Figure 9(b), the bottom half of the cell is open and a flexible polyethylene container was sealed under the butyl specimen. With this design, the penetrant emerging from the underside of the butyl specimen was automatically sealed off from the walls of the cells and from other sources of contamination. Subsequent operations consisted of merely cutting the plastic bag and exposing the underside of the butyl specimen.

Recovery of penetrant was achieved either by continuously purging the underside of the test specimen with a flow of hydrocarbon free air or by vigorously rubbing and washing the penetrant free. Penetration by simple organic liquids was determined by sweeping the underside with a flow of 2 lpm of processed air cleaned by passage through a carbon bed followed in line by a bed of heated hopcalite. The resultant hydrocarbon content of the sweep air was maintained at <2.0 ppm.



a. Arrangement for Swatch and Penetration Test with Gases



b. Arrangement for Penetration Test in Contaminant Free Environment

FIGURE 9 - MODIFICATIONS OF PENETRATION CELL FOR GASES AND CONTAMINANT FREE SERVICE

Penetration by metal salts solution was determined by vigorously swabbing the underside of the butyl using 10 cc of water and processed glass wool or a flat Teflon rod.

3.3.2 Typical Test Operation

Butyl rubber test specimens consisted of circular discs measuring 9.76 cm (3.84 in.) diameter overall.

For simple organic liquids, the test specimen was installed in the cell as shown in Figure 7. The completed cell was then placed on the four unit module as shown in Figure 8. A vacuum pump aspirated a flow of 2 lpm of clean air through the lower portion of the cell. A reading of the Magnehelic gage insured that a significant negative pressure relative to the atmosphere was not developing. Normal vacuum developed as a result of aspirating the air flow was limited to <0.13 cm (<0.05 in.) water. At selected intervals, the clean air sweep passing through the chemically free cell was diverted to the analyzer. The cell was considered clean when the analyzer showed no difference in quality between the clean air at its source and the clean air which passed through the cell. At this point, the test was initiated by the addition of 10 cc of chemical to the upper portion of the cell. The cell was continuously purged by the 2 lpm flow until the test was terminated (20 hrs). As a minimum, analysis of the quantity of penetrant in the purge air was performed at the end of 3 hours and again at 20 hours.

Penetration by inorganic salt solutions was studied in the open-end cell unit shown in Figure 9(b). A quantity of 10 cc of a saturated water solution of the salt was applied to the top of the butyl specimen. No air purge was used and the test apparatus was stored at room temperature for 20 hours. After this period of time, the chemical was removed, the cell was inverted and the underside of the butyl was exposed and subsequently scrubbed/washed with 10 cc of distilled water. Collected washings were subsequently analyzed for selected metal ions in components.

Methods of detection are summarized in Section 3.8.

3.4 Single Decon Tests

When a butyl rubber specimen passed the 20-hour penetration test, the effectiveness to decontaminate the chemical from the butyl rubber was examined. The single decon test consisted of removing the butyl rubber from the penetration test apparatus, wiping and rinsing off excess chemical. It was then placed in a wire basket suspended from the lid of a household blender containing one liter of cold water with a 1% concentration of powder detergent. The blender was operated for one minute.

The specimen was removed and rinsed with cold water and excess water removed with an absorbent paper towel. The specimens were checked for decontamination of the organic or inorganic chemicals as discussed below.

3.4.1 Organic Chemicals

Effectiveness of the single decon test was examined by placing the butyl rubber in the penetration test cell. The chemically exposed side was mounted as the underside where it was swept with clean air flowing into the total hydrocarbon analyzer. Any increase in the total hydrocarbon concentration above the clean air reading indicated residual chemical contamination and ineffective decontamination. Ineffective decontamination then required that a new butyl rubber specimen be given a multiple decontamination test.

3.4.2 Inorganic Chemicals

Effectiveness of the single decon test was examined by placing the butyl rubber specimen on a petrie dish. A 10 cc syringe was filled with distilled water and discharged onto the chemically exposed side of the butyl specimen. A Teflon spatula was scraped over the butyl rubber and distilled water was used to extract any residual chemical remaining. The distilled water/solution was decanted from the petrie dish into a test tube and analysis made of the water in the manner described in 3.8 to determine if the single decon test was effective. Any detection of the test chemical required that a new butyl rubber specimen be given a multiple decontamination test.

3.4.3 Single Decon Instrumentation

Instrumentation and procedures used in the single decon test consisted of those discussed in the penetration test.

3.5 Multi-Decon Test

When the butyl rubber specimens exposed to the chemical for 20 hours failed after a single decon, a multi-decon test was conducted. As discussed previously, this test consisted of exposing a new butyl rubber specimen for three hours followed by a single cold water detergent wash. Examination for residual chemical was made and if chemical was present future R&D alternate decontamination studies were deemed necessary. If no detection was made after three hours, eight 2-hour exposures and decons were performed and after the eighth cycle examination made for presence of residual chemical. Similarly, as after the initial 3-hour exposure, detection of the chemical placed it in the category of future R&D alternate decontamination studies. If the chemical was not detected after the exposure cycles, butyl

rubber was given a pass performance rating. If any contaminant was detected after the initial 3-hour exposure or after the eight 2-hour exposures, the butyl rubber was assigned a fail performance rating (see Appendix C).

3.5.1 Butyl Rubber Test Specimen

Butyl rubber specimens (MIL-C-12189E) were cut identically to those used in the penetration test.

3.5.2 Test Procedure

Apparatus and analytical procedures were the same as for the penetration test. Chemical was placed on the butyl rubber for a three hour period. The butyl rubber was removed from the test cell and then given a single one minute decon wash and dried. It was then examined for any trace of the chemical. If the chemical was detected, it was assigned in future R&D alternate decontamination studies. If no chemical was detected, the butyl rubber was exposed to the chemical for eight 2-hour exposure cycles with a decon wash given between each cycle. After the eighth cycle, the butyl rubber was examined again for any trace of the chemical.

3.6 Concentration vs Time Tests

Butyl rubber failing between three and 20 hours was given the concentration versus time test. Butyl rubber specimens, apparatus and test procedures were the same as followed in the penetration tests with the exception that additional monitoring was done to determine breakthrough time period.

3.7 Seam Test

The purpose of this test was to investigate edge effects and soundness of the seam design used in the HCPCO suit construction.

3.7.1 Seam Test Specimen

Typical seams used in the HCPCO suit were obtained from ILC Dover, Fredrica, Delaware. The test specimen was circular and cut to the size used in the penetration test. It was cut so the seam was centerline in the penetration cell. Seam construction is a lap fold sewn with a 2.54 cm (1 inch) butyl strip glued (Bostic Co. 1177) to both the inner and outer surface of the butyl rubber sections it forms.

3.7.2 Seam Test Chemicals

Seam test chemicals were chosen primarily from those chemicals which had been tested in the penetration/single decon tests and found acceptable.

3.7.3 Test Procedure

The seam specimen was placed in the cells used for the penetration test. Because these seamed specimens were thicker than the single layer butyl rubber fabric used in the penetration test, additional takeup to achieve a seal required the use of a silicone rubber gasket rather than a Teflon gasket. Since the silicone rubber gasket is less chemically inert than the Teflon, it was placed under the butyl rubber seamed specimen to prevent it from contacting the chemical. Otherwise, apparatus and procedure remained the same as followed in the penetration test; the specimen being examined after three hours and 20 hour time period.

3.8 Summary of Analytical Methods

Table 13 summarizes the analytical methods used in this program. For practical reasons, the number of different procedures were held to a minimum.

The lower limits of detection listed in Table 13 are a reasonable estimate of the minimum quantity of chemical that could be detected under the test conditions. Invariably, trace background contamination was present in which case the quantity of chemical which could be detected above the background level was approximately twice the suggested or ideal lower limit.

3.8.1 Detection of Organic Vapors

Analysis of organic vapors in the effluent purge gas was performed exclusively by a MSA Hydrocarbon Analyzer. This instrument offers an extended range with the bulk of the work performed on the 0-12 ppm full scale range. The instrument was calibrated with 5.0 ppm methane gas mixture supplied by Matheson, East Rutherford, NJ.

3.8.2 Detection of Metal Salts

A Model 303 Perkin Elmer Atomic Absorption Spectrophotometer was used to analyze metal ions dissolved in the specimen wash liquid.

Penetration and decon effectiveness were determined by using a control or blank and also included the generation of a recovery factor. In short, washing an uncontaminated test specimen was performed in order to determine background contamination that could be present. To a second specimen, a known quantity of a corresponding metal salt in solution was added and allowed to dry for 20 hours. Usually, the added spike totalled 50 µg of the metal ion. The specimen with the added contamination was subsequently washed and the washings processed along with the washings of test material. The amount recovered was usually about 30 to 50%

TABLE 13 - SUMMARY OF ANALYTICAL METHODS

Basic Method Employed	Chemical Detected	Lower Limits of Detection (ppm)*
Hydrocarbon Analyzer	Organic Vapor	0.05
Atomic Adsorption	Metal ions	
	Cd^{++}	0.04
	Cr(III)	0.15
	Cr(VI)	0.15
	Na^{+}	0.015
	K^{+}	0.05
	Pb^{++}	0.07
	Hg(II)	11.0
	Hg(II)	11.0
	Zn^{++}	0.025
	Li^{+}	0.04
	Ni^{++}	0.15
Specific Ion Electrode	Selected non-metal ions	
	NH_4^{+}	0.2
	F^{-}	0.2
Detector Tubes	Selected Gases/Vapors	
	SO_2	<2.5
	H_2S	<1-2
	Cl_2	<0.5

*Present in the 2 lpm air sweep or in 10 cc of wash liquid.

of the initial added quantity. In all cases, the wash procedure was found effective for metal ion recovery when used at the 50 µg level of contamination.

3.8.3 Detection of Nonmetal Ion

Ammonium and fluoride in wash liquid were determined using specific ion electrodes obtained from Fisher Scientific. Recovery factors and trace contamination levels (blanks) were established as described above.

3.8.4 Use of Detector Tubes

The detector tubes were obtained from MSA. These tubes are certified to offer a minimum of 35% accurcy at the concentrations listed in Table 13. When the tubes are used for qualitative purposes the lower limits of detection can be reduced by at least a factor of three. In the laboratory, the detector tubes were used for both quantitative and qualitative purposes.

4.0 DISCUSSION OF RESULTS

Absence of complete toxiological data was the primary obstacle in establishing Levels of Protection categories for all of the 985 chemicals. A sealed suit requirement was designated for 403 chemicals. There were 327 chemicals in this list of 403 chemicals which were based upon Sax's Toxic Rating Guide and 76 chemicals which were based upon other standards or best judgment. In the total of 985 chemicals reviewed there were 45 chemicals in which no level of protection assignment was made. The breakdown of the Level of Protection results were as follows:

Requirement (Level of Protection)	No. Chemicals
Sealed Suit	403
Nonsealed Suit	436
Fire Suit	15
Goggles, gloves, hard-hat and footwear	86
Unassigned	45
Total	985

Assignment of level of protection was given for 940 of the 985 chemicals and 45 chemicals remain for further definition pending additional toxiological information. Assignment of 403 chemicals to the category of sealed suit became the basis of material compatibility testing investigation.

Survey of commercially available protection clothing revealed that a variety of sealed, nonsealed and other protective apparel are available. Being less sophisticated and not subject to special military type specifications, the commercial type protective clothing is much less expensive than the HCPCO sealed suit. Commercially available protective clothing material is primarily elastomeric polyvinyl chloride, polyvinyl alcohol, butyl rubber, neoprene rubber, urethane,polyethylene, etc., some of which are sandwiched over nylon or cotton inner fabrics. Even considering this variety of materials relative to the listing of CHRIS chemicals, lack of chemical resistance data obscured a complete alternate material substitution listing. This also applied to head protection materials such as clear polyvinyl chloride, polycarbonate, cellulose acetate and acrylic most commonly employed. Because of its chemical inertness, Teflon promises the most universal chemical resistance; however, state-of-the-art fabrication has negated its applicability because of its inherent inertness properties. A somewhat clear Teflon material is available and can be considered for a visor although

it does not possess as good visual properties as clear polycarbonate. Teflon yarn is available for sewing seams. Bonding patches over the seams would be required to cover holes left from sewing.

Because of insufficient chemical compatibility data on butyl rubber and polycarbonate used in the HCPCO suit, a testing program was required. In addition, testing was required to further explore penetration and decontamination properties since little or no such data was available for the majority of the chemicals. Consequently, a test program plan had to be devised to establish an overall performance rating since chemical resistance data was insufficient for butyl rubber but judged adequate for polycarbonate. A test program plan was developed in this effort. This plan represents a model of the experimental process one can employ in evaluating the material protective properties against a spilled chemical contaminant. The output of the experimental model served as a guide to ascertain suitability of butyl rubber for use as a sealed suit.

The plan included provisions for dealing with certain chemicals which, because of practical or technical reasons, could not be processed in a straightforward manner. Along these lines certain classes of chemicals were excluded from the experimental portion of the test plan. These classes were: water reactive, solid insolubles and chemical formulations containing one or more components known to be material incompatible.

The threat of chemicals which are both solid and insoluble in water is mainly particulate and a well-made suit would normally offer adequate protection. The performance rating assigned in this case was the generally accepted literature designation. Chemicals which were formulated as mixtures containing a solvent or vehicle known to adversely affect the test materials were failed. This was a frequent occurrence with agricultural type formulations, e.g., chlordane in hexane and the specific ingredient or solvent was suitably identified.

Realistically, a spill of a water reactive compound can be encountered in the field as a mixture ranging in composition from 100% pure compound to 100% reaction products. A closer examination of the chemicals for sealed suit use showed the predominant reaction product to be a strong mineral acid, notably HCl. Selected studies showed HCl solution at concentrations of even 10% caused serious damage to the structural strength of the butyl. In one case, no penetration was observed from the parent or unreacted compound. The addition of water caused a dramatic increase in temperature ($\Delta T = 25°C$) and resulted in immediate chemical penetration. As a consequence, all water reactive chemicals yielding strong mineral acids were categorically failed. Water reactive materials yielding less reactive products were assigned the literature designation with this rating limited to the parent or unreacted chemical.

Basically, five different types of experimental tests were conducted in the test plan sequence. The tests and test functions were:

Test Type	Test Function
Swatch	Establish basic compatibility data for chemical where no data was available (applicable to both butyl rubber and polycarbonate).
Penetration	Evaluate butyl rubber as an impermeable protective barrier.
Single Decon	Isolated chemicals in which no decontamination problems exist after 20 hours chemical contact.
Multi-Decon	A less demanding test revealing decontamination effectiveness for a shorter or single mission 2-3 hour exposure period to the chemical.
Concentration vs Time	Establish use limits of butyl rubber relative to service time.

To provide supplementary data, seam testing was conducted to show soundness of the HCPCO suit seams and any limitation of decontaminating presented by edge/adhesive effects.

Appendix C lists a test performance rating of polycarbonate and butyl rubber for 403 chemicals requiring a sealed suit. A summary of test performance rating results were as follows:

Polycarbonate

Pass (20 hr contact)	211
Pass (>3 hr <20 hr)	1
[Pass] (Parent compound, water reactive)	29
Fail (<3 hr contact)	90
[Fail] (Parent compound, water reactive)	29
No data	43
Total	403

Butyl Rubber

Pass (totally acceptable)	142
Pass (>3 hr <20 hr)	5
[Pass] (Parent compound, water reactive)	6
Fail (unacceptable)	183
[Fail] (Parent compound, water reactive)	4
No data	63
Total	403

Both polycarbonate and butyl rubber offered excellent protection against all metal ions and neutral salts. This fact tends to exaggerate the applicability of these two plastics. Table 14 lists the overall performance of these materials against specific classes of chemicals as categorized by CHRIS. The findings suggest that both polycarbonate and butyl rubber are somewhat weak against the more abundantly produced organic chemicals. On the basis of test results wherein chemical compatibility for both butyl rubber and polycarbonate exists, 130 chemicals can be handled with the HCPCO suit. Acceptability for use mandates that both materials be compatible with the chemical of interest.

It is logical, especially in view of the high failure rate, to examine the viability of the test methods. The impact of specific experimental tests on the number of fail ratings is shown below:

Type of Test	Test Condition	% Failed*	% of All Failures
Penetration	3 hr contact	35*	78.5
Penetration	20 hr contact	9.4	--
Single Decon	20 hr contact	33	--
Multi Decon	3 hr contact	52	17.5
Multi Decon	8 2-hr contact	25	4

*Based on total number entering test

The bulk of the failures were recorded during the first three hours of the penetration tests, and this suggests an inherent weakness in the butyl. Conducting the test for 20 hours did not result in a significant increase in failure rate. It is interesting to note that one out of three chemicals could not be removed from butyl rubber by a simple water/soap wash when the contact time was 20 hours. Approximately half these chemicals could not be removed when the contact time was reduced to 3 hours. Overall, the various decontamination tests were responsible for only 16 failures or a total of 21.5% of all failure ratings.

TABLE 14 - CHEMICAL RESISTANCE BY CLASS

	Chemical Groupings	Performance Rating Polycarbonate	Butyl
1.	Nonoxidizing Mineral Acids	Pass	Fail
2.	Sulfuric Acids Spent 98% or less	Fail	Fail
3.	Nitric Acid	Fail	Fail
4.	Organic Acid	Pass	Pass
5.	Caustics	Fail	Pass
6.	Ammonia	Pass	Pass
7.	Aliphatic Amines	Fail	Fail/Pass
8.	Aromatic Amines	Fail	Fail
9.	Organic Anhydrides	Pass	Pass
10.	Isocyanates	Pass	Pass
11.	Vinyl Acetate	Pass	Fail
12.	Acrylates	Fail/Pass	Fail
13.	Substituted Alkyls	Pass/Fail	Fail
14.	Alkylene Oxide	Pass	Fail
15.	Epichlorohydrin	Pass	Fail
16.	Ketones	Pass	Fail
17.	Aldehydes	Fail/Pass	Fail
18.	Alcohols, Glycols	Pass	Pass
19.	Phenols and Cresols	Pass/Fail	Fail/Pass
20.	Caprolactum Solution	Pass	Pass
21.	Aromatic Hydrocarbons	Fail	Fail
22.	Vinyl Halides	Pass/Fail	Fail
23.	Halogenated Hydrocarbons	Fail/Pass	Fail/Pass
24.	Nitriles	Pass	Fail
25.	Carbon Disulfide	Fail	Fail
26.	Ethers	Fail	Fail
27.	Nitrocompounds	Fail/Pass	Fail

Certainly, the adoption of "detectable quantity" for the above tests impacted directly on the relative number of pass or fail ratings. Undoubtedly detection levels for the tests could be lowered by the use of more sophisticated and involved methods of enrichment and detection which presumably would have resulted in a higher failure rate. This can be countered somewhat by the fact that the final disposition of the chemical either as a penetrant or as a residual following decon is uncertain. Realistically, the Strike Team does not experience a chronic exposure to the same chemical as would be the case for an industrial worker. Overall, the method and procedure used in the experimental program reflects a certain middle-of-the-road approach.

This study provided an improved and protective base for recommending levels of protection and protective equipment needed by Strike Team personnel. Because of the large number of chemicals, the different types of chemicals and the lack of toxicological data, recommendations could not be formulated for all 985 chemicals on the CHRIS list. Additional R&D is required, and specific recommendations are presented in Section 5.0.

5.0 RECOMMENDATIONS

5.1 General Comments

Butyl rubber and polycarbonate materials are used in the HCPCO sealed suit. A preliminary literature survey on chemical compatibility of these materials indicated a higher degree of compatibility than actually found in the testing programs. This was because the testing program was more extensive in scope and was used to evaluate not only compatibility but also penetration and decontamination. For example, butyl rubber was found to be about 38% compatible from the experimental testing whereas the indicated chemical compatibility from preliminary literature survey indicated much higher chemical compatibility.

Combining compatibility test result data for both butyl rubber and polycarbonate materials jointly further reduces the compatibility of the HCPCO suit ensemble. Mutual combination of compatibility data for these materials indicates the suit to be satisfactory for only 130 (32%) of the 403 chemicals requiring use of a sealed suit.

Alternate candidate materials would be expected to have a lower acceptability rate than what might be expected from literature and manufacturers data, also. However, alternate material investigation is viewed as necessary because of the limitations of butyl rubber and polycarbonate used in the HCPCO suit.

5.2 Future R&D Effort (Task VI)

Future R&D efforts are recommended as follows:

1. Alternative material investigation for butyl rubber and polycarbonate used in the HCPCO suit.

2. Additional testing of those chemicals which were not evaluated because of water reactivity, insolubility, unavailability coupled with the absence of pertinent literature data.

3. Determination of levels of protection for those chemicals with insufficient toxicological data. Sealed suit level of protection assignment will require additional butyl rubber and polycarbonate testing.

4. Assessment of alternate decon agents and methods.

5.2.1 Alternative Material Investigation

Appendix A lists some alternative materials for cases where butyl rubber and polycarbonate were not compatible or when data did not exist. This data served only as a guideline to establish compatible or incompatible status; the more rigorous testing conducted in Task V (Material Compatibility Testing) showed that an unacceptable status could develop even when compatibility was indicated. Table 15 was prepared to list those chemicals and alternative materials that can be considered for future R&D investigation. Available literature was used to select alternative materials. Thus, it is a preliminary guideline for materials which must be further verified by testing. Table 15 also shows the need for alternative materials because of the weakness of butyl rubber and polycarbonate when their performance is compared with the variety of chemical groups involved. There are cases in which the chemical or chemical group in which a material choice could not be determined. In some cases where chemical compatibility data indicates good or excellent resistance, disappointing results were obtained in the more rigorous tests conducted in this program.

5.2.2 Additional Testing of Butyl Rubber and Polycarbonate

There were instances where no compatibility data was generated relative to the testing program plan. This was because of insoluble solids, lack of availability and insufficient information to relate it with a similar chemical reactivity group (see Table 16).

On a practical basis, solid chemicals would be encountered as dusts or general particulate matter. The insoluble nature of these chemicals suggests a certain chemical inertness although this argument is not sufficiently convincing to suggest that no attack (solid-solid reaction) with the protective ensemble can occur.

Some decisions on compatibility were based on the by-product materials, primarily acids formed by the reaction of the parent product with water. In some cases, the data indicated that butyl rubber and/or polycarbonate were compatible with the parent compound but not with the reaction products. Additional testing of water reactive compounds and reaction products is recommended.

5.2.3 Levels of Protection

Table 7 lists 44 chemicals for which assignment of levels or protection data were not available. It is possible that additional toxicological information may be forthcoming from chemical manufacturers and other sources. In general, however, toxicological studies are long term activities requiring many years of study before

TABLE 15 - POTENTIAL ALTERNATIVE MATERIALS FOR INVESTIGATION AS PER CHRIS CHEMICAL REACTIVITY GROUPING

Chemical Groupings	Available Data		Alternative Material Guide						
			Hood Material			Suit Material			
	Polycarbonate	Butyl	Acetate	Vinyl	Others	Vinyl	Polyethylene	Neoprene	Others
1. Non-Oxidizing Mineral Acids									
Hydrochloric, Hydrofluoric Acid	Pass	Fail	NA	NA	--	X	--	--	Chlorinated Polyethylene
2. Sulfuric Acids									
Spent & 98% or less	Fail	Fail	--	X	--	X	--	X	--
3. Nitric Acid	Fail	Fail	--	X	--	X	--	--	--
4. Organic Acid									
Acetic	Pass	Pass	NA	NA	NA	NA	NA	NA	NA
Acrylic Acid	Pass	3 hr	NA	NA	NA	--	--	--	Chlorinated Polyethylene
Oxalic Acid	Pass	(Pass)	NA	NA	NA	X	X	--	Chlorinated Polyethylene
5. Caustics									
Potassium & Sodium Hydroxic	Fail	Pass	--	X	--	NA	NA	NA	--
6. Ammonia	(Pass)	Pass	NA	NA	NA	NA	NA	NA	NA
7. Aliphatic Amines									
Butyl Amine	Fail	Fail				--	--	--	Chlorinated Polyethylene
Cyclohexylamine	Fail	Fail							--
Dibutylamine	Fail	Fail				--	--	--	Chlorinated Polyethylene
Di-n-propylamine	Fail	Fail							
Ethyl Amine	Fail								
Propylamine	Fail	Fail							
Tetraethylenepentamine	Fail	Pass							
Triethylamine	Fail	Fail							
Triethylenetetramine	Fail	Pass							
8. Aromatic Amines									
Aniline	Fail	Fail	--	--	Polyethylene Polypropylene	--	X	--	
9. Organic Anhydrides									
Acetic Anhydride	Pass	Pass	NA	NA	NA	NA	NA	NA	NA
10. Isocyanates									
Diphenyl Methane Diisocyanate	Pass	Pass	NA	NA	NA	NA	NA	NA	NA
11. Vinyl Acetate									
Vinyl Acetate, Inhibited	(Pass)	(Fail)	NA	NA	NA	--	--	--	Chlorinated Polyethylene
12. Acrylates									
Ethyl Acrylate (Inhibited)	(Fail)	Fail							Chlorinated Polyethylene
2-Ethylhexyl Acrylate (Inhibited)	(Fail)	Fail							
Ethyl Methacrylate (Inhibited)	(Fail)	Pass	NA	NA	NA	NA	NA	NA	NA
Methy Acrylate (Inhibited)	(Pass)	Fail	NA	NA	NA				
Methyl Methacrylate (Inhibited)	(Fail)	Fail							
13. Substituted Allyls									
Acrylonitrile (Inhibited)	(Pass	Fail	NA	NA	NA	--	--	--	Chlorinated Polyethylene
Allyl Alcohol	(Pa	Fail	NA	NA	NA	--	--	--	Chlorinated Polyethylene
Allyl Chloride	(Fail	Fail							
14. Alkylene Oxide									
Butylene Oxide	(Pass)	Fail	NA	NA	NA				
15. Epichlorohydrin									
Epichlorohydrin	(Pass)	Fail	NA	NA	NA	--	X	X	--
16. Ketones									
Mesityl Oxide	(Pass)	Fail	NA	NA	NA	--	--	--	Ethylene Propylene Chlorinated Polyethylene
17. Aldehydes									
Acetaldehyde	(Fail)	Fail	--	--	Ethyl Cellulose	--	--	X	Silicone
Acrolein	(Pass)	Fail	NA	NA	NA	--	--	X	--
Butraldehyde	Fail	Fail							
Decaldehyde	Fail	Fail							
Ethylhexaldehyde	Fail	Fail				X	X	--	--
Formaldehyde	Pass	Fail	NA	NA	NA	X	--	--	Nylon, Viton
Glutraldehyde Solution	Pass	Fail	NA	NA	NA				
18. Alcohols, Glycols									
Cyclohexanol	Pass	Pass	NA	NA	NA	NA	NA	NA	NA
19. Phenols & Cresols									
Carbolic Oil	(Pass)	Fail	NA	NA	NA	NA	NA	NA	NA
Creosote, Coal Tar	Pass	Fail(D)	NA	NA	NA				
Nonyl Phenol	Pass	Pass	NA	NA	NA	NA	NA	NA	NA
Phenol	(Fail)	Fail				--	--	--	Chlorinated Polyethylene
20. Caprolactum Solution									
Caprolactum Solution	(Pass)	(Pass)	NA	NA	NA	NA	NA	NA	NA
21. Aromatic Hydrocarbons									
Benzene	Fail	Fail			Acetal Polyvinyl Acetate	--	--	--	Viton
Cumene									
22. Vinyl Halides									
Vinyl Chloride	(Pass)	(Fail)	NA	NA	NA				
Vinylidene Chloride (Inhibited)	Fail	Fail							
23. Halogenated Hydrocarbons									
Chloroform	Fail	Fail							Nylon
Dichlorobenzene		Fail							Viton
1-1, Dichloroethane									
Dichloroethyl Ether	Fail	Fail							
Ethyl Chloride		(Pass)				--	--	--	--
Ethylene Dibromide	(Pass)	Fail	NA	NA	NA				
Ethylene Dichloride	(Fail)	Fail							
Methyl Bromide	Fail	(Fail)							
1,1,2,2-Tetrachloroethane	(Fail)	Fail							
24. Nitriles									
Acetonitrile	(Pass)	5> 20 hr	NA	NA	NA				
Adiponitrile	(Pass)	Fail	NA	NA	NA				
25. Carbon Disulfide									
Carbon Disulfide	Fail	Fail	--	--	Chlorinated Polyether				Nylon Viton
26. Ethers									
Tetrahydrofuran	(Fail)	Fail							
27. Nitrocompounds									
(mono-) Nitrobenzene	(Fail)	Fail							
1 or 2-Nitropropane	(Pass)	Fail	NA	NA	NA	--	--	--	Polyvinyl Alcohol
Nitrotoluene	Fail	Fail							

NA - not applicable

TABLE 16 - SEALED SUIT CHEMICALS FOR FUTURE R&D EVALUATION

CHRIS Code	Chemical Name	Untested Status	Performance Data Sought	
			Polycarbonate	Butyl Rubber
BDE	Bisphenol A Diglycidyl Ether	Unavailable	X	X
CAS	Calcium Arsenite	Insoluble	X	X
OBT	O-Chloronitrobenzene	Insoluble	X	X
CMC	Chromyl Chloride	Water React.	X	-
COU	Coumaphos	Insoluble	X	X
DZP	Di-(p-Chlorobenzoyl) Peroxide	Unavailable	X	X
DPT	Dibutyl Phenol	Insoluble	X	X
DIU	Diuron	Insoluble	-	X
DNZ	Dinitrobenzene	Insoluble	X	X
ESF	Endosulfane	Insoluble	X	X
ETI	Ethylene Imine	Water React.	-	X
FFX	Ferric Fluoride	Water React.	X	X
FSA	Fluosulfonic Acid	Water React.	X	-
KPE	Kepone	Insoluble	X	X
LSA	Lead Stearate	Insoluble	X	X
MLH	Maleic Hydrazide	Insoluble	X	X
MRT	Mercuric Thiocyanate	Insoluble	X	X
MPK	Methylisopropenyl Ketone	Unavailable	X	X
MCT	Methylcyclopentadienyl Manganese Tricarbonyl	Unavailable	X	X
MRX	Mirex	Insoluble	X	X
NLD	Naled	Insoluble	X	X
NKD	Nickel Hydroxide	Insoluble	X	X
NTL	Nitralin	Insoluble	X	X
NAA	Nitrotriacetic Acid, Salts	Insoluble	X	X
NAL	4-Nitroaniline	Insoluble	X	X
OXA	Oxalic Acid	Analytical	-	X
PPP	Phosphorous Pentasulfide	Water React.	-	X
PCB	Polychlorinated Biphenyl	Unavailable	-	X
PBO	Potassium Binoxalate	Unavailable	-	X
SML	Sodium Methylate	Water React.	-	X
SCM	Strontium Chromate	Insoluble	X	X
STR	Strychnine	Insoluble	X	X
TED	Tetramethyldithiopyrophosphate	Insoluble	X	X
TEP	Tetraethylpyrophosphate	Slow Water React.	-	X
TTT	Titanium Tetrachloride	Water React.	X	-
TCA	2,4,5-Trichlorophenoxyacetic Acid	Insoluble	X	X
TPO	Tris(Azidinyl)Phosphine Oxide	Unavailable	X	X
TDT	Toluene 2,4-Diisocyanate	Slow Water React.	-	X
URP	Uranium Peroxide	Insoluble	X	X
UAN	Uranium Nitrate	Analytical	X	X
URS	Uranium Sulfate	Analytical	X	X
VSF	Vanadyl Sulfate	Analytical	-	X
VCM	Vinyl Chloride	Unavailable	-	X
ZEC	Zectran	Insoluble	X	X
ZCN	Zinc Cyanide	Insoluble	X	X
ZCT	Zirconium Tetrachloride	Water React.	X	-

recommended exposure levels are established. Therefore, until the data becomes available, fully encapsulating suits should be used for spills of these 44 chemicals. This dictates the need for additional materials compatibility studies for these chemicals.

5.2.4 Alternative Decon Agents

The decon method employed in this work was a cold water, detergent solution wash. Chemicals ineffectively decontaminated are listed in Table 11. Alternate decon materials and methods suggested for future R&D investigation are:

1. Use of hot water and strong detergent solution wash cycle.

2. Investigate longer and multiple wash cycle times.

3. Use of decon agents other than the detergent:
   (a) Acid type chemicals; use 5% basic solution wash cycle.
   (b) Basic type chemical; use 5% weak acid wash cycle.

4. Specialized techniques such as steaming, vacuuming, autoclaving, extended airing, etc.

An acceptable decon agent is one which does not in itself present a toxic hazard or else additional deconning would be necessary. An acceptable decon agent and method must be inexpensive and implemented without logistic problems. An examination of the general class of chemicals found to require additional decon studies shows they are closely related to chemical classes which were ultimately found to cause a breakthrough such as aldehydes, amines, aromatic types, etc. This can be interpreted that these chemicals have penetrated somewhat into the matrix of the butyl. Depth of penetration apparently is not severe; however, experience suggests that these chemicals would eventually defy rather mild methods of deconning.

Depending upon the chemical and its penetration into the matrix of the fabric, there is the possibility that deconning may be obtained after an extended time in the open air.

No edge effects resulted with the circular butyl specimens decontaminated because the periphery of the specimen was outside the chemically exposed surface. In conducting seam tests, edge effects were present and this presents another matter. Some chemicals which were effectively decontaminated from the butyl

rubber with no edge effects but which were found to fail with butyl rubber specimens having seamed edge/adhesive present are:

1. ACY - Acetone Cyanohydrin
2. CHN - Cyclohexanol
3. NTT - p-Nitrotoluene
4. CBN - 4-Chlorobutrylnitrile

Although these seamed specimens passed the penetration test, edge effects can present other decon considerations to reckon with. This suggests that perhaps future testing be more expediently conducted including seam portions of the fabric.

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APPENDIX A

LEVELS OF PROTECTION

(References listed by number in the tables are included in the Bibliography)

Legend:

C	- CHRIS Code
CN	- Chemical Name
S	- State
WR	- Water Reactive
F	- Flammable
VP	- Vapor Pressure (mm Hg @ 37.8°C)
TWA	- Time Weighted Average
STEL	- Short Term Exposure Limit
IN	- Inhalation
SA	- Skin Absorption
IR	- Irritant
PF	- Particulate Filter
CC	- Chemical Canister
AS	- Air Supply
SS	- Sealed Suit
NS	- Nonsealed Suit
B	- Butyl
P	- Polycarbonate
DNA	- Data Not Available
( )	- TLV or Hazard Rating Shown in Parentheses Based on Decomposition Products

INTRODUCTION

Strike Team personnel could be exposed to hazardous chemicals in liquid, solid and/or vapor states during cleanup of spills. Protective clothing and respiratory protection could be required, and the degree of protection will depend upon the chemical involved and the nature of that chemical. Since Strike Team members could be in direct contact with hazardous liquids, solids and/or vapors during initial entry into a spill area, a conservative or "safe side" approach was used in recommending levels of protection. As cleanup progresses and the degree of hazard is better characterized, the On-Site Coordinator may decide that a lesser level of protection is acceptable.

Attempts were made to assign levels of protection for each of the 985 chemicals listed in CHRIS. A toxic hazard rating developed by Sax (Sax, 1975) was used to estimate the acute exposure effects due to inhalation, skin absorption or irritation (Table A-1). These estimates were used in recommending the type of respiratory protection and clothing required for the various chemicals (Table A-2). The compatibility of butyl rubber and polycarbonate, the materials used in the Hazardous Chemical Protective Clothing Outfit (HCPCO), with the chemicals were determined from a literature search.

This Appendix contains information which will be useful for decision making by the On-Site Coordinator. A few examples are given to assist the user in interpreting the information in the Appendix.

Acetone is a liquid (S) at normal temperatures and is not water reactive (WR). It is flammable (F) and has a moderate vapor pressure (VP) of 37 mm Hg. The permissible 8 hr exposure level (TWA) is 1000 ppm, and the short term exposure level (STEL) is 1250 ppm. It poses a moderate inhalation (IN) and skin absorption (SA) hazard but is not particularly irritating (IR). A chemical cartridge respirator (CC) or an air supply (AS) is recommended, but a sealed suit is not required (NS). Butyl rubber (B) is compatible with acetone, but polycarbonate (P) may have a limited lifetime before clouding occurs.

Anhydrous ammonia is a gas (S) at normal temperatures and is water reactive (WR). It is flammable (F) and exhibits an extremely high vapor pressure (VP). The permissible 8 hr exposure level (TWA) is 25 ppm and the short term exposure

TABLE A-1 - TOXIC HAZARD RATINGS ACCORDING TO SAX

Rating	Effect	Comments
0	None	(a) No harm under any conditions; (b) Harmful only under unusual conditions or overwhelming dosage.
1	Slight	Causes readily reversible changes which disappear after end of exposure.
2	Moderate	May involve both irreversible and reversible changes not severe enough to cause death or permanent injury.
3	High	May cause death or permanent injury after very short exposure to small quantities.
U	Unknown	No information on humans considered valid by authors.

TABLE A-2 - GUIDELINES FOR SELECTION OF PERSONAL PROTECTION EQUIPMENT

Toxicity Rating	Mode of Entry	Response: Gas & Liquids		Response: Solids	
		Respiratory	Clothing	Respiratory	Clothing
0	Inhalation	None required	None required	None required	None required
	Skin Absorption	"	"	"	"
	Irritation	"	"	"	"
1	Inhalation	Chemical filter[2]	----	Particulate	----
	Skin Absorption	----	Nonsealed	----	Nonsealed
	Irritation	----	Nonsealed	----	Nonsealed
2	Inhalation	Chemical filter or air supply[2]	----	Particulate & chemical filter	----
	Skin Absorption	----	Nonsealed	----	Nonsealed
	Irritation	----	Nonsealed	----	Nonsealed
3	Inhalation	Air supply[3]	----	Air supply[3]	----
	Skin Absorption	----	FES[1]	----	FES[1]
	Irritation	----	FES[1]	----	FES[1]

[1]Fully encapsulating sealed suit indicates need for air supply

[2]Contaminants in gaseous form at STP indicates need for air supply

[3]Carcinogens indicate need for air supply

limit (STEL) is 35 ppm. It is a severe inhalation hazard (IN) and irritant (IR). An air supply or self-contained breathing apparatus (AS) and a sealed suit (SS)are recommended. Both butyl rubber and polycarbonate are compatible with the chemical.

Ammonia bisulfite is a solid (S) at normal temperatures and is water reactive (WR). No data were available on the flammability or vapor pressure of the chemical. The permissible 8 hr exposure level (TWA) is 5 ppm based on the chemical-water reaction product of SO_2. Sulfur dioxide is a severe inhalation (IN) hazard and irritant (IR). An air supply or self-contained breathing apparatus (AS) and a sealed suit (SS)are recommended. No data were available on the compatibility of butyl rubber and polycarbonate with sodium bisulfite, however these materials are compatible with SO_2.

It was, of course, impossible to assign levels of protection for all 985 of the chemicals on the CHRIS list. Additional research is being conducted to determine the hazards posed by the various chemicals, the required levels of protection and the type of materials to be used in spill clean up. As this information becomes available, it is anticipated that the information contained herein will be updated. Meanwhile, On-Site Coordinators and Strike Team personnel should find this information valuable and should become acquainted with the usage of this information.

C	CN	S	WR	F	VP	TLV (PPM OR MG/M³)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION: RESPIRATORY			CLOTHING		MATERIAL COMPATI-BILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	NS	B	P	
AAD	Acetaldehyde	L	No	Yes	>760	100	150	3	-	3	-	-	X	X	-	Yes	No(ACE)	[12]
AAC	Acetic Acid	L	No	Yes (vapor)	31.0	10	15	2	-	3	-	-	X	X	-	Yes	Yes	
ACA	Acetic Anhydride	L	Yes	Yes	12.0	5	-	2	-	3	-	-	X	X	-	Yes	Yes	
ACT	Acetone	L	No	Yes	37.0	1000	1250	2	2	1	-	X	X	-	X	Yes	No(ACR)	[12]
ACY	Acetone Cyanohydrin	L	No	Yes	0.7	(10)	-	(3)	(3)	(2)	-	-	X	X	-	Yes	Yes	Toxic rating & TLV as HCN [8]
ATN	Acetonitrile	L	No	Yes	260	40	60	(3)	(3)	(1)	-	-	X	X	-	Yes	Yes	Toxic rating as CN [8]
ACP	Acetophenone	L	No	Yes	1.0	200	-	U	U	U	-	X	-	-	X	Yes	Yes	Animal experiments indicate low toxicity [8]
ABM	Acetyl Bromide	L	Yes	Yes	210	(10)	(25)	3	-	3	-	-	X	X	-	Yes	Yes	TLV as acetic acid [8]
ACC	Acetyl Chloride	L	Yes	Yes	470	1	-	3	-	3	-	-	X	X	-	Yes	No	
APB	Acetyl Peroxide Solution	L	Yes	Yes	~10	DNA	-	2	-	2	-	X	X	-	X	Yes	Yes	
ATA	Acetyl Acetone	L	No	Yes	18	DNA	-	2	-	1	-	X	X	-	X	Yes	No	
ACE	Acetylene	G	No	Yes	>760	5000	-	2	0	0	-	X	X	-	-	Yes	Yes	
ACD	Acridene	S	No	Yes	<0.01	0.2*	-	2	-	2	X	X	-	-	X	Yes	Yes	
ARL	Acrolein	L	No	Yes	686	0.1	0.3	3	2	2	-	-	X	X	-	Yes	Yes	
AAM	Acrylamide	S	No	Yes	DNA	0.3*	0.6*	3	2	3	-	-	X	X	-	Yes	No	
ACR	Acrylic Acid	L	No	Yes	11	DNA	-	3	-	3	-	-	X	X	-	Yes	Yes	
ACN	Acrylonitrile	L	No	Yes	390	20	30	(3)	(3)	(1)	-	-	X	X	-	Yes	Yes	Toxic rating as CN [8]
ADA	Adipic Acid	S	No	Yes	<0.01	-	-	U	U	U	X	-	-	-	-	Yes	Yes	Low toxicity food additive [5]
ADN	Adiponitrile	L	No	Yes	<0.25	18	-	3	3	-	-	-	X	X	-	Yes	Yes	
ALD	Aldrin	S	No	No	<0.25	0.25*	0.75*	3	2	-	-	-	X	X	-	Yes	Yes	Insecticide carcinogen
ABS	Alkylbenzenesulfonic Acid	L	No	No	<0.3	0.017	-	-	-	1				-	X			
ALA	Allyl Alcohol	L	No	Yes	55	2	4	3	2	3	-	-	X	X	-	Yes	Yes	
ABR	Allyl Bromide	L	No	Yes	~200	-	-	2	2	2	-	X	X	-	X	Yes	Yes	
ALC	Allyl Chloride	L	No	Yes	~600	1	2	3	2	3	-	-	X	X	-	Yes	Nc	
ATC	Allyl Trichlorosilane	L	Yes	Yes	36	(5)	-	(3)	-	(3)	-	-	X	X	-	Yes	No	Toxic rating as silanes, TLV as HCl [8]
ACF	Allyl Chloroformate	L	Yes	Yes	~600	-	-	3	-	3	-	-	X	X	-	Yes	No	
ACL	Aluminum Chloride	S	Yes	No	<0.25	(5)	-	3	-	3	-	-	X	X	-	Yes	Yes	TLV as HCl [8]
ALF	Aluminum Fluoride	S	No	No	<0.25	(2.5)*	-	(3)	-	(3)	-	-	X	X	-	Yes	Yes	TLV & toxic rating as fluoride [8]
ALN	Aluminum Nitrate	S	No	No	<0.25	-	-	(2)		U	X	X	-	-	-	Yes	Yes	Toxic rating as nitrates [8]
ALM	Aluminum Sulfate	S	No	No	<0.25	(1)*	-	(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating & TLV as sulfuric acids [8]
AEA	n-Aminoethylethanolamine	L	No	Yes	0.04	-	-	U	U	U						Yes	No	Experiments indicate low toxicity [8]
AMA	Ammonia, Anhydrous	G	Yes	Yes	>760	25	35	3	-	3	-	-	X	X	-	Yes	Yes	
AAT	Ammonium Acetate	S	No	Yes	<0.25	-	-				X	-	-	-	-	Yes	Yes	Meat preservative [5]
ABZ	Ammonium Benzoate	S	No	No	<0.25	-	-				X	-	-	-	-	Yes	Yes	Food preservative [5]
ABC	Ammonium Bicarbonate	S	No	No	<0.25	-	-				X	-	-	-	-	Yes	Yes	Nontoxic [5]
ABF	Ammonium Bifluoride	S	No	No	<0.25	(2.5)*	-	(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as fluorides [8]
ASU	Ammonium Bisulfite	S	Yes	-	-	(5)	-	(3)	-	(3)	-	-	X	X	-			TLV & toxic rating as SO_2
AMB	Ammonium Bromide	S	No	No	<0.1	DNA		(2)	-	(1)	X	X	-	-	X			Toxic rating as bromides
ACM	Ammonium Carbamate	S	No	-	decomp. in air	(25)	35	(3)	-	(3)	-	-	X	X	-			TLV & toxic rating as NH_3
ACB	Ammonium Carbonate	S	No	No	0.25	(25)	35	1	-	1	X	-	-	-	X	Yes	Yes	TLV as NH_3

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATI-BILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
AMC	Ammonium Chloride	S	No	No	<0.25	10*	20*	-	-	-	X	-	-	-	-	Yes	Yes	
ACH	Ammonium Chromate	S	No	-	-	(0.1)*	-	(3)	-	(3)	-	-	X	X	-			Carcinogen, TLV & toxic rating as CrO_3 [8]
ACI	Ammonium Citrate	S	No	No	<0.25	DNA	-				X	-	-	-	-	Yes	Yes	Low toxicity [5]
AMD	Ammonium Dichromate	S	No	Yes	<0.25	(0.1)*	-	(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating & TLV as CrO_3 [8]
AFB	Ammonium Fluoborate	S	No	-	sublimes	DNA		(3)	-	(3)	-	-	X	X	-			Toxic rating as fluoride [8]
AFR	Ammonium Fluoride	S	No	No	<0.25	(2.5)*		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as fluoride [8]
AFM	Ammonium Formate	S	No	Yes	<0.25	(5)		(2)	-	(2)	X	X	-	-	X	Yes	Yes	TLV & toxic rating as formic acid [8]
AGC	Ammonium Gluconate	S	No	No	<0.25	DNA		-	-	-	X	-	-	-	-	Yes	Yes	Nontoxic [5]
AMH	Ammonium Hydroxide(28% Sol'n.)	L	No	No	-	1		2	-	2	-	X	X	-	X	Yes	No(PVC)	[12]
AHP	Ammonium Hypophosphate	S	No	No	-	(0.3)	(1)	(3)		(2)	-	-	X	-	X			TLV & toxic rating as phosphine
AID	Ammonium Iodide	S	No	No	<0.25	DNA		(2)	-	-	X	X	-	-	-	Yes	Yes	Toxic rating as iodide [8]
ALT	Ammonium Lactate	S/L	No	No	<0.25	DNA					X	-	-	-	-	Yes	Yes	Nontoxic [10]
ALS	Ammonium Lauryl Sulfate	L	No	No	0.2	DNA										Yes	Yes	No toxicity data[5-8]
AMB	Ammonium Molybdate	S	No	No	<0.25	5*		2	-	2	X	X	-	-	X	Yes	Yes	
AMN	Ammonium Nitrate	S	No	No	<0.25	DNA		1	-	1	X	-	-	-	X	Yes	Yes	
ANP	Ammonium Nitrate-Phosphate Mix	S	No	No	<0.25	DNA		(1)		(1)	X	-	-	-	X	Yes	Yes	Toxic rating as ammonium nitrate [8]
ANS	Ammonium Nitrate-Sulfate Mix	S	No	No	<0.25	DNA		(1)	-	(1)	X	-	-	-	X	Yes	Yes	No toxicity data
ANU	Ammonium Nitrate-Urea Solution	L	No	No	<0.25	DNA		(1)		(1)	X	-	-	-	X	Yes	Yes	Toxic rating as ammonium nitrate
AOL	Ammonium Oleate	S	No	Yes	<0.25	DNA					X	-	-	-	-	Yes	Yes	Nontoxic [10]
AOX	Ammonium Oxalate	S	No	No	<0.25	DNA		-	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as oxalates[8]
APB	Ammonium Pentaborate	S	No	No	<0.25	10*		(2)	-	-	X	X	-	-	X	Yes	Yes	Toxic rating for boron cmpds[8]
AMP	Ammonium Perchlorate	S	No	No	<0.25	DNA		(2)	-	(2)	X	X	-	-	X	Yes	Yes	Toxic rating for perchlorates[8]
APE	Ammonium Persulfate	S	No	Yes	<0.25	DNA		1	-	1	X	-	-	-	X	Yes	Yes	
APP	Ammonium Phosphate	S	No	No	<0.25	DNA		U	U	U	X	-	-	-	-	Yes	Yes	Low toxicity [5]
ASL	Ammonium Silicofluoride	S	No	No	<0.25	2.4*		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as fluoride & fluosilicates [8]
AMR	Ammonium Stearate	S	No	Yes	<0.25	DNA					X	-	-	-	-	Yes	Yes	Low toxicity [5]
ASM	Ammonium Sulfamate	S	No	No	<0.25	10*					X	-	-	-	-	Yes	Yes	Animal experiments indicate low toxicity [5]
AMS	Ammonium Sulfate	S	No	No	0.25	DNA		1	-	1	X	-	-	-	X	Yes	Yes	
ASF	Ammonium Sulfide	L	No	Yes	~721	(10)	(15)	(3)	-	(3)	-	-	X	X	-	Yes	Yes	TLV & toxic rating as H_2S [8]
AMF	Ammonium Sulfite	S	Yes	No	<0.25	(1)		(2)	-	(2)	X	X	-	-	X	Yes	Yes	TLV * toxic rating as NH_4OH [8]
ATR	Ammonium Tartrate	S	No	No	<0.25	DNA					X	-	-	-	-	Yes	Yes	No toxic data
AMT	Ammonium Thiocyanate	S	No	No	<0.25	DNA										Yes	Yes	Low acute toxicity [8]
ATF	Ammonium Thiosulfate	S	No	No	<0.25	DNA		1	-	1	X	-	-	-	X	Yes	Yes	
AML	n-Amyl Acetate	L	No	Yes	<10.9	100	105	2	-	1	-	X	X	-	X	Yes	No	
AAN	n-Amyl Alcohol	L	No	Yes	6.8	100		2	-	2	-	X	X	-	X	Yes	Yes	
AMY	n-Amyl Chloride	L	No	Yes	> 15	DNA		U	U	U						Yes	No	Narcotic in high concentration [5]
AMN	n-Amyl Mercaptan	L	No	Yes	26.2	DNA		1	-	1	-	X	-	-	X			
AMK	n-Amyl Methyl Ketone	L	No	Yes	4.0	100		(2)	(2)	(1)	-	X	X	-	X	Yes	No	Toxic rating as acetone
ANI	Iso-Amyl Nitrite	L	Yes	No	~19	DNA		2	-	-	-	X	X	-	X	Yes	No	Moderately toxic [5]
ANT	n-Amyl Nitrate	L	No	Yes	~8	DNA		2	-	2	-	X	X	-	X	Yes	Yes	

C	CN	[illegible]	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATI-BILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
ATS	n-Amyltrichlorosilane	L	Yes	Yes	[illegible]	(5)		(3)	-	(3)	-	-	X	X	-	Yes	No	TLV & toxic rating as HCl [8]
ANL	Aniline	L	No	Yes	2	5		3	-	3	-	-	X	X	-	Yes	No	
ASC	Anisoyl Chloride	S/L	Yes	Yes	0.15	(5)		(3)	-	(3)	-	-	X	X	-	Yes	No	TLV as HCl
ATH	Anthracene	S	No	Yes	<0.001	1*		-	-	-	-	-	X	X	-	Yes	Yes	Skin carcinogen
AP	Antimony Pentachloride	L	Yes	No	4.5	0.5*(Sb)		3	-	3	-	-	X	X	-	Yes	No(viny)	[6]
APF	Antimony Pentafluoride	L	Yes	No	16	0.5*(Sb)		3	-	3	-	-	X	X	-	Yes	Yes	
APT	Antimony Potassium Tartrate	S	No	No	<0.25	0.5*(Sb)		3	-	-	-	-	X	-	X	Yes	Yes	
ATB	Antimony Tribromide	S	Yes	-		0.5*(Sb)		3	-	1	-	-	X	-	X	Yes	Yes	
ATM	Antimony Trichloride	S	Yes	No	<0.6	0.5*(Sb)		3	-	3	-	-	X	X	-	Yes	[illegible]	Strong irritant,eyes & skin, fumes
ATT	Antimony Trifluoride	S	No	No	<<0.25	0.5*(Sb)		3	-	3	-	-	X	X	-	Yes	Yes	
ATX	Antimony Trioxide	S	No	No	<<0.25	0.5*(Sb)		3	-	-	-	-	X	-	X	Yes	Yes	
ASA	Arsenic Acid	S	No	No	DNA	0.5*(Sb)		(3)	-	(2)	-	-	X	-	X	Yes	Yes	Toxic rating as arsenic
APC	Arsenic Pentoxide	S	Yes	-	DNA	0.25*		(3)	-	(2)	-	-	X	-	X	Yes	No(PVC)	[12] Arsenic acid forms with water contact
ARD	Arsenic Sulfide(DI)	S	Yes	Yes	DNA	0.5*(As)		(3)	-	(2)	-	-	X	-	X	Yes	Yes	Treat like SO_2 when water contacts
AST	Arsenic Trichloride	L	Yes	No	23	0.35*		(3)	-	(2)	-	-	X	-	X	Yes	Yes	High toxicity,decomposes in air
ATO	Arsenic Trioxide	S	No	No	<<0.25	0.5*(As)		(3)	-	(2)	-	-	Z	-	X	Yes	Yes	
ART	Arsenic Trisulfide	S	Yes	No	<<0.25	0.5*(As)		(3)	-	(2)	-	-	X	-	X			
ASP	Asphalt	S/L	No	Yes	<<0.25	5*	10*	-	-	2	-	X	X	-	X	Yes	Yes	
ARF	Asphalt Blending Stocks, Roofers Flux	L	No	Yes	DNA	DNA		-	-	(2)	-	X	X	-	X	Yes	Yes	Use same TLV as for asphalt
ASR	Asphalt Blending Stocks,Straight Run Residue	L	No	Yes	DNA	DNA		-	-	(2)	-	X	X	-	X	Yes	Yes	Use same TLV as for asphalt
ATX	Atrazine	S	No	No	DNA	10*		2	-	-	X	X	-	-	X	Yes	Yes	Moderately toxic, herbicide
AZM	Azinphosmethyl	S	No	Yes	<<0.25	0.2*		3	3	-	-	-	X	X	-	Yes	Yes	Cholinesterace inhibitor
BRC	Barium Carbonate	S	No	No	<<0.25	0.5*(Ba)		(3)	-	(1)	-	-	X	-	X	Yes	Yes	Toxic rating as barium
BCR	Barium Chlorate	S	No	No	<<0.25	0.5*(Ba)		(3)	-	(1)	-	-	X	-	X	Yes	Yes	
BCY	Barium Cyanide	S	No	-		0.5*(Ba)		(3)	(3)	(1)	-	-	X	X	-			Toxic rating as CN
BNT	Barium Nitrate	S	No	Yes	<<0.25	0.5*(Ba)		(3)	-	(1)	-	-	X	-	X	Yes	Yes	
BPC	Barium Perchlorate	S	No	No	<<0.25	0.5*(Ba)		(3)	-	(1)	-	-	X	-	X	Yes	Yes	
BPM	Barium Permanganate	S	No	Yes	<<0.25	0.5*(Ba)		(3)	-	(1)	-	-	X	-	X	Yes	Yes	
BPO	Barium Peroxide	S	No	No	<<0.25	0.066		(3)	-	(1)	-	-	X	-	X	Yes	Yes	
BCD	Benzaldehyde	L	No	Yes	2.0	DNA		(3)	1	(3)	-	-	X	X	-	Yes	No(PVC)	Toxic rating as aldehydes [8]
BNZ	Benzene	L	No	Yes	165	10		2	2	2	-	-	X	X	-	No	[11]	Carcinogen
BHC	Benzene Hexachloride	S	No	No	<<0.01	0.5*		2	-	1	X	X	-	-	X	Yes	Yes	May be skin absorbed
BPD	Benzene Phosphorous Dichloride	L	Yes	Yes	<<0.25	DNA		2	0	2	-	X	X	-	X	Yes	No	
BPT	Benzene Phosphorous Thiodichloride	L	Yes	Yes	2.4	DNA		U	U	U	-	-	X	X	-	Yes	No	Fumes in air, reacts with
BZA	Benzoic Acid	L	No	Yes	0.012	DNA		1	-	1	X	-	-	-	X	Yes	Yes	
BZN	Benzonitrile	L	No	Yes	3	DNA		U	U	U	-	-	X	X	-	Yes	Yes	Highly toxic [8]
BZP	Benzophenone	S	No	Yes	<<0.25	DNA		U	U	U						Yes	Yes	
BZC	Benzoyl Chloride	L	Yes	Yes	2	DNA		2	-	2	-	X	X	-	X	Yes	No	
BAL	Benzyl Alcohol	L	No	Yes	0.22	DNA		2	2	2	-	X	X	-	X	Yes	Yes	
BBR	Benzyl Bromide	L	No	Yes	9.5	DNA		3	3	3	-	-	X	X	-	Yes	Yes	

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	CLOTHING AS	CLOTHING SS	CLOTHING NS	B	P	
BCL	Benzyl Chloride	L	No	Yes	27	1		3	3	3	-	-	X	X	-	No	Yes	
BCF	Benzyl Chloroformate	L	Yes	Yes	<0.25	5(HCl)		2	-	2	-	X	X	-	X	No		Reacts with water to form HCl
BBP	Benzyl n-Butyl Pathalate	L	No	Yes	<<0.25	DNA										No		No toxicity data found
BZM	Benzylamine	L	No	Yes	2.4	DNA		3	-	3	-	-	X	X	-	Yes	No	
BZO	Benzyl Dimethyl-octa decylammonium Chloride	S/L	No	Yes	<<0.25	DNA												
BMA	Benzyl Trimethyl Ammonium Chloride	L	No	Yes	<<0.25	DNA		U	U	U								
BEC	Beryllium Chloride	S	Yes	No	<<0.25	0.002*(Be)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxicity rating as beryllium
BEF	Beryllium Fluoride	S	No	No	<<0.25	0.002*(Be)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxicity rating as beryllium
BEM	Beryllium Nitrate	S	No	No	<<0.25	0.002*(Be)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxicity rating as beryllium
BEO	Beryllium Oxide	S	No	No	<<0.25	0.002*(Be)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxicity rating as beryllium
BEM	Beryllium, Metallic	S	No	Yes	<<0.25	0.002*	0.025	(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxicity rating as beryllium
BES	Beryllium Sulfate	S	No	No	<<0.25	0.002*(Be)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxicity rating as beryllium
BOC	Bismuth Oxychloride	S	No	No	<<0.25	DNA		-	-	1	X	-	-	-	X	Yes	Yes	
BPA	Bisphenol A	S	No	Yes	<<0.25	DNA		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as phenol
BDE	Bisphenol A Diglycidyl Ether	L	No	Yes	<<0.25	0.5		(3)	(3)	(3)	-	-	X	X	-			Toxic rating as phenol
BCP	Boiler Compound-Liquid	L	No	No	-	(2*)		(2)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as NaOH
BAC	Boric Acid	S	No	No	<<0.25	10*		(2)	(2)	(2)	X	X	-	-	X	Yes	Yes	Toxic rating as boron
BTB	Boron Tribromide	L	Yes	No	114	1.0	3.0	(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as for HBr
BRT	Boron Trichloride	L	Yes	No	>760	DNA		(3)	-	(3)	-	-	X	X	-	Yes	No(PVC) [18]	Toxic rating as for HCl
BRM	Bromine	L	No	No	362	0.1	0.3	3	-	3	-	-	X	X	-	Yes	No	
BPR	Bromine Pentafluoride	L/G	Yes	No	690	0.1	0.3	3	-	3	-	-	X	X	-	No		
BTF	Bromine Trifluoride	L	Yes	No	67	(0.1)	(0.3)	(3)	-	(3)	-	-	X	X	-	No		Toxic rating as BFP
BBZ	Bromobenzene	L	No	Yes	10	DNA		1	-	2	-	X	-	-	X	No		
BRU	Brucine	S	No	Yes	<< 0.25	DNA		3	-	-	-	-	X	-	X	Yes	No	
BDI	Butadiene Inhibited	G	No	Yes	>760	1000	1250	2	-	2	-	X	X	-	X	Yes	Yes	
BUT	Butane	G	No	Yes	>760	500	750	2	0	0	-	X	X	-	-	Yes	Yes	
BDO	1,3-Butanediol	L	No	Yes	0.06 [20]	DNA		U	U	U						Yes	Yes	
BUD	1,4-Butenediol	L	No	Yes	>3	DNA		U	U	U						Yes	Yes	
BCN	n-Butyl Acetate	L	No	Yes	24	150	200	2	1	1	-	X	X	-	X	Yes	No	
BTA	sec-Butyl Acetate	L	No	Yes	51	200	250	2	1	1	-	X	X	-	X	Yes	No(PVC)	
BYA	tert-Butyl Acetate	L	No	Yes		200	250	2	1	1	-	X	X	-	X			
BAI	iso-Butyl Acrylate	L	No	Yes	40	DNA		-	-	(2)	-	X	X	-	X	Yes	Yes	Toxicity as BTC
BTC	n-Butyl Acrylate	L	No	Yes	10.3	10		-	-	(2)	-	X	X	-	X	Yes	Yes	
BAN	n-Butyl Alcohol	L	No	Yes	18	50		2	2	1	-	X	X	-	X	Yes	Yes	
BAS	sec-Butyl Alcohol	L	No	Yes	~ 41	150		2	1	1	-	X	X	-	X	Yes	Yes	
BAT	tert-Butyl Alcohol	L	No	Yes	~ 93	100	150	2	2	1	-	X	X	-	X	Yes	Yes	
BHP	tert-Butyl Hydroperoxide	L	No	Yes	~ 30	DNA					-	-	X	X	-	Yes	Yes	Highly reactive peroxide compound [5]
BTM	n-Butyl Mercaptan	L	No	Yes	80	0.5		2	-	2	-	X	X	-	X	No		
BMN	n-Butyl Methacrylate	L	No	Yes	10	DNA		2	-	2	-	X	X	-	X	Yes	Yes	
BAM	n-Bytyl Amine	L	No	Yes	~ 280	5/5min		3	3	2	-	-	X	X	-	Yes	No	

C	CN	S	WR	F	VP	TLV (ppm or mg/m³)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
BTL	sec-Butylamine	L	No	Yes	386	DNA		2	-	2	-	X	X	-	X	Yes	No	
BUA	tert-Butylamine	L	No	Yes	590	DNA		2	-	2	-	X	X	-	X	Yes	No	
BTN	Butylene	G	No	Yes	>760	DNA					-	-	X	-	X	Yes	Yes	Asphyxiant
BTO	1,2-Butylene Oxide	L	No	Yes	370	DNA		3	-	3	-	-	X	X	-	Yes	Yes	
BTP	p-tert-Butylphenol	S	No	Yes	~0.1	DNA		-	-	2	-	X	-	-	X	Yes	Yes	
BCS	Butyltrichlorosilane	L	Yes	Yes	41	(5)		(3)	-	(3)	-	-	X	X	-	Yes	No	Toxic rating as chlorosilanes, TLV as HCl
BTD	1,4-Butynediol	S	No	Yes	0.25	DNA		3	-	3	-	-	X	X	-	Yes	No	
BAD	iso-Butylraldehyde	L	No	Yes	248	DNA		(3)	(1)	(3)	-	-	X	X	-	Yes	No	Toxic rating as aldehydes
BTR	n-Butraldehyde	L	No	Yes	~248	DNA		(3)	(1)	(3)	-	-	X	X	-	Yes	No	Toxic rating as aldehydes
BRA	n-Butyric Acid	L	No	Yes	~2.7	DNA		1	1	1	-	X	-	-	X	Yes	Yes	
CDA	Cacodylic Acid	S	No	No	<0.25	DNA		1	-	1	X	-	-	-	X	Yes	Yes	
CAT	Cadmium Acetate	S	No	No	<0.25	0.05*(Cd)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as cadmium compound Suspected carcinogen
CMB	Cadmium Bromide	S	No	No	<0.25	0.05*(Cd)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as cadmium compound Suspected carcinogen
CDC	Cadmium Chloride	S	No	No	<0.25	0.05*(Cd)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " " "
CFB	Cadmium Fluoborate	L	No	No	<0.25	0.0157		(3)	-	(3)	-	-	X	X	-			" " " " "
CMN	Cadmium Nitrate	S	No	No	<0.25	0.05*(Cd)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " " "
COX	Cadmium Oxide	S	No	No	<0.25	0.05*(Cd)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as cadmium compound Suspected carcinogen
CMS	Cadmium Sulfate	S	No	No	<0.25	0.05*(Cd)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " " "
CCA	Calcium Arsenate	S	No	No	<0.25	0.5*(As)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Recognized carcinogen. Toxic rating as arsenic compound
CAS	Calcium Arsenite	S	No	No		DNA		(3)	-	(3)	-	-	X	X	-			Toxic rating as arsenic cmpd.
CCB	Calcium Carbide	S	Yes	No	<0.25	5000	(AsC_2H_2)	(1)	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as calcium cmpd.
CCC	Caldium Chlorate	S	No	No	<0.25	DNA		(1)	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as calcium cmpd.
CLC	Calcium Chloride	S	No	No	<0.25	DNA		(1)	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as calcium cmpd.
CCR	Calcium Chromate	S	No	o	<0.25	0.1*		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as chromium cmpd. Recognized carcinogen
CCN	Calcium Cyanide	S	Yes	No	<0.25	5*		(3)	(3)	(1)	-	-	X	X	-	Yes	Yes	Toxic rating as CN
CAF	Calcium Fluoride	S	No	No	<0.25	2.5*		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as fluorides
CAH	Calcium Hydroxide	S	No	No	<0.25	DNA		(1)	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as calcium cmpd.
CHY	Calcium Hypochlorite	S	No	No		DNA		3	-	2	-	-	X	-	X	Yes	Yes	
CAM	Calcium, Metallic	S	Yes	Yes	<0.25	DNA		(1)	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as calcium cmpd.
CNT	Calcium Nitrate	S	No	No	<0.25	DNA		(2)	-	-	X	X	-	-	X	Yes	Yes	Toxic rating as nitrates
CAO	Calcium Oxide	S	Yes	No	<0.25	2*		(1)	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as calcium cmpd.
CCP	Calcium Peroxide	S	No	No	<0.25	DNA		(1)	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as calcium cmpd.
CAL	Calcium Phosphate	S	No	No	<<0.25	DNA		U	U	U	X	-	-	-	X	Yes	Yes	Nuisance dust
CPP	Calcium Phosphide	S	Yes	Yes		(0.3)/ (0.4)*		(3)	-	(2)	-	-	X	-	X	Yes	Yes	Toxic rating & TLV as PH_3
CRE	Calcium Resinate	S	No	Yes	<<0.25	DNA		U	U	U								Pyrophoric
CPH	Camphene	S	No	No	9.5	DNA		U	U	U								Gives off flammable vapors when heated
CPO	Camphor (Oil)	L	No	Yes	0.7	3/30 min		-	-	2	-	X	-	-	X	Yes	Yes	
CLS	Caprolactam (Solution)	L	No	Yes	0.12	5										Yes	Yes	Eye, skin irritant [9]
CPT	Captan	S	No	No	~0.002	DNA					-	-	X	X	-	Yes	Yes	Poisonous via skin
CBY	Carbaryl	S	No	No	<0.25	5*		2	2	2	X	X	-	-	X	Yes	Yes	

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
											RESPIRATORY			CLOTHING				
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	NS	B	P	
CBO	Carbolic Oil	L	No	Yes	1.7	(5)		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as phenols
CDO	Carbon Dioxide	G	No	No	>760	5000	15000	1	-	-	-	X	X	-	-	Yes	Yes[12]	
CBB	Carbon Disulfide	L	No	Yes	570	20	30	3	3	3	-	-	X	X	-	No	(ACE)	
CMO	Carbon Monoxide	G	No	Yes	>760	50	400	3	-	-	-	-	X	-	-	Yes	Yes	
CBT	Carbon Tetrachloride	L	No	No	270	10	20	3	1	0	-	-	X	-	X	No[14]	(ACE) (Nitrile[12]	
CAR	Carene	L	-	Yes	5.1	DNA												By product wood turpentine
CTC	Catechol	S	No	Yes	~0.1	5/20*		3	3	3	-	-	X	X	-	Yes	Yes	
CPS	Caustic Potash (solution)	L	No	No	<0.25	2*		3	-	3	-	-	X	X	-	Yes	No Yes[12]	
CSS	Caustic Soda (solution)	L	No	No	<0.25	2*		2	-	3	-	-	X	X	-	Yes	No Yes[12]	
CHC	Charcoal	S	No	Yes	<<0.25	DNA		1	-	-	X	-	-	-	-	Yes	Yes	
CDN	Chlordane	L	No	Yes	<<0.25	0.027		3	3	-	-	-	X	X	-	Yes	Yes	
CLX	Chlorine	G	Yes	No	>760	1	3	3	-	x	-	-	X	X	-	Yes	Yes	
CTF	Chlorine Trifluoride	G/L	Yes	Yes	>760	0.1		(3)	-	(3)	-	-	X	X	-	No		Toxic rating as chlorine, fluorine, fluorides
CTO	4-Chloro-o-Toluidine	S	-	Yes	<0.9	DNA					-	-	X	X	-	No		Highly toxic
CRA	Chloroacetophenone	S	No	Yes	0.25	0.345*		3	-	3	-	-	X	X	-	Yes	Yes	Powerful lachrymator
CAC	Chloroacetyl Chloride	L	Yes	No	30	(5)		(3)		(3)	-	-	X	X	-	Yes	No	TLV & toxic rating as HCl
CAP	p-Chloroaniline	S	No	Yes	0.26	(2)	(5)	(3)	(3)	-	-	-	X	X	-	Yes	Yes	Toxic rating & TLV as analine
CRB	Chlorobenzene	L	No	Yes	26	75		2	1	1		X	X	-	X	No		
CBN	4-Chlorobutyronitrile	L	No	-	1.7	DNA					-	-	X	X	-	No	No	Organic cyanide
CRF	Chloroform	L	No	Yes	346	25		3	-	1	-	-	X	X	-	No		Suspected carcinogen
CHD	Chlorohydrin (crude)	L	No	Yes	16	5		U	U	U	-	-		X	-	No		Irritant
CME	Chloromethyl Methyl Ether	L	Yes	Yes	180	DNA		(3)	(3)	(3)	-	-		X	-			Toxic rating as chloroethylether
CNC	o-Chloronitrobenzene	L	No	Yes		1 [2]		3	U	U	-	-		X	-			Highly toxic [8]
CPN	p-Chlorophenol	S	No	Yes	0.66	DNA		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as phenol
CPL	Chloropicrin	L	No	Yes	44	0.1	0.3	3	-	3	-	-	X	X	-	Yes	Yes	Lachrymator & irritant
CRP	Chloroprene	L	No	Yes		25	35	2	3	2	-	-	X	X	-	No	No	
CSA	Chlorosulfonic Acid	L	Yes	Yes	1.6	(5.0)[9]		(3)	-	(3)	-	-	X	X	-	No(PVC) [10] No[11]	(No)(PVC) [10]	As sulfuric acid
CKW	p-Chlorotoluene	L	No	Yes	7.6	DNA		U	U	U								
CRT	Chromic Acetate	S	No			(0.05)*		(3)	-	(3)	-	-	X	X	-			As chromic compound, recognized carcinogen
CMA	Chromic Anhydride	S	No	No	<0.25	(0.05)*		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " " " "
CHS	Chromic Sulfate	S	No	-		(0.05)*		(3)	-	(3)	-	-	X	X	-	Yes	No	" " " " " "
CRC	Chromous Chloride	S	No	-		(0.05)*		(3)	-	(3)	-	-	X	X	-			" " " " " "
CMC	Chromyl Chloride	L	Yes	No	32	(0.05)*		(3)	-	(3)	-	-	X	X	-			" " " " " "
CIT	Citric Acid	S	No	Yes	<0.25	DNA					X	-	-	-	-	Yes	Yes	Nontoxic[5];moderately irritant organic acid[8]
CBA	Cobalt Acetate(ous)	S	No	No	<0.25	0.1*(Co)		(1)	-	-	X	-	-	-	X	Yes	Yes	As cobalt compounds
COB	Cobalt Bromide(ous)	S	No			DNA		(2)	-	-	X	X	-	-	X			As bromide compounds
CBC	Cobalt Chloride(ous)	S	No	No	<0.25	0.1*(Co)		(1)	-	-	X	-	-	-	X	Yes	Yes	As cobalt compounds
COF	Cobalt Fluoride(ous)	S	Yes			(2.5*)[5] (F)		(3)	-	(3)	-	-	X	X	-			As fluorides
CFM	Cobalt Formate(ous)	S	No			DNA		(2)	-	(2)	X	X	-	-	X			As formic acid
CON	Cobalt Nitrate(ous)	S	No	Yes	<0.25	0.1*(Co)		(2)	-	-	X	X	-	-	X	Yes	Yes	As nitrates

C	CN	S	WR	F	VP	TLV (PPM OR MG/M³)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
COS	Cobalt Sulfamate(ous)					DNA												
CBS	Cobalt Sulfate(ous)	S	No	No	<<0.25	0.1*(Co) [9]		U	U	U	X	-	-	-	X	Yes	Yes	Primarily a respiratory threat
CLD	Collodion	L	No	Yes	DNA	400 [9]		(2)	(2)	(2)	-	X	X	-	X	Yes	No	Toxicity based on ether content
COP	Copper Acetic(ic)	S	No	No	<0.25	(1)*		(2)	-	(1)	X	X	-	-	X	Yes	Yes	As copper cmpds;TWA as 0.2* as fumes
CAA	Copper Acetoarsenite(ic)	S	No	No	<0.25	0.5*(As) [9]		(3)	-	(2)	-	-	X	X	-	Yes	Yes	As arsenic compounds, recognized carcinogen
CPA	Copper Arsenite(ic)	S	No	No	<0.25	"		(3)	-	(2)	-	-	X	X	-	Yes	Yes	" " " " " " "
CPB	Copper Bromide(ic)	S	No	No	<0.25	DNA		(2)	-	(1)	X	X	-	-	X	Yes	Yes	As bromides & copper compounds
CBD	Copper Bromide(ous)	S	No			DNA		(2)	-	(1)	X	X	-	-				As bromides & copper compounds
CPC	Copper Chloride(ic)	S	No	No	<0.25	DNA		(2)	-	(1)	X	X	-	-	X	Yes	Yes	As copper compounds
CCY	Copper Cyanide(ous)	S	No	No	<0.25	5* [9]		(3)	(3)	(1)	-	-	X	X	-	Yes	Yes	As cyanides
CPF	Copper Fluoborate(ic)	L	No	No	<0.25	DNA		(3)		(3)	-	-	X	X	-	Yes	Yes	As fluoride as fluoroborate
CUF	Copper Formate(ic)	S	No			DNA		(2)	-	(1)	X	X	-	-	-			As copper compounds
CPG	Copper Glycinate	S	No	-		(1*)Cu					X	-	-	-	X	Yes	Yes	TLV as copper cmpd,additive to animal feed
CID	Copper Iodide(ous)	S	No	No	<0.25	(1*)Cu		(2)	-	(1)	X	X	-	-	X			As copper cmpd,toxic rating &TLV
CLT	Copper Lactate(ic)	S	No	-		(1*)Cu		(2)	--	(1)	X	X	-	-	X			" " " " " " "
CNN	Copper Napthenate(ic)	L	-	Yes	7.4	500[9]		(2)	--	(1)	-	X	X	-	X	Yes	Yes	" " " " " " "
CNI	Copper Nitrate(ic)	S	No	Yes	<0.25	(1*)Cu		(2)	-	(1)	-	X	X	-	X	Yes	Yes	As copper cmpd,toxic rating
COL	Copper Oxalate(ic)	S	No	No	<0.25	(1*)Cu		(2)	-	(3)	-	-	X	X	-	Yes	Yes	As copper & oxalate compounds
CST	Copper Subacetate(ic)	S	No	-		(1*)Cu		(2)	-	(1)	X	X	-	-	X	Yes[16]		As copper compounds
CSF	Copper Sulfate(ic)	S	No	No	<0.25	(1*)Cu		(2)	-	(1)	X	X	-	-	X	Yes	Yes	As copper compounds
CSN	Copper Sulfate(ic) Ammonated	S	No	-		(1*)Cu		(3)	-	(3)	-	-	X	X	-			As ammonia;TLV as copper
CTT	Copper Tartrate(ic)	S	No	-		(1*)Cu		(2)	-	(1)	X	X	-	-	X			As copper compounds, toxic rating & TLV
CSY	Corn Syrup	L	No	No	-	DNA					-	-	-	-	-	Yes	Yes	Nontoxic [6]
COU	Coumaphos	S	No	-	<0.25	DNA					-	-	X	X	-			Cholinesterace inhibitor [5]
CCT	Cresote, Coal Tar	L	No	Yes	<0.1	DNA		2	-	2	-	-	X	X	-	Yes	Yes	Recognized carcinogen of skin; experimental carcinogen of lungs
CRS	Cresols	L	No	Yes	1.7	5		2	2	2	-	X	X	-	X	Yes	Yes	
CGE	Cresyl Glycidyl Ether	S	-	Yes	<1.0	DNA												
CTA	Crotonaldehyde	L	No	Yes	27	2	6	3	3	3	-	-	X	X	-	Yes	No	
CUM	Cumene	L	No	Yes	25	50	7.5	3	3	1	-	-	X	X	-	Yes	Yes	
CMH	Cumene Hydroperoxide	L	No	Yes	0.8	DNA		3	3	3	-	-	X	X	-	Yes	Yes	
CES	Cupriethylenediamine Solution	L	-	-	DNA	DNA		-	-	-	-	-	X	X	-			Strong irritant to tissues, toxic [5]
CYA	Cyanoacetic Acid	S	No	Yes	~0.2	(5*)[8]		(3)	(3)	(1)	-	-	X	X	-	Yes	Yes	As cyanides,toxic rating & TLV
CYG	Cyanogen	G	No	Yes	>760	10		(3)	(3)	(1)	-	-	X	X	-	Yes	Yes	As cyanides
CBR	Cyanogen Bromide	S	Yes	No	280	0.5 [9]		(3)	(3)	(1)	-	-	X	X	-	Yes	Yes	As cyanides
CCL	Cyanogen Chloride	L/G	No	No	>760	0.5 [9]		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As hydrochloric acid
CHX	Cyclohexane	L	No	Yes	165	300		2	-	2	-	X	X	-	X	No	Yes[12]	
CHN	Cyclohexanol	S/L	No	Yes	3.1	50		2	1	1	-	-	X	X	-	Yes	Yes	Suspected carcinogen
CCH	Cyclohexanone	L	No	Yes	~39	50		1	-	2	-	X	-	-	X	Yes	No	
CHP	Cyclohexanone Peroxide	L	No	Yes	39	DNA					-	-	X	X	-	Yes	Yes	Peroxide,organic-irritating to skin, eyes
CHT	Cyclohexenyltrichlorosilane	L	Yes	Yes	DNA	(5)		(3)	-	(3)	-	-	X	X	-	Yes	No	As hydrochloric acid,TLV & toxic rating

C	CN	S	MR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
CHA	Cyclohexylamine	L	No	Yes	22	10		3	3	2	-	-	X	X	-	Yes	No	
CYP	Cyclopentane	L	No	Yes	520	DNA		2	-	-	-	X	X	-	X	Yes	Yes	
CPR	Cyclopropane	G	No	Yes	720	400 [9]		2	-	-	-	X	X	-	X	Yes	Yes	
CMP	p-Cymene	L	No	Yes	3.5	DNA		(2)	-	-	-	X	X	-	X	Yes	Yes	As toluene, toxic rating
DES	2,4-D Esters	L	No	-	<0.25	DNA												Moderately toxic, irritant as acid[5], herbicide
DLP	Dalapon	L	No	-		DNA		2	-	2	-	X	X	-	X			
DDD	DDD	S	No	No	<0.25	DNA		1	-	-	X	-	-	-	X	Yes	Yes	Skin adsorption from solutions, insoluble in water
DDT	DDT	S	No	Yes	<0.25	1		1	-	-	X	-	-	-	X	Yes	Yes	Toxic by inhalation & ingestion
DBR	Decaborane	S	Yes	Yes	0.18	0.3*	0.9*	(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as boron hydride high toxicity, skin absorp.
DHN	Decahydronaphthalene	L	No	Yes	0.27	25		-	-	2	-	X	X	-	X	Yes	No	
DAL	Decaldehyde	L	No	Yes	1.7	DNA		(3)	(1)	(3)	-	-	X	X	-	Yes	No	Aldehyde
DCE	1-Decene	L	No	Yes	2.7	DNA		(2)	-	(2)	-	X	X	-	X	Yes	Yes	Irritant & narcotic. Toxicity rating as hexene.
DAN	Decyl Alcohol	L	No	Yes	0.02	DNA		U	U	U	-	-	-	-	X	Yes	Yes	Animal experiments indicate low toxicity.
DBZ	n-Decylbenzene	L	No	Yes	~0.02	DNA		U	U	U								
DTN	Demeton	L	No	Yes	<0.25	0.0087		(3)	(3)	-	-	-	X	X	-	Yes	Yes	Toxic rating as parathion. Cholinesterace inhibitor.
DTS	Dextrose Solution	L	No	No	<0.25	DNA		U	U	U	-	-	-	-	-	Yes	Yes	Nontoxic [5]
DEP	Di-(2-Ethylhexyl) Phosphoric Acid	L	No	Yes	0.25	DNA					-	-	-	X	-	Yes	Yes	High toxicity [8]
DZP	Di-(p-Chlorobenzoyl) Peroxide	L	No	Yes	0.25	DNA					-	-	X	X	-			Irriting to eyes, skin, membranes. organic peroxide [8]
DAP	Di-n-Amyl Phthalate	L	No	Yes	0.25	DNA		(3)	-	(2)	-	-	X	-	X	No		Toxic rating as amyl alcohol
DBE	Di-n-Butyl Ether	L	No	Yes	13.5	DNA		(2)	-	(1)	-	X	X	-	X	No		Toxic rating as phthalic acid
DBK	Di-n-Butyl Ketone	L	No	Yes	-	DNA					-	X	-	-	X			Classed as ketone
DBA	Di-n-Butylamine	L	No	Yes	5.8	DNA		3	-	3	-	-	X	X	-	Yes	No	
DNA	Di-n-Propylamine	L	No	Yes	>50	DNA		U	U	U	-	-	X	X	-			High vapor pressure, irritating organic amine
DAA	Diacetone Alcohol	L	No	Yes	3.3	50		2	-	2	-	X	X	-	X	Yes	Yes	
DZN	Diazinon	L	No	Yes	<0.25	0.1*	0.3*	(3)	(3)		-	-	X	X	-	Yes	Yes	Toxic rating as parathion, cholinesterace inhibitor
DPO	Dibenzoyl Peroxide	S	No	Yes	~0.003	*		2	-	2	X	X	-	-	X	Yes	Yes	
DPA	Dibutyl Phthalate	L	No	Yes	~0.01	0.403		(2)	(2)	(2)	-	X	X	-	X	Yes	No(ACE) [12]	Toxic rating as butyl alcohol
DBT	Dibutyl Phenol	S	No	Yes	<0.25	(5)	(10)	(3)	(3)	(3)	-	-	X	X	-			Toxic rating & TLV as phenol
DI	Dicamba	S	No	-	DNA	D												Probably moderately toxic, herbicide & pest control [5]
DIB	Dichlobenil	S	No	-	~0.001	DNA					X	-	-	-	X			Toxic by inhalation & ingestion [5]
DCL	Dichlone	S	No	-	DNA	DNA		2	-	2	X	X	-	-	X			Fungicide
DTM	4,4 Dicnloro-Alpha Trichloromethyl-Benzhydrol	S	-	Yes	<0.25	DNA					-	-	X	-	X			Low toxicity, air supply
DBO	o-Dichlorobenzene	L	No	Yes	3.2	50		2	-	3	-	-	X	X		No		
DBP	p-Dichlorobenzene	S	No	Yes	4.8	75		1	-	1	X	-	-	-	X	Yes	Yes	
DCB	Dichlorobutene	L	No	Yes	7.4	DNA		U	U	U	-	-	X	X	-			Irritant to eyes, skin, causes blisters [5]
DCF	Dichlorodifluoromethane	G	No	No	>760	1000	1250	1	-	-	-	X	-	-	X	Yes	Yes	
DCH	1,1-Dichloroethane	L	No	Yes		DNA		2	-	1	-	X	X	-	X	No[14] (Nitrile)		Moderately toxic [5]
DEE	Dichloroethylether	L	Yes	Yes	1.2	5	10	3	3	3	-	-	X	X	-	No		
DEL	1,2-Dichloroethylene	L	No	Yes	432	200	250	2	2	1	-	X	X	-	X	Yes	No	
DCM	Dichloromethane	L	No	Yes	>760	200	250	3	2	2	-	-	X	-	X	Yes	No	

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION: RESPIRATORY			CLOTHING		MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	NS	B	P	
DCP	2,4-Dichlorophenol	S	No	Yes	0.35	DNA		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as chlorinated phenols
DCA	2,4-Dichlorophenoxyacetic Acid	S	No	Yes	<0.25	10*		2	-	2	X	X	-	-	X	Yes	Yes	
DPP	1,2-Dichloropropane	L	No	Yes	93	75	110	3	3	2	-	-	X	X	-	Yes	No	
DPR	Dichloropropene	L	No	Yes	026	DNA		2	-	2	-	X	X	-	X	Yes	No	
DCV	Dichlorovos	L	No	-	14*	0.1	0.3				-	-	X	X	-			Highly toxic [8]
DPT	Dicyclopentadiene	S	No	Yes	6.5	75					-	-	X	X	-	Yes	Yes	Very toxic [8]
DEC	Dieldrin	S	No	No	<0.25	0.25*		3	3	-	-	-	X	X	-	Yes	Yes	
DEA	Diethanolamine	L	No	Yes	<0.01	DNA		1	-	1	-	X	-	-	X	Yes	No	Low toxicity
DEC	Diethyl Carbonate	L	No	Yes	21	200		2	-	2	-	X	X	-	X	Yes	Yes	
DPH	Diethyl Fhthalate	L	No	Yes	<0.25	5*	10*	2	-	2	-	X	X	-	X			
DEN	Diethylamine	L	No	Yes	39	25		-	-	2	-	X	X	-	X	Yes	No	
DEB	Diethylbenzene	L	No	Yes	2.6	DNA		2	2	2	-	X	X	-	X	Yes	No	
DEG	Diethylene Glycol	L	No	Yes	0.01	100		2	-	1	-	X	X	-	X	Yes	Yes	
DGD	Diethylene Glycol Dimethyl Ether	L	No	Yes	6.0	DNA		(2)	-	(1)	-	X	X	-	X	Yes	No	As glycol
DME	Diethylene Glycol Monobutyl Ether	L	No	Yes	0.17	DNA		(2)	-	(1)	-	X	X	-	X	Yes	No	As glycol
DEM	Diethylene Glycol Monobutyl Ether Acetate	L	No	Yes	0.02	DNA		(2)	-	(1)	-	X	X	-	X			As glycol
DGF	Diethylene Glycol Monoethyl Ether	L	No	Yes	0.6	100		(2)	-	(1)	-	X	X	-	X			As glycol
DGM	Diethylene Glycol Monomethyl Ether	L	No	Yes	0.7	DNA		(2)	-	(1)	-	X	X	-	X	No		As glycol
DET	Diethylenetriamine	L	No	Yes	1.1	1		2	2	2	-	X	X	-	X	Yes	No(ACE) [12]	
DEZ	Diethyl Zinc	L	Yes	Yes	36.1	DNA								Fire	Suit			Decomposes violently in water, ignites spontaneously in air
DFE	1,1 Difluoroethane	G	No	Yes	>760	200		2	-	1	-	X	X	-	X	Yes	Yes	
DFA	Difluorophosphoric Acid Anhydrous	L	Yes	No	58	DNA		(3)	-	(3)	-	-	X	X	-	Yes	No	Toxic rating as fluorides
DHP	Diheptylphthalate	L	-	Yes	<0.25	DNA		-	-	(2)	-	-	-	-	X			Toxic rating as DID
DIK	Diisobutyl Ketone	L	No	Yes	5.0	25		2	-	2	-	X	X	-	X	Yes	No	
DBC	Diisobutylcarbinol	L	No	Yes	3	DNA					-	X	X	-	X	Yes	Yes	Animal experiments indicate low toxicity
DBL	Disobutylene	L	No	Yes	67	DNA		1	-	2	-	X	-	-	X	Yes	Yes	Narcotic in high concentrations
DID	Diisodecylphthalate	L	-	Yes	<0.25	DNA		-	-	2	-	-	-	-	X	No		
DIP	Diisopropanolamine	S/L	No	Yes	<0.02	DNA					-	X	-	-	X	Yes	No	Low toxicity [5]
DIA	Diisopropylamine	L	No	Yes	136	5.0		2	2	2	-	X	X	-	X	Yes	No	
DIH	Diisopropylbenzene Hydroperoxide	L	-	-	<0.25	DNA		U	U	U	-	-	X	X	-			Strong oxidizer, probably toxic
DIM	Dimethyl Ether	G	No	Yes	>760	DNA		2	2	1	-	X	X	-	X	No		
DSF	Dimethyl Sulfate	L	No	Yes	1.6	0.1		3	3	3	-	-	X	X	-	Yes	Yes	
DSL	Dimethyl Sulfide	L	No	Yes	>760	DNA		U	U	U	-	-	X	X	-	Yes	Yes	Probably highly toxic, see sulfides as irritant
DMS	Dimethyl Sulfoxide	L	No	Yes	1.5	DNA		1	2	2	-	X	-	-	X	Yes	Yes	
DMT	Dimethyl Terephthalate	S	No	Yes	<0.01	DNA					X	-	-	-	X	Yes	Yes	Dust not harmful
DAC	Dimethylacetamide	L	No	Yes	4.2	10	15	3	3	2	-	-	X	X	-	Yes	No	
DMA	Dimethylamine	G	No	Yes	>760	10		2	-	2	-	X	X	-	X	Yes	No	
DMD	Dimethyldichlorosilane	L	Yes	Yes	240	DNA		(3)	-	(3)	-	-	X	X	-	Yes	No	Toxic rating as chlorosilanes
DMF	Dimethylformamide	L	No	Yes	0.8	10	20	2	2	2	-	X	X	-	X	Yes	No	
DDM	Dimethylhexane Dihydroperoxide, Wet	S	No	Yes	<0.25	DNA					-	-	X	X	-			Organic peroxides, irritant to skin & tissue & eyes

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
DMH	1,1 Dimethylhydrazine	L	Yes	Yes	~5	0.5	1.0	3	3	3	-	-	X	X	-	Yes	No	Experimental carcinogen
DMP	Dimethylpolysiloxane	L	No	Yes	DNA	DNA					-	-	-	-	X			10 ppm in food (0 in milk)[5] irritating to eyes
DMZ	Dimethylzinc	L	-	-	595	DNA								Fire	Suit			Pyrophoric
DNT	2,4-Dinitroaniline	S	No	Yes	<0.25	DNA		2	-	2	X	X	-	-	X			
DNZ	Dinitrobenzene	S	No	Yes	<0.1	0.15/1*	0.5	3	3	-	-	-	X	X	-			Slight fire hazard
DNB	Dinitrobenzene(M-)	S	No	Yes	<0.25	0.1* [9]		(3)	(3)	-	-	-	X	X	-	Yes	Yes	As dinitrobenzene,toxic rating
DNC	Dinitrocresols	S	No	Yes	<0.01	0.2* [9]		3	3	3	-	-	X	X	-	Yes	Yes	
DNP	2,4-Dinitrophenol	S	No	Yes	<0.25	DNA		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	As 2-3 dinitrophenol
DOT	2,4-Dinitrotoluene	S	No	Yes	<0.01	1.5* [9]		3	3	1	-	-	X	X	-	Yes	Yes	
DOA	Dioctyl Adipate	L	No	Yes	<0.25	DNA					-	-	-	-	X	Yes	No	Low toxicity[5], irritating to eyes
DOP	Dioctyl Phthalate	L	No	Yes	<0.25	DNA		2	-	0	-	X	-	-	-	Yes	No	Low vapor pressure
DSS	Dioctyl Sodium Sulfosuccinate	S/L	No	No	<0.25	DNA		1	-	1	-	X	-	-	X	Yes	Yes	
DOX	1,4-Dioxane	L	Yes	Yes	67	50		3	2	2	-	-	X	-	X	No		
DPN	Dipentene	L	No	Yes	5.7	DNA		1	-	2	-	X	-	-	X	Yes	Yes	
DPE	Diphenylether	L	No	Yes	0.2	1.0 [9]					-	X	-	-	X	No		Vapor toxic by inhalation[8]; low toxicity [5]
DAM	Diphenylamine	S	No	Yes	<0.25	10* [9]		3	3	-	-	-	X	X	-	Yes	Yes	
DPD	Diphenyldichlorosilane	L	Yes	Yes [5]	~0.01	DNA		3	-	3	-	-	X	X	-			
DPM	Diphenylmethane Diisocyanate	S	Slow	Yes	<0.25	0.02 [5]					-	-	X	X	-	Yes	Yes	Toxic,strong irritant [5]
DPG	Dipropylene Glycol	L	No	Yes	<0.01	DNA		U	U	U	-	X	-	-	-	Yes	Yes	Moderately toxic by ingestion[5]
DIQ	Diquat	S	No	-	0.5*			3	3	3	-	-	X	X	-			Highly toxic contact herbicide & desiccant; see paraquat
DFF	Distillates, Flashed Feed Stocks	L	No	Yes	93	500/30 min [9]					-	-	X	-	X	No		Mixed hydrocarbon-low toxicity
DSR	Distillates, Straight Run	L	No	Yes	93	"					-	-	X	-	X	No		Same as DFF
DIS	Disulfton	L	No	-	DNA	0.1*					-	-	X	X	-			Insecticide,cholinesterace inhibitor [5])
DIU	Diuron	S	No	-		10*		U	U	U	-	-	X	X	-			Skin irritant; hydrolyze to di-chloroaniline; see Aniline
DDN	Dodecanol	S	No	Yes	0.03	DNA		U	U	U	X	-	-	-	X	Yes	Yes	Low toxicity[5]; animal experiments indicate low toxicity[8]
DOD	Dodecene	L	No	Yes	0.56	200 [9]		U	U	U	-	X	-	-	X	Yes	Yes	Probably irritant & narcotic in high conc. [5]
DDC	1-Dodecene	L	No	Yes	0.56	DNA					-	X	-	-	X	Yes	Yes	Same as above [5]
DSA	Dodecyl Benzene Sulfonic Acid	S	No	Yes		DNA					X	-	-	-	X			Biodeg.detergent;strong org.acid
DAS	Dodecyl Benzene Sulfonic Acid, Sodium Salt	S	No	Yes	-	DNA					X	-	-	-	X			As DSA, some skin irritation
DSD	Dodecyl Sulfate, Diethanolamine Salt	L	-	-	<0.25	DNA												Irritates eyes & skin
DSM	Dodecyl Sulfate, Magnesium Salt	L	-	-	<0.25	DNA												Irritates eyes & skin
DDS	Dodecyl Sulfate, Sodium Salt	S	-	-	<0.25	DNA												Irritates eyes & skin
DST	Dodecyl Sulfate, Triethanolamine Salt	L	-	-	<0.25	DNA												Irritates eyes & skin
DDB	Dodecylbenzene	L	No	Yes[5]	<0.25	DNA		U	U	U	-	-	X	X	-			Moderately toxic by ingestion [5], see benzene [5]
DCS	Dodecylbenzene Sulfonic Acid, Calcium Salt	L	-	Yes		DNA					-	X	-	-	X			Similar to DSA
DAI	Dodecylbenzene Sulfonic Acid, Isopropylamine Salt	S	-	-	<0.25	DNA												
DBS	Dodecylbenzene Sulfonic Acid, Triethanolamine Salt	L	-	-	<0.25	DNA					-	X	-	-	X			Based on triethanolamine
DTC	Dodecyltrichlorosilane	L	Yes	Yes	<0.03	DNA		(3)	-	(3)	-	-	X	X	-	Yes	No	As silanes;irritant, toxic mtl.
DTH	Dowtherm	L	No	Yes	~0.07	DNA		-	-	-	-	-	-	-	X	Yes	Yes	Liquid heating transfer media
DUR	Dursban	-	-	-		DNA		(3)	(3)	-	-	-	X	X	-			As parathion; cholinesterace inhibitor

C	CN	S	WR	F	VP	TLV (PPM OR MG/M³)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
ESF	Endosulfane	S	No	-		0.1*[5]		-	-	-	-	-	X	X	-			Highly toxic insecticide; skin adsorption
EDR	Endrin	S	No	Yes	<0.01	0.1*[9]		(3)	(3)	-	-	-	X	X	-	Yes	Yes	As aldrins; insecticide
EPC	Epichlorohydrin	L	No	Yes	34	5	10	3	3	3	-	-	X	X	-	Yes	Yes	
EVO	Epoxied Vegetable Oils	L	-	Yes	-	DNA	-				-	-	-	-	-	Yes	Yes	Not harmful
ETH	Ethane	G	No	Yes	>760	1000		2	-	-	-	X	X	-	-	Yes	Yes	
ETO	Ethion	L	No	-		0.4*		(3)	(3)	-	-	-	X	X	-			As parathions; cholinesterace inhibitor
ETG	Ethoxy Triglycol	L	No	Yes	<0.1	DNA		-	-	-	-	X	-	-	X	Yes	Yes	Low toxicity[5]; most glycols not toxic [8]
EHP	Ethoxydihydropyran	L	No	Yes[5]	DNA	DNA												Mod. toxic-in animal experiments
EOD	Ethoxylated Dodecanol	L	No	Yes	<0.25	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Burns eyes, irritates skin, surfactant
ENO	Ethoxylated Nonylphenol	L	-	-	<0.25	DNA		U	U	U	-	X	-	-	X			Irritates skin & eyes, surfactant
EOP	Ethoxylated Pentadecanol	L	No	Yes	<0.25	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Burns eyes, irritates skin
EOT	Ethoxylated Tetradecanol	L	No	Yes	<0.25	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Burns eyes, irritates skin
ETD	Ethoxylated Tridecanol	L	No	Yes	<0.25	DNA					-	X	-	-	X	Yes	Yes	Burns eyes, irritates skin
ETA	Ethyl Acetate	L	No	Yes	165	400		2	2	1	-	X	X	-	X	Yes	Yes	
EAA	Ethyl Acetoacetate	L	No	Yes	5	50[2]		2	-	2	-	X	X	-	X	Yes	No	
EAC	Ethyl Acrylate	L	No	Yes	77	25		3	3	3	-	-	X	X	-	Yes	No	
EAL	Ethyl Alcohol	L	No	Yes	67	1000		2	1	1	-	X	X	-	X	Yes	Yes	
EBT	Ethyl Butanol	L	No	Yes	3.5	2		-	-	-	-	X	-	-	X	Yes	Yes	Low toxicity[5]; no general statement; alcohols, burns eyes
EBR	Ethyl Butyrate	L	No	Yes	37	DNA		U	U	U						Yes	No	Irritating to eyes & mucous membranes; narcotic in high conc.[5]
ECL	Ethyl Chloride	G	Yes	Yes	>760	1000	1250	2	-	1	-	-	X	-	X	Yes	No(ACE)	[12]
ECA	Ethyl Chloroacetate	L	Yes	Yes	10	DNA		2	-	2	-	X	X	-	X	Yes	No	
ECF	Ethyl Chloroformate	L	Yes	Yes	19	DNA		3	-	3	-	-	X	X	-	Yes	No	
EET	Ethyl Ether	L	No	Yes	>760	400	500	2	2	2	-	X	X	-	X	Yes	No(ACE)	[12]
EFM	Ethyl Formate	L	Yes	Yes	413	100	150	2	-	2	-	X	X	-	X	Yes	No	
EHX	2-Ethyl Hexanol	L	No	Yes	0.7	DNA		-	-	-	-	X	-	-	X	Yes	Yes	Low toxicity [5]
ELT	Ethyl Lactate	L	No	Yes	10	DNA					-	X	X	-	X	Yes	No	Low toxicity [5]; harmful if swallowed
EMC	Ethyl Mercaptan	L	Yes	Yes	>760	0.5	2.0	2	-	2	-	X	X	-	X	Yes	Yes	Moderately toxic [5]
EMA	Ethyl Methacrylate	L	No	Yes	37	DNA		-		-	-	-	X	X	-	Yes	Yes	Readily polymerizes; mod toxic & irritating in animal expt.[5]
ENI	Ethyl Nitrite	L/G	Yes	Yes	>760	DNA		2	-	-						Yes	Yes	Narcotic high conc. [8]
EPD	Ethyl Phosphonothioic Dichloride, Anhydrous	L	-	Yes	5.1	DNA		U	U	U	-	-	X	X	-			Corrosive, highly toxic[8], poisonous gas contact w/water
EPP	Ethyl Phosphorodichloridate	L	Yes	Yes	3.8	DNA					-	-	X	X	-			Burns skin & eyes
ESC	Ethyl Silicate	L	Yes	Yes	5.5	100		2	-	2	-	X	X	-	X	Yes	Yes	
EPA	2-Ethyl-3-Propylacrolein	L	No	Yes	3.6	DNA		2	-	2	-	X	X	-	X	Yes	Yes	Powerful odor [5]
EAD	Ethyl Aluminum Dichloride	L	Yes	Yes	1.5	DNA		-	-	-	-		X	Fire Suit		Yes	No	Very irritating & toxic, pyrophoric, pyrophoric suit
EAS	Ethyl Aluminum Sesquichloride	L	Yes	Yes	1.5	DNA		-	-	-				Fire Suit				Pyrophoric, fire suit
EAM	Ethylamine	L	No	Yes	>760	10		3	-	3	-	-	X	X	-	Yes	No	
ETB	Ethylbenzene	L	No	Yes	18	100	125	2	2	2	-	X	X	-	X	No		
ECS	Ethyldichlorosilane	L	Yes	Yes	213	DNA		3	-	3	-	-	X	X	-	Yes	No	
ETL	Ethylene	G	No	Yes	>760	1000		2	0	0	-	X	X	-	-	Yes	Yes	
ECH	Ethylene Chlorohydrin	L	Yes	Yes	14.6	5		3	3	2	-	-	X	X	-	Yes	No	

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATI-BILITY		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
ETC	Ethylene Cyanohydrin	L	Yes	Yes	0.15	DNA		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as CN
EDB	Ethylene Dibromide	L	No	No	28	0.385		3	3	3	-	-	X	X	-	Yes	Yes	
EDC	Ethylene Dichloride	L	No	Yes	139	5		3	-	3	-	-	X	X	-	Yes	No	
EGL	Ethylene Glycol	L	No	Yes	0.25	100					-	X	-	-	X	Yes	Yes	Ingestion hazard, toxic in particulate form [8]
EGY	Ethylene Glycol Diacetate	L	No	Yes	1.0	DNA		U	U	U	-	X	-	-	X			Low toxicity[5], irritates skin & eyes
EEE	Ethylene Glycol Diethyl Ether	L	No	Yes	9.7	DNA					-	-	X	-	X			" " " "
EGD	Ethylene Glycol Dimethyl Ether	L	No	Yes	119	DNA		U	U	U	-	-	X	-	X	Yes	No	Fire risk[5],not skin irritant
EGM	Ethylene Glycol Monobutyl Ether	L	No	Yes	1.9	50		-	-	-	-	X	X	-	X	Yes	No	Toxicity-glycol;mod. toxic[5]
EMA	Ethylene Glycol Monobutyl Ether Acetate	L	No	Yes	0.37	DNA		-	-	-	-	X	-	-	X	Yes[11]		Low toxicity[5], irritates skin & eyes
EGE	Ethylene Glycol Monoethyl Ether	L	No	Yes	11.9	200		-	2	1	-	X	X	-	X	Yes	No	
EGA	Ethylene Glycol Monoethyl Ether Acetate	L	No	Yes	51	25	35	1	2	1	-	X	-	-	X	Yes	No	Low toxicity [5]
EME	Ethylene Glycol Monomethyl Ether	L	No	Yes	23	25		U	U	U	-	-	X	-	X	Yes	Yes	Toxic by inhalation & ingestion [5]
EOX	Ethylene Oxide	G	No	Yes	>760	50	75	2	-	3	-	-	X	X	-	Yes	Yes	
EDA	Ethylenediamine	L	No	Yes	29	10		3	2	3	-	-	X	-	X	Yes	No(ACE) [12]	
EDT	Ethylenediamine Tetracetic Acid	S	No	No	<0.25	DNA		1	-	1	X	-	-	-	X	Yes	No	Low toxicity [5]
ETI	Ethyleneimine	L	No	Yes	362	5/30 min		3	3	3	-	-	X	X	-	Yes	No	
EHA	Ethylhexaldehyde	L	No	Yes	5.7	DNA		(3)	1	(3)	-	-	X	X	-			Toxic rating as aldehydes
EAI	2-Ethylhexyl Acrylate	L	No	Yes	0.43	DNA		(3)	-	(3)	-	-	X	X	-	Yes	No	Toxic rating as acrylic acid
EHT	Ethylhexyl Tallate	L	No	Yes	DNA	DNA					-	-	-	-	-	Yes	Yes	Not harmful
ENB	Ethylidenenorbornene	L	Nc	Yes	11.3	0.2[5]					-	-	X	X	-			Toxic [5]
EPS	Ethylphenyl Dichlorosilane	L	Yes	Yes	0.57	DNA		3	-	3	-	-	X	X	-	Yes	No	
ETS	Ethyltrichlorosilane	L	Yes	Yes	61	DNA		3	-	3	-	-	X	X	-	Yes	No	
FAC	Ferric Ammonium Citrate	S	No	Yes	<0.25	DNA		U	U	U	X	-	-	-	X	Yes	Yes	Low toxicity
FAO	Ferric Ammonium Oxalate	S	No	No	<0.25	1* (Fe)					-	-	X	X	-	Yes	Yes	Moderately toxic [5], burns skin
FCL	Ferric Chloride	S	Yes	No	<0.25	1* (Fe)		-	-	1*	-	-	X	X	1	Yes	Yes	Water reacts to HCl, strong irritant skin & tissue [5]
FX	Ferric Fluoride	S	No	-		2.5 (F)		(3)	-	(3)	-	-	X	X	-			Toxic strong irritant; toxic rating as fluoride
FCP	Ferric Glycerophosphate	S	No	No	<0.25	1* (Fe)					X	-	-	-	X	Yes	Yes	Used in pharmaceuticals [5]
FNT	Ferric Nitrate	S	No	Yes	<0.25	1* (Fe)		1	-	2	X	-	-	-	X	Yes	Yes	
FSF	Ferric Sulfate	S	No	No	<0.25	1* (Fe)		-	-	1	X	-	-	-	X	Yes	Yes	
FAS	Ferrous Ammonium Sulfate	S	No	No	<0.25	1* (Fe)					X	-	-	-	X	Yes	Yes	Based on ferrous sulfate and ammonium sulfate
FEC	Ferrous Chloride	S	No	No	<0.25	1* (Fe)		-	-	,	X	-	-	-	X	Yes	Yes	
FFB	Ferrous Fluoborate	L	-	-	DNA	0.098					-	-	X	X	-			Poisonous if inhaled,irritant to skin & tissue
FOX	Ferrous Oxalate	S	No	No	<0.25	50 (Co)		-	-	3	-	-	X	X	-	Yes	Yes	Evolves CO on heating; toxic rating oxalates
FRS	Ferrous Sulfate	S	No	No	<0.25	DNA		2	-	1	X	X	-	-	X	Yes	Yes	Low toxicity
FXX	Fluorine	G	Yes	No	>750	1	2	3	-	3	-	-	X	X	-	No	PVC)[18]	
FSL	Fluosilicic Acid	L	Yes	No	Fumes	DNA		3	-	3	-	-	X	X	-	No(PVC) [11]	(PVC) [11]	Fuming liquid, high toxicity
FSA	Fluosulfonic Acid	L	Yes	No	6.0	DNA		3	-	3	-	-	X	X	-	No		
FMS	Formaldehyde Solution	L	No	Yes	4.6	2		3	-	3	-	-	X	X	-	Yes	Yes	
FMA	Formic Acid	L	No	Yes	77	5		2	-	2	-	X	X	-	X	Yes	Yes	Avoid skin contact [5]
FUM	Fumaric Acid	S	No	Yes	<0.1	DNA		-	-	1	X	-	-	-	X	Yes	Yes	

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
											RESPIRATORY			CLOTHING				
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	NS	B	P	
FFA	Furfural	L	No	Yes	5.1	5	15	2	2	2	-	X	X	-	X	Yes	Yes	Dangerous to eyes [8]
FAL	Furfuryl Alcohol	L	No	Yes	0.16	5	10	-	-	-	-	X	-	-	X	Yes	Yes	Toxic by inhalation [5], but used as food additive
GLA	Gallic Acid	S	No	Yes	<0.11	DNA		-	-	-	X	-	-	-	X	Yes [11]	(PVC) [11]	Mild irritant
GOC	Gas Oil: Cracked	L	No	Yes	Propane	500/30min		(2)	-	(1)	-	X	X	-	X			Toxic rating as kerosene
GAK	Gas Blending Stocks: Alkalates	L	No	Yes	Hexane	500/30min		(1)	-	(1)	-	X	-	-	X	No		Toxic rating as hexane
GRF	Gas Blending Stocks: Reformates	L	No	Yes	Hexane	500/30min		(2)	-	(2)	-	X	X	-	X			Toxic rating as hexane
GAT	Gasoline, Automotive (4.23 G PB/Gal)	L	No	Yes	Propane	500/30min		(2)	(0)	(0)	-	X	X	-	-	No		Toxic rating as propane
GAV	Gasoline, Aviation 4.86 G PB/Gal)	L	No	Yes	Butane	500/30min		(2)	(0)	(0)	-	X	X	-	-	No		Toxic rating as butane
GCS	Gasoline: Casinghead	L	No	Yes	Butane	500/30min					-	X	X	-	X	No		Irritates skin & eyes
GPL	Gasoline: Polymer	L	No	Yes	Pentane	500/30min		(1)	(0)	(0)	-	X	-	-	-			Toxic rating as pentane
GSR	Gasoline: Straight Run	L	No	Yes	Pentane	500/30min		(2)	(1)	-	-	X	X	-	X	No[11] (PVC[11])	Yes[12]	Toxic rating as pentane
GTA	Glutaraldehyde, Solution	L	No	No	0.1	0.25*		(3)	(1)	(3)	-	-	X	X	-			Toxic rating as aldehydes
GCR	Glycerine	L	No	Yes	0.1	DNA		-	-	1	-	X	-	-	X	Yes	Yes	Low toxicity [5]
GCM	Glycidyl Methacralate	L	No	Yes	<0.25	25					-	-	X	X	-	Yes	Yes	Burns skin & eyes, glycidyl acrylate - Sax 3 Rating
GOS	Glyoxal, 40% Solution	L	Yes	Yes	~300	DNA		2	-	2	-	X	X	-	X			
HTC	Heptachlor	S	No	No	<0.25	0.5*					-	-	X	X	-	Yes	Yes	Highly toxic by inhalation, skin, ingestion
HPT	Heptane	L	No	Yes	98	400	500	-	-	1	-	-	X	-	X	No(ACE) [12]	Yes[12]	Narcotic high conc.,irritates respiratory track
HTN	Heptanol	L	No	Yes	1.2	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Low toxicity[5],not harmful
HTE	1-Heptene	L	No	Yes	103	DNA		1	-	-	-	X	-	-	X	No		Asphyxiant,effects as argon[8]
HCC	Hexachlorocyclopentadiene	L	No	No	0.26	0.1	0.3	3	1	0	-	-	X	-	X			Toxic rating as CCl_4, toxic[5] readily skin absorbed
HSS	Hexadecyl Sulfate, Sodium Salt	L	-	-	0.26	DNA					-	X	-	-	X			Similar to surfactants,cosmetics
HAC	Hexadecytrimethylammonium Chloride	L	-	Yes	<0.25	DNA					-	-	X	X	-			Irritates skin & eyes Severe eye & skin damage on cont
HAL	n-Hexaldehyde	L	No	Yes	~10	DNA		(3)	1	(3)	-	-	X	X	-	Yes[11]		Toxic rating as aldehydes
HMD	Hexamethylenediamine	S	No	Yes	17	DNA		-	-	2	-	-	X	X	-	Yes	No.	Poisonous if swallowed, strong skin irritant or skin exposed[5]
HMI	Hexmethyleneimine	L	No	Yes	1.0	DNA		U	U	U	-	-	X	X	-			Burns skin & eyes
HMT	Hexamethylenetetramine	S	No	Yes	<0.25	DNA		-	-	2	-	-	X	X	-	Yes	Yes	Same as HMD
HXA	Hexane	L	No	Yes	258	100	125	1	-	1	-	X	-	-	X	No(PVC [11]	(PVC) [11]	
HXN	Hexanol	L	No	Yes	39	DNA		-	-	-	-	-	X	-	X	Yes	Yes	Toxicity ~alcohols, Low
HXE	1-Hexene	L	No	Yes	310	500		2	-	2	-	X	X	-	X	No		
HXG	Hexylene Glycol	L	No	Yes	0.3	25		1	-	2	-	X	-	-	X	Yes	Yes	
HDZ	Hydrazine	L	No	Yes	29	0.1		3	3	3	-		X	X	-	Yes[11]	Yes[12]	Poisonous through skin
HCL	Hydrochloric Acid	L	Yes	No	362	5		3	-	3	-	-	X	X	-	Yes[11]	PVC[11]	
HFA	Hydrofluoric Acid	L	Yes	No		3		3	-	3	-	-	X	X	-	No(PVC [11]	PVC[11]	
HBR	Hydrogen Bromide	G	Yes	No	>760	3		3	-	3	-	-	X	X		Yes[11]	PVC[11]	
HDC	Hydrogen Chloride	G	Yes	No	>760	5		3	-	3	-	-	X	X	-	Yes[11]	PVC[11]	
HCN	Hydrogen Cyanide	G	Yes	Yes	>760	10	15	3	3	2	-	-	X	X	-	Yes[11]	PVC[11]	
HFX	Hydrogen Fluoride	G	Yes	No	>760	3		3	-	3	-	-	X	X	-	No PVC [11]	PVC[11]	
HPO	Hydrogen Peroxide	L	No	Yes		1	2	3	-	3	-	-	X	X	-	Yes	Yes	
HDS	Hydrogen Sulfide	G	No	Yes	>760	10	15	3	-	3	-	-	X	X	-	Yes[11]	Yes[12] PVC[11]	
HXX	Hydrogen, Liquified	L/G	No	Yes	>760	DNA		1	0	0	-	X	X	-	-	Yes	Yes	

C	CN	S	MR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	CLOTHING AS	CLOTHING SS	CLOTHING NS	B	P	
HDQ	Hydroquinone	S	No	Yes	0.11	2*		3	-	2	-	-	X	-	X	No[11] PVC[11]	PVC[11]	
HAI	2-Hydroxyethyl Acrylate (Inhibited)	L	-	Yes	~1.0	DNA					-	-	X	X	-			Burns skin & eyes
HDA	Hydroxylamine	S	No	Yes	<10	DNA		2	-	2	X	X	-	-	X			
HAS	Hydroxylamine Sulfate	L	No	Yes	DNA	DNA		(3)	-	(3)	-	-	X	X	-	(PVC)[18]	(PVC)[18]	Toxic rating as sulfuric acid
HPA	Hydroxypropyl Acrylate	L	-	Yes	<20	DNA					-	-	X	X	-			Acrylates-generally high toxicity Burns skin & eyes
HPM	Hydroxypropyl Methacrylate	L	No	Yes	<1	DNA					-	X	-	-	X			Low toxicity[5],burns eyes
IAA	Isoamyl Alcohol	L	No	Yes	8.3	100	125	3	-	2	-	-	X	-	X	Yes	Yes	
IBT	Isobutane	G	No	Yes	>760	DNA		1	0	0	-	X	-	-	-	Yes	Yes	
IBA	Isobutyl Acetate	L	Yes	Yes	35	150	187	2	-	2	-	X	X	-	X	Yes	No	
IAL	Isobutyl Alcohol	L	No	Yes	26	50	75	2	-	2	-	X	X	-	X	Yes	Yes	
IAM	Isobutylamine	L	No	Yes	244	5		2	-	3	-	-	X	X	-	Yes	No	
IBL	Isobutylene	L	-	Yes	>760	1000		-	-	-	-	-	X	-	-	Yes	Yes	Asphyxiant, nontoxic [5]
IBR	Isobutyric Acid	L	No	Yes	3.6	DNA		(1)	(1)	2				-	X	Yes	Yes	Toxic rating inhal. - Skin as butric acid
IBN	Isobutyronitrile	L	No	Yes	43	22		(3)	(3)	(1)	-	-	X	X	-			Toxic rating as cyanide
IOC	Isoctaldehyde	L	-	Yes	0.9	DNA		(3)	(1)	(3)	-	-	X	X	-	Yes	No	Toxic rating as aldehydes
IDA	Isodecaldehyde	L	No	Yes	~0.4	DNA		(3)	(1)	(3)	-	-	X	X	-	Yes	No	Toxic rating as aldehydes
IAI	Isodecyl Acrylate (Inhibited)	L	No	Yes	~0.25	DNA					-	-	X	X	-			Same as HAI
ISA	Isodecyl Alcohol	L	No	Yes	<0.25	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Alcohols generally low toxicity [5]
IHX	Isohexane	L	No	Yes	362	DNA		(1)	-	(1)	-	X	-	-	X	No		Toxic rating as hexane; low toxicity
IOA	Isooctyl Alcohol	L	No	Yes	1.4	DNA					-	X	-	-	X	Yes	Yes	Low toxicity[5], alcohol
IPT	Isopentane	L	No	Yes	103	DNA		(1)	U	U	-	X	-	-	-	No		Low toxicity[5]; see pentane
IPH	Isophorone	L	No	Yes	1.0	(C) 5		3	-	2	-	-	X	-	X	Yes	Yes	
IPL	Isophthalic Acid	S	No	Yes	<0.25	DNA		1	-	1	X	-	-	-	X	Yes	Yes	
IPR	Isoprene	L	No	Yes	>760	DNA		2	-	2	-	X	X	-	X	No		
IAC	Isopropyl Acetate	L	No	Yes	103	250	310	2	-	1	-	X	X	-	X	Yes	No	
IPA	Isopropyl Alcohol	L	No	Yes	93	400	500	2	-	1	-	X	X	-	X	Yes	Yes	
IPE	Isopropyl Ether	L	No	Yes	242	250	310	2	-	3	-	-	X	X	-	Yes	Yes	
IPM	Isopropyl Mercaptan	L	-	Yes	~150	DNA		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as mercaptan
IPC	Isopropyl Percarbonate	S	No	Yes	DNA	DNA		U	U	U						Yes	Yes	Legal name Diisopropyl peroxy dicarbonate;unstable & stable forms.Flammable & corrosive fumes
IPP	Isopropylamine	L	No	Yes	>760	5.0	10	2	-	3	-	-	X	X	-	Yes	No	
IVA	Isovaleraldehyde	L	No	Yes	111	DNA		(3)	(1)	(3)	-	-	X	X	-	Yes	No	As aldehydes, low toxicity[5]
JPO	Jet Fuel:JP-1 (Kerosene)	L	No	Yes	5	200[9]		(2)	-	(1)	-	X	X	-	X	No(PVC)	Yes[12]	As kerosene toxicity
JPT	Jet Fuel: JP-3	L	No	Yes	299	200[9]		(2)	-	(1)	-	X	X	-	X	No(Buna PVC[11]	Yes	As kerosene toxicity
JPF	Jet Fuel: JP-4	L	No	Yes	145	200[9]		(2)	-	(1)	-	X	X	-	X	"	Yes	As kerosene
JPV	Jet Fuel: JP-5(Kerosene, Heavy)	L	No	Yes	2	200[9]		(2)	-	(1)	-	X	X	-	X	"	Yes	As kerosene
KPE	Kepone		No	-	-	DNA		(2)	-	(1)	-	X	X	-	X	"	Yes	As kerosene
KRS	Kerosene	L	No	Yes	5	200[9]		2	-	1	-	X	X	-	X	No(PVC)[12]	Yes[12]	
LTA	Lactic Acid	L	No	Yes	~0.1	DNA		-	-	2	-	X	X	-	X	Yes	Yes	
LLS	Latex, Liquid Synthetic	L	No	No	<0.25	DNA		-	-	2	-	X	-	-	X	Yes	Yes	Could contain ammonia [5]
LPO	Lauroyl Peroxide	S	No	Yes	<0.03	DNA		3	-	3	-	-	X	X	-	Yes	Yes	

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
LPM	Lauryl Mercaptan	L	No	Yes	~0.03	DNA		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As mercaptans
LAC	Lead Acetate	S	No	No	<0.25	0.15*(Pb)		3	-	0	-	-	X	X	-	Yes	Yes	Suspected carcinogen as lead[8]; absorbed via skin,inhalation[5]
LAR	Lead Arsenate	S	No	No	<0.25	0.15*(Pb)		(3)	-	(2)	-	-	X	X	-	Yes	Yes	As arsenic compounds;suspected carcinogen[8]
LCL	Lead Chloride	S	No	No	-	0.15*(Pb)		3	0	0	-	-	X	-	X			
LFB	Lead Fluoborate	L	-	-	DNA	DNA		(3)		(3)	-	-	X	X	-			As fluoride, as fluoborate
LTR	Lead Fluoride	S	No	No	<0.25	0.15*(Pb) [9]		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As fluorides,toxic rating,strong irritant [5]
LID	Lead Iodide	S	No	No	<0.25	"		(3)	(0)	(0)	-	-	X	-	X	Yes	Yes	As lead cmpds; toxic rating
LNT	Lead Nitrate	S	No	Yes	<0.25	0.15*(Pb)		2)(3)	.0)	(0)	-	-	X	-	X	Yes	Yes	As nitrate(2-inhalation)as lead (3-inhalation)
LSA	Lead Stearate	S	No	Yes	-	DNA		(3)	(0)	(0)	-	-	X	X	-			As lead cmpd;absorbed by skin
LSF	Lead Sulfate	S	No	No	-	0.15*(Pb) [5]		(3)	(0)	(0)	-	-	X	-	X	Yes[11]	(PVC) [11]	As lead compds; toxic rating
LTT	Lead Tetraacetate	S	-	Yes	<0.25	0.15*(Pb)		(3)	(0)	(0)	-	-	X	X	-	Yes	Yes	As lead cmpd;absorbed by skin[5]
LTC	Lead Thiocynate	S	No	No	<0.25	0.15*(Pb)		(3)	(0)	(0)	-	-	X	-	X	Yes	Yes	As lead cmpd; toxic rating,decomp. hot water
LTS	Lead Thiosulfate	S	No	-		0.15*(Pb)		(3)	(0)	(0)	-	-	X	-	X	"	"	" "
LTU	Lead Tungstate	S	No			0.15*(Pb)		(3)	(0)	(0)	-	-	X	-	X	"	"	" "
LAL	Linear Alcohols (12-15 Carbons)	L	No	Yes	<0.03	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Alcohols, low toxicity [5]
LNG	Liquefied Natural Gas	L/G	No	Yes	>760	DNA		1	0	0	-	-	X	-	-	Yes	Yes	Asphyxiant
LPG	Liquefied Petroleum Gas	L	No	Yes	>760	1000		1	0	0	-	X	-	-	-	Yes	Yes	Asphyxiant
LTH	Litharge	S	No	No	<0.25	0.2*		(3)	(0)	(0)	-	-	X	-	X			Toxic rating as lead compound
LAH	Lithium Aluminum Hydride	S	Yes	Yes		DNA		(2)	-	(2)	X	X	-	-	X	Yes	Yes	Toxic rating as lithium compound
LBC	Lithium Bichromate	S	No			DNA		(3)	-	(3)	-	-	X	X	-			Carcinogen [8], toxic rating as chromium compound
LCR	Lithium Chromate	S	No	-		DNA		(3)	-	(3)	-	-	X	X	-			Carcinogen. Toxic rating as chromium compound
LHD	Lithium Hydride	S	Yes	Yes		0.0705		(2)	-	(2)	X	X	-	-	X			Toxic rating as lithium compound
LTM	Lithium Metal	S	Yes	Yes	<0.25	DNA		(2)	-	(2)	X	X	-	-	X	Yes	Yes	Low toxicity
MGX	Magnesium	S	Yes	Yes	<0.25	DNA		(2)	-	(1)	X	X	-	-	X	Yes	Yes	Toxic rating as magnesium cmpd.
MPG	Magnesium Perchlorate	S	No	Yes	<0.25	DNA		2	-	2	X	X	-	-	X	Yes	Yes	
MLT	Malathion	L	No	Yes	<0.25	0.00077					-	-	X	X	-	Yes	Yes	Cholinesterace inhibitor, inhal. & skin absorp. [5]
MLI	Maleic Acid	S	No	Yes	<0.25	DNA		2	-	3	-	-	X	X	-	Yes	Yes	
MLA	Maleic Anhydride	S	Yes	Yes	0.6	0.25/1*		3	-	3	-	-	X	X	-	Yes	Yes	
MLH	Maleic Hydrazide	S	No	Yes	~0.1	DNA		(3)	(3)	(3)	-	-	X	X	-			Toxic rating as hydrazine
MAT	Mercuric Acetate	S	No	No	DNA	0.05*(Hg)		(3)	(2)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating, organic Hg cmpd. Skin absorp. [5]
MCC	Mercuric Ammonium Chloride	S	No	No	DNA	0.05*(Hg)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " "
MRC	Mercuric Chloride	S	No	No	0.00047	0.05*(Hg)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " "
MCN	Mercuric Cyanide	S	No	No	DNA	0.05*(Hg)		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as cyanide
MID	Mercuric Iodide	S	No	No	<0.25	0.05*(Hg)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating-inorg. Hg. cmpd.
MNT	Mercuric Nitrate	S	No	Yes	DNA	0.05*(Hg)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " "
MOX	Mercuric Oxide	S	No	No	<0.25	0.05*(Hg)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " "
MRS	Mercuric Sulfate	S	Yes	-		0.05*(Hg)	0.15*	(3)	-	(3)	-	-	X	X	-	(PVC) [12]	Yes [12]	Toxic rating -inorg. Hg. cmpd.
MSF	Mercuric Sulfide	S	No	Yes	<0.25	0.05*(Hg)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " "
MRT	Mercuric Thiocyanate	S	No	-		0.05*(Hg)	0.15*	(3)	(2)	(3)	-	-	X	X	-			Toxic rating-org. Hg compounds
MRR	Mercurous Chloride	S	No	No	<0.25	0.05*(Hg)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating-inorg. Hg cmpds.

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
MRN	Mercurous Nitrate	S	No	Yes	DNA	0.05*(Hg)		(3)	-	(3)	-	-	-	-	-	Yes	Yes	Toxic rating-inorg. Hg cmpds. (shock sens.)
MCR	Mercury	L	No	No	0.005	0.05*(Hg)		(3)	-	(3)	-	-	X	X	-	Yes	Yes	" " " "
MSO	Mesityl Oxide	L	No	Yes	20	25		-	-	3	-	-	X	X	-	Yes	Yes	Toxicity;irr. inhal, skin [5]
MCL	Methallyl Chloride	L	No	Yes	220	DNA		2	-	2	-	X	X	-	X	No		
MTH	Methane	G	No	Yes	>160	DNA		1	0	0	-	-	X	-	-	Yes	Yes	
MSA	Methane Arsonic Acid, Sodium Salt	S	No	No	DNA	DNA		(1)	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as methane arsonic acid
MOC	Methoxychlor	S	No	No	<0.25	0.65		1	-	1	X	-	-	-	X	Yes	Yes	Less toxic than DDT [5]
MAP	Methyl Acetylene, Propadiene Mixture	L/G	No	Yes	>760	1000					-	-	X	-	X	No		Animal test indicate minimal toxicity.Inhal. toxic [5]
MTT	Methyl Acetate	L	No	Yes	360	200	250	2	2	1	-	X	X	-	X	No[11] (PET)	No[12] [ACE][12]	Asphyxiant
MAL	Methyl Alcohol	L	No	Yes	237	200	250	2	2	1	-	X	X	-	X	Yes	Yes	Poisonous through skin [5]
MAL	Methyl Amyl Acetate	L	No	Yes	1.0	DNA		2	-	1	-	X	X	-	X	Yes	No	
MAA	Methyl Amyl Alcohol	L	No	Yes	14.0	25	40	3	3	3	-	-	X	X	-	Yes	Yes	Poisonous through skin [5]
MTB	Methyl Bromide	L/G	No	Yes	>760	15		3	-	3	-	-	X	X	-	No Yes[14]		
MTC	Methyl Chloride	G	No	Yes	760	100	125	3	-	1	-	-	X	-	X	Yes	No	
MCH	Methyl Chloroformate	L	Yes	Yes	220	DNA		3	-	3	-	-	X	X	-	No		
MCS	Methyldichlorosilane	L	Yes	Yes	~750	5(HCl)		3	-	3	-	-	X	X	-	Yes	No	
MEK	Methyl Ethyl Ketone	L	No	Yes	165	200	300	2	-	1	-	X	X	-	X	Yes	No	
MTF	Methyl Formal	L	No	Yes	660	1000[9]		2	-	-	-	-	X	-	X			Skin,eyes,nose,throat irritant
MFM	Methyl Formate	L	No	Yes	>760	100	150	3	-	2	-	-	X	-	X	Yes	Yes	
MHZ	Methyl Hydrazine	L	No	Yes	95	0.2 [9]		(3)	(3)	(3)	-	-	X	X	-	No		As hydrazine
MIC	Methyl Isobutyl Carbinol	L	No	Yes	14	25	40	3	3	3	-	-	X	X	-	Yes	Yes	
MIK	Methyl Isobutyl Ketone	L	No	Yes	38	100	125	(3)	-	(2)	-	-	X	-	X	Yes	No	
MPK	Methyl Isopropenyl Ketone (Inhibited)	L	-	Yes	79	100[9]		U	U	U	-	-	X	X	-			Irritates eyes,skin;prolonged contact blisters skin
MMC	Methyl Mercaptan	L/G	No	Yes	>760	0.5		(2)	-	(2)	-	X	X	-	X	Yes	Yes	
MMA	Methyl Methacrylate	L	No	Yes	77	100	125	1	-	1	-	X	-	-	X	Yes	Yes	
MPT	Methyl Parathion	S	Yes	Yes	< 0.01	0.2*	0.6*	(3)	(3)	U	-	-	X	X	-	Yes	Yes	As parathion,cholinesterace inhibitor, 8 day half life
MVK	Methyl Vinyl Ketone	L/G	No	Yes	153	DNA					-	-	X	X	-	No		Skin irritant & lachrymator, cause skin burn
MBK	Methyl-n-Butyl Ketone	L	No	Yes	36	100[9]		3	-	2	-	-	X	-	X	Yes	No	
MAM	Methyl Acrylate	L	No	Yes	155	10		3	3	3	-	-	X	X	-	Yes	Yes	
MTA	Methylamine	G	No	Yes	>760	10		(3)	-	(3)	-	-	X	X	-	Yes	No	As monomethylamine
MAN	n-Methylaniline	L	No	Yes	1.2	2 [9]		3	3	-	-	-	X	X	-	Yes	Yes	
MCT	Methylcyclopentadieneyl Manganese Tricarbonyl	L	No	-	0.2	0.1 [9]	0.3				-	-	X	X	-			Poisonous if swallowed or skin exposed
MCP	Methylcyclopentane	L	No	Yes	2.28	DNA		U	U	U						No ACE[12]	Yes [12]	Eyes & skin irritant & narcotic in high concentrations
MEP	Methylethylpyridine	L	No	Yes	5	DNA		(1)	(2)	(2)	-	X	-	-	X	Yes	No	As pyridine
MPD	Methylphosphonuinioic Dichloride,Anhydrous	L	-	-	0.9	DNA					-	-	X	X	-			Highly toxic irritant,corrosive
MPY	1-Methylpyrrolidone	L	No	Yes	DNA	DNA		U	U	U	-	-	X	X	-			Very corrosive(like ammonia), highly toxic irritant
MSR	Methylstyrene, Alpha	L	No	Yes	5.4	100		2	-	2	-	X	X	-	X	Yes	Yes	
MTS	Methyltrichlorosilane	L	Yes	Yes	294	5 (HCl)		(3)	U	(3)	-	-	X	X	-	Yes	No	As chlorosilane
MNS	Mineral Spirits	L	No	Yes	6	200		2	-	1	-	X	X	-	X	No (PVC)[15]	(PVC) [15]	
MRX	Mirex	S	No	-	-	DNA					-	-	X	X	-			highly toxic stomach insect.[8]

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
MTO	Molybdic Trioxide	S	No	No	DNA	5*(Mo)[9]		-	-	1	X	-	-	-	X	Yes	Yes	
MCA	Monochloroacetic Acid	S	No	Yes	0.9	DNA		2	-	2	X	X	-	-	X	Yes	Yes	
MCF	Monochlorodifluoromethane	G	No	No	>760	1000		2	U	U	-	X	X	-	X	Yes	Yes	Refrigerant; liquid can cause frostbite [8]
MEA	Monoethanolamine	L	No	Yes	1.1	3		2	-	2	-	X	X	-	X	Yes	No(PVC) [5]	
MPA	Monoisopropanolamine	L	No	Yes	2.3	5[9]		U	U	U						Yes	No	Toxic by inhal. & inges. irritates stomach tissue [5]
MPL	Morpholine	L	No	Yes	28	20	30	2	2	2	-	X	X	-	X	Yes	No	
MFA	Motor Fuel Antiknock Cmpds.(Pb Alkyls)	L	No	Yes	0.67	0.1(Pb) [8]		(3)			-	-	X	X	-	Yes	No(PVC) [11]	As lead cmpds; Pb alkyls absorbed by skin [5]
NAB	Nabam	S	No	No	<0.25	DNA		-	-	-	-	-	X	X	-	Yes	Yes	Recog. carcinogen;narcotic at high conc;skin & mucous irritant
NLD	Naled	S	No	-	~1	DNA		U	U	U	-	-	X	X	-			Cholinesterase inhibitors [5]
NCT	Naphtha: Coal Tar	L	No	Yes	6.7	100		3	3	2	-	-	X	X	-	No[14] (Nitrile, Neoprene)	Yes	
NSV	Naphtha: Solvent	L	No	Yes	6.7	200		3	3	2	-	-	X	X	-	No"	(PVC)[18]	
NSS	Naphtha: Stoddard Solvent	L	No	Yes	6.7	200		2	-	1	-	X	X	-	X	No"	"	
NVM	Naphtha: VM_P (75 Naphtha)	L	No	Yes	6.7	500/30 min [6]		2	-	2	-	X	X	-	-	No	"	
NTM	Naphthalene, Molten	S	Yes	Yes	@80°C	10/50*		2	2	2	X	X	-	-	X	No		Standard conditions
NTI	Naphthenic Acid	S	No	Yes	DNA	1		(2)	-	-	X	X	-	-	X	No[11]		As cyclopentane(an assoc.cmpd.)
NAO	Naphthylamine	S	No	Yes	~0.01	DNA		3	3	2	-	-	X	X	-	Yes	Yes	Recognized carcinogen
NHX	Neohexane	L	-	Yes[5]	~700	DNA		U	U	U	-	-	X	-	X			Low toxicity; narcotic in high conc.[5],eye,nose,throat irrit.
NKA	Nickel Acetate	S	No	No	<0.25	1*(Ni)[9]		(3)	-	(1)	-	-	X	-	X	Yes	Yes	As Ni cmpd; recog.carcinogen
NAS	Nickel Ammonium Sulfate	S	No	No	<0.25	"		(3)	-	(1)	-	-	X	-	X	Yes	Yes	" " " "
NBR	Nickel Bromide	S	No	No	<0.25	"		(3)	-	(1)	-	-	X	-	X	Yes	Yes	As Ni compounds
NKC	Nickel Carbonyl	L	No	Yes	634	"		3	-	-	-	-	X	X	-	Yes	Yes	Recognized carcinogen
NCL	Nickel Chloride	S	No	No	<0.25	"		(3)	-	(1)	-	-	X	-	X	Yes	Yes	As Ni cmpd,toxic rating, carcinogen
NCN	Nickel Cyanide	S	No	No	DNA	DNA		(3)	(3)	(1)	-	-	X	X	-	Yes	Yes	As cyanides;recog.carcinogen
NFB	Nickel Fluoborate	L	-	-	DNA	DNA		(3)	-	(3)	-	-	X	X	-			Toxic rating as fluorides
NFM	Nickle Formate	S	No	-	DNA	0.12[9]		(3)	-	(1)	-	-	X	X	-	Yes	Yes	Toxic rating as nickel cmpd, carcinogen
NKH	Nickel Hydroxide	S	No	-		1*(Ni)[5]		(3)	-	(1)	-	-	X	X	-	Yes	Yes	" " " " " "
NNT	Nickel Nitrate	S	No	Yes	<0.25	1*(Ni)[9]		(3)	-	(1)	-	-	X	X	-	Yes	Yes	" " " " " "
NKS	Nickel Sulfate	S	No	No	~0.25	"		(3)	-	(1)	-	-	X	X	-	Yes	Yes	" " " " " "
NIC	Nicotine	L	No	Yes	~0.25	0.069[9]		3	3	2	-	-	X	X	-	Yes	Yes	
NCS	Nicotine Sulfate	S	No	No	<0.25	DNA		(3)	(3)	(2)	-	-	X	X	-	Yes	Yes	As nicotine,toxic rating
NTL	Nitralin	S	No	-	<0.25	DNA					-	-	X	X	-			Herbicide[5],inhal. poison, skin,eye irritant
NAC	Nitric Acid	L	Yes	No	82	2	4	3	-	3	-	-	X	X	-	No Yes [11]	(PVC) [11]	
NTX	Nitric Oxide	G	Yes	No	>760	25	35	3	-	3	-	-	X	X	-	Yes	Yes	
NAA	Nitrilotriacetic Acid and Salts	S	No	Yes	<0.25	DNA					-	-	X	X	-			Confirmed carcinogen in rats and mice [5]
NTA	2-Nitroaniline	S	No	Yes	~0.25	1/6*		(3)	3	(U)	-	-	X	X	-	Yes	Yes	As p-Nitroaniline,toxic rating
NAL	4-Nitroaniline	S	No	Yes	<0.01	1/6*	2	(3)	(3)	(U)	-	-	X	X	-			" " " " "
NTB	Nitrobenzene	L	No	Yes	0.7	1	2	3	3	U	-	-	X	X	-	No	No(ACE) [12]	
NTE	Nitroethane	L	No	Yes	38	100	150	2	-	2	-	X	X	-	X	Yes	Yes	
NOX	Nitrogen Tetroxide	L/G	Yes	No	>760	5 [9]		(3)	-	(3)	-	-	X	X	-	No Yes [16]		As nitric oxide,toxic rating
NXX	Nitrogen, Liquefied	L	Yes	No	>760	9x10 [5]					-	-	X	-	-	Yes	Yes	Asphixiant,component of air

C	CN	S	MR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATI-BILITY		NOTES
											RESPIRATORY			CLOTHING				
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	NS	B	P	
NMT	Nitromethane	L	No	Yes	82	100	150	3	-	2	-	-	X	-	X	Yes	Yes	No appreciable harm to skin,eyes
NIP	Nitrophenol	S	No	Yes	0.5	DNA		(3)	(U)	(3)	-	-	X	-	X	Yes	Yes	As p-Nitrophenol,toxic rating
NTP	2-Nitrophenol	S	No	Yes	0.5	DNA		(3)	(U)	(U)	-	-	X	-	X	Yes	Yes	" " "
NPH	4-Nitrophenol	S	No	Yes	0.5	DNA		(3)	(U)	(U)	-	-	X	-	X	Yes	Yes	" " "
NPP	2-Nitropropane	L	No	Yes	37	25		2	-	1	-	-	X	X	-	Yes	Yes	Carcinogen,NIOSH Rpt. 1978
NTC	Nitrosyl Chloride	L/G	Yes	No	760	1		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as p-nitrotoluene
NTE	o-Nitrotoluene	L	No	Yes	0.5	5		3	3	2	-	-	X	X	-			Poisonous via skin
NTT	p-Nitrotoluene	S	No	Yes	0.5	5/30*		3	3	2	-	-	X	X	-			Poisonous via skin
NTO	Nitrous Oxide	L/G	No	No	760	DNA		2	0	0	-	X	X	-	-	Yes	Yes	Asphyxiant
NAN	Nonane	L	No	Yes	10	200	250	2	-	-	-	X	X	-	-	Yes	Yes	Irritant to respiratory track, narcotic
NNN	Nonanol	L	No	Yes	0.2	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Low toxicity[5]
NON	Nonene	L	No	Yes	11.4	DNA					-	X	-	-	X	Yes	Yes	Irritates skin,eyes & throat
NNE	1-Nonene	L	No	Yes	11.4	DNA					-	X	-	-	X	Yes	Yes	Wetting agent,irritates eyes, throat,skin
NNP	Nonyl Phenol	L	No	Yes	0.1	DNA		3	3	3	-	-	X	X	-	Yes	No	Toxic rating as phenol
OAN	Octane	L	No	Yes	28	300	375	2	0	0	-	X	X	-	-	No[]2]	Yes[12]	Asphyxiant,narcotic in high conc.
OTA	Octanol	L	No	Yes	0.3	DNA		-	-	-	-	X	-	-	-	Yes	Yes	Low toxicity
OTE	1-Octene	L	No	Yes	33	DNA		U	U	U	-	-	X	-	X	Yes	Yes	Unsaturated straight chain hydrocarbon [5]
OET	Octyl Epoxy Tallate	L	-	-	0.25	DNA												
OCA	Oil, Edible: Castor	L	No	Yes	5.1	DNA		-	-	1	-	-	-	-	-	Yes	Yes	
OCC	Oil, Edible: Coconut	L	No	Yes	DNA	DNA		-	-	-	-	-	-	-	-	Yes	Yes	
OCS	Oil, Edible: Cottonseed	L	No	Yes	5.1	DNA		0	0	0	-	-	-	-	-	Yes	Yes	
OFS	Oil, Edible: Fish	L	No	Yes	5.1	DNA		-	-	-	-	-	-	-	-	Yes	Yes	Non-toxic[5] but suspected carcinogen [8]
OLD	Oil, Edible: Lard	L	No	Yes	5.1	DNA		-	-	-	-	-	-	-	-	Yes	Yes	" " "
OOL	Oil, Edible: Olive	L	No	Yes	DNA	DNA		-	-	-	-	-	-	-	-	Yes	Yes	" " "
OPM	Oil, Edible: Palm	L	No	Yes	DNA	DNA		0	0	1	-	-	-	-	-	Yes	Yes	
OPN	Oil, Edible: Peanut	L	No	Yes	5.1	DNA		U	U	1	-	-	-	-	-	Yes	Yes	
OSF	Oil, Edible: Safflower	L	No	Yes	DNA	DNA		U	U	U	-	-	-	-	-	Yes	Yes	
OSB	Oil, Edible: Soya Bean	L	No	Yes	5.1	DNA		-	-	-	-	-	-	-	-	Yes	Yes	
OTC	Oil, Edible: Tucum	L	No	Yes	DNA	DNA					-	-	-	-	-	Yes	Yes	
OVC	Oil, Edible: Vegetable	L	No	Yes	5.1	DNA		-	-	-	-	-	-	-	-	Yes	Yes	
OOM	Oil, Fuel: No. 1 (Kerosene)	L	No	Yes	5.1	200		(2)	-	(1)	-	X	X	-	X	No[12] (Neoprene)	Yes[12]	Toxic rating as kerosene
OOD	Oil, Fuel: No. 1-D	L	No	Yes	5.1	200		(2)	-	(1)	-	X	X	-	X	No	Yes	Toxic rating as kerosene
OTW	Oil, Fuel: No. 2	L	No	Yes	5.1	200		(2)	-	(1)	-	X	X	-	X	No	Yes	Diesel oil,recognized carcinogen [8],toxic rating as kerosene
OTD	Oil, Fuel: No. 2-D	L	No	Yes	5.1	200		(2)	-	(1)	-	X	X	-	X	No	Yes	Toxic rating as kerosene
OFR	Oil, Fuel: No. 4	L	No	Yes	5.1	200		U	U	U	-	X	X	-	X	No	Yes	Heavier distillate than 1 & 2 fuel oil
OFV	Oil, Fuel: No. 5	L	No	Yes	5.1	200		U	U	U	-	X	X	-	X	No	Yes	" " "
OSX	Oil, Fuel: No. 6	L	No	Yes	5.1	200		U	U	U	-	X	X	-	X	No	Yes	" " "
OAS	Oil, Misc: Absorption	L	No	Yes	5.1	DNA					-	X	X	-	X	No		Irritating to skin & eyes
OCT	Oil, Misc. Coal Tar	L	No	Yes	5.1	DNA		1	-	1	-	X	X	-	X	No[12] (PVC)	Yes[12]	" " "
OCR	Oil, Misc: Croton	L	No	Yes	DNA	DNA		-	-	2	-	-	X	X	-	No		Poison if swallowed or skin exposed,strong skin irritant[5]

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATI-BILITY (10)		NOTES
											RESPIRATORY			CLOTHING				
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	NS	B	P	
OLS	Oil, Misc: Linseed	L	No	Yes	DNA	DNA		-	-	1	-	X	-	-	X	Yes	Yes	Nontoxic[5];not harmful [5]
OLB	Oil, Misc: Lubricating	L	No	Yes	5.1	DNA		U	U	U	-	X	-	-	X	No(PVC) [12]	Yes[12]	Irritates eyes & skin [9]
OMN	Oil, Misc: Mineral	L	No	Yes	5.1	DNA		U	U	U	-	X	-	-	X	"	"	Irritates eyes & skin; recognized carcinogen [8]
OMS	Oil, Misc: Mineral Seal	L	No	Yes	5.1	200		(2)	-	(1)	-	X	X	-	X	No		Toxic rating as kerosene
OMT	Oil, Misc: Motor	L	No	Yes	5.1	DNA		-	-	1	-	X	-	-	X			Irritates eyes & skin [9]
ONF	Oil, Misc: Neatsfoot	L	No	Yes	5.1	DNA		U	U	U	-	-	-	-	-	Yes	Yes	Not harmful
OPT	Oil, Misc: Penetrating	L	No	Yes	5.1	DNA					-	X	-	-	X	No		Irritates eyes & skin [9]
ORG	Oil, Misc: Range	L	No	Yes	5.1	200		(2)	-	(1)	-	X	X	-	X	No		Toxic rating as kerosene
ORS	Oil, Misc: Resin	L	No	Yes	5.1	DNA		U	U	U						Yes	Yes	Exposure data not available
ORD	Oil, Misc: Road	L	No	Yes	5.1	5*		-	-	-						No		Burns skin & eyes [9]
ORN	Oil, Misc: Rosin	L	No	Yes	5.1	DNA		U	U	U						Yes	Yes	Exposure data not available
OSP	Oil, Misc: Sperm	L	No	Yes	5.1	DNA		U	U	U						Yes	Yes	Carcinogen suspect[8], exposure data not available [9]
OSD	Oil, Misc: Spindle	L	No	Yes	5.1	DNA		U	U	U	-	X	-	-	X	No		Irritates skin & eyes [9]
OSY	Oil, Misc: Spray	L	No	Yes	5.1	200					-	X	-	-	X	No		Irritates skin & eyes [9]
OTL	Oil, Misc: Tall	L	No	Yes	5.1	DNA		-	-	1	-	X	-	-	X			Low toxicity [5]
OTN	Oil, Misc: Tanners	L	No	Yes	5.1	DNA												Exposure data not available [5,8,9]
OTF	Oil, Misc: Transformer	L	No	Yes	5.1	DNA		U	U	U	-	X	-	-	X	No		Irritates skin & eyes, chlorinated biphenyls or mineral oil
OTB	Oil, Misc: Turbine	L	No	Yes	~5.1	0.43?					-	X	-	-	X	No		Irritates eyes,nose,throat,skin[9]
OCF	Oil, Misc: Clarified	L	No	Yes	5.1	DNA										Yes	Yes	Data not available [5,8]
OIL	Oil: Crude	L	No	Yes	5.1	DNA		1	-	1	-	X	-	-	X	No		
ODS	Oil: Diesel	L	No	Yes	5.1	DNA		2	-	?	-	X	X	-	X	No (Nitrile)		
OLA	Oleic Acid	L	No	Yes	<<0.25	DNA		-	-	1	-	-	-	-	X	Yes	Yes	Nontoxic [5]
OAP	Oleic Acid, Potassium Salt	S	No	No	<0.25	DNA		-	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as oleic acid
OAC	Oleic Acid, Sodium Salt	S	No	No	<0.25	DNA		-	-	(1)	X	-	-	-	X	Yes	Yes	Toxic rating as oleic acid[8], low toxicity [5]
OLM	Oleum	L	Yes	No	>1.1	1*		3	U	3	-	-	X	X	-	No(PVC) [11]	(PVC) [11]	
OXA	Oxalic Acid	S	No	Yes	~0.005	1*	2	3	-	3	-	-	X	X	-	Yes	Yes	
OXY	Oxygen, Liquid	L	No	No	>760	DNA					-	-	-	-	-	Yes	Yes	
PFA	Paraformaldehyde	S	Yes	Yes	22	5		2	-	2	X	X	-	-	X	Yes	Yes	
PDH	Paraldehyde	L	No	Yes	23	DNA		2	-	1	-	X	X	-	X			Decomposes on standing to aldehydes
PTO	Parathion	L	No	No	0.001	0.00077		3	3	U	-	-	X	X	-	Yes	Yes	
PTB	Pentaborane	L	Yes	Yes	~150	0.005		3	-	3	-	-	X	X	-	No		
PCP	Pentachlorophenol	S	No	No	<0.25	0.5*		3	3	3	-	-	X	X	-	Yes	Yes	
PDC	Pentadecanol	L	No	Yes	<0.25	10*		U	U	U	-	X	-	-	X	Yes	Yes	Linear alcohol;low toxicity[5]
PET	Pentaerythritol	S	No	Yes	<0.25	DNA		-	-	-	X	-	-	-	-	Yes	Yes	Nuisance dust[5]);not harmful[9]
PTA	Pentane	L	No	Yes	>760	600	750	1	U	U	-	X	-	-	-	No		Narcotic in high concentration
PTE	1-Pentene	L	No	Yes	>760	DNA		2	1	-	-	X	X	-	X	No		Asphyxiant
PAA	Peracetic Acid	L	No	Yes	36.6	DNA		3	-	3	-	-	X	X	-	Yes	Yes	
PCL	Perchloric Acid	L	No	Yes	<0.25	DNA		3	-	3	-	-	X	X	-	Yes	Yes	Unstable liquid,explodes with shock,heat & organics [5]
PCM	Perchloromethyl Mercaptan	L	Yes	Yes	~1.8	0.1		3	-	3	-	-	X	X	-	Yes	No	Mildly decomposes in moist air[5]
PTL	Petrolatum	L	No	Yes	<0.25	DNA		U	U	U	-	-	X	X	-	Yes	Yes	Recognized carcinogen [8]

C	CN	S	WR	F	VP	TLV (PPM OR MG/M³)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION: RESPIRATORY			CLOTHING		MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	MS	B	P	
PTN	Petroleum Naphtha	L	No	Yes	12	500/30 min		2	1	2	-	X	X	-	X	No(PVC) [12]	Yes[12]	
PHN	Phenol	S	No	Yes	18	5/19*	10	3	3	3	-	-	X		X	Yes	Yes	
PDL	Phenyldichloroarsine, Liquid	L	Yes	Yes	0.21	DNA		3	-	3	-	-	X	X	-	Yes	No	
PHH	Phenylhydrazine Hydrochloride	S	No	No	< 0.25	DNA		3	3	2	-	-	X	X	-	Yes	No	
PHD	Phosdrin	L	No	Yes	-	0.01	0.03	(3)	(3)	(U)	-	-	X	X	-			As parathion[8]
PHG	Phosgene	G/L	Yes	No	> 760	0.1		3	-	3	-	-	X	X	-	Yes	Yes	
PAC	Phosphoric Acid	L	No	No	< 0.25	0.23[9]		2	-	2	-	X	X	-	X	Yes	Yes	
PPB	Phosphorous, Black	S	No	Yes	-	DNA												Does not spontaneously ignite, stable in air
PPO	Phosphorous Oxychloride	L	Yes	No	< 0.25	0.5		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As hydrochloric acid [8]
PPP	Phosphorous Pentasulfide	S	Yes	Yes	< 0.25	10(H_2S)		3	-	3	-	-	X	X	-	Yes	Yes	
PBR	Phosphorous Tribromide	L	Yes	No	6.3	DNA		(3)	-	(3)	-	-	X	X	-	No		As hydrobromic acid [8]
PPT	Phosphorous Trichloride	L	Yes	No	21	0.5		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As hydrochloric acid [8]
PPR	Phosphorous, Red	S	Yes	Yes	< 0.25	DNA		(2)		(2)	-	-	X	Fire	Suit	Yes	Yes	Reacts with water to form phosphine[5] which ignites
PPW	Phosphorous, White	S	No	Yes	< 0.25	0.1* [9]		3	-	3	-	-	X	Fire	Suit	Yes	Yes	Waxy solid; spontaneously ignites air @ 86°F
PAN	Phthalic Anhydride	S/L	Yes	Yes	< 0.01	1	4	1	-	1	-	X	-	-	X	Yes	Yes	
PPZ	Piperazene	S	No	Yes	2.9	DNA		-	-	1	-	-	-	-	X	Yes	Yes	
PLB	Polybutene	L	No	Yes	< 0.25	DNA		2	U	U	-	-	X	-	-	Yes	Yes	Vapor may act as asphixiant[6] as olefins [d]
PCB	Polychlorinated Biphenyls	S/L	No	Yes	< 0.01	0.5	1.0	(3)	(3)	(2)	-	-	X	X	-	Yes	Yes	As chlorinated diphenyls[8]
PPI	Polymethylene Polyphenyl Isocyanate	L	-	Yes	0.0001	0.357*[9]					-	X	X	-	X			Polymer of methylene (4 phenyl-isocyanate irritant [8]
PPA	Polyphosphoric Acid	L	Yes	No	< 0.25	DNA		-	-	2	-	X	-	-	X	Yes	Yes	Phosphorous comp.low toxicity
PLP	Polypropylene	S	No	Yes	< 0.25	DNA		U	U	U	-	-	-	-	-	Yes	Yes	Nontoxic [5]
PGC	Polypropylene Glycol	L	No	Yes	< 0.25	DNA					-	-	-	-	-	Yes	Yes	Most indust. used glycols,not toxic [8]
PGM	Polypropylene Glycol Methyl Ether	L	No	Yes	< 0.25	DNA					-	X	-	-	-			Low toxicity;high conc.anesthetic
PTM	Potassium	S	Yes	Yes	< 0.25	DNA		3	-	3	-	-	X	Fire	Suit	No(PVC	(PVC)	Caustic potash,mat'l. compat.
PAS	Potassium Arsenate	S	No	No	< 0.25	0.5*[9]		3	-	2	-	-	X	-	X	Yes	Yes	Recognized carcinogen, As arsenic comp. [8]
POA	Potassium Arsenite	S	No	-	-	DNA		3	-	2	-	-	X	-	X			" " "
PBO	Potassium Binoxalate	S	No	No	< 0.25	DNA		-	-	(3)	-	-	X	X	-	Yes	Yes	As oxalates [8]
PCR	Potassium Chlorate	S	No	Yes	< 0.25	DNA		-	-	1	X[10]	-	-	-	X	Yes	Yes	
PCH	Potassium Chromate	S	No	No	< 0.25	1* [9]		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As chromium compounds [8]
PTC	Potassium Cyanide	S	Yes	No	< 0.25	5*(CN)[5]		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	As cyanides [8]
PDT	Potassium Dichloro-s-Triazinetrione	S	No	No	DNA	DNA					X	-	-	-	X	Yes	Yes	Irritates skin & eyes [9]
PTD	Potassium Dichromate	S	No	No	< 0.25	DNA		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Recognized carcinogen, As chromium compound [8]
PTH	Potassium Hydroxide	S	Yes	No	< 0.25	DNA		3	-	3	-	-	X	X	-	Yes	No	
PTI	Potassium Iodide	S	No	No	< 0.25	DNA		2	-	-	X	X	-	-	-	Yes	Yes	Low toxicity [8]
PTS	Potassium Oxalate	S	No	No	< 0.25	DNA		-	-	3	-	-	X	X	-	Yes	Yes	
PTP	Potassium Permanganate	S	No	No	< 0.25	DNA		3	-	3	-	-	X	X	-	Yes	Yes	
POP	Potassium Peroxide	S	Yes	Yes	< 0.25	DNA		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As hydrogen peroxide, peroxides, inorganic [8] [8]
PRP	Propane	G	No	Yes	> 760	1000		1	0	0	-	-	X	-	-	Yes	Yes	Asphiant & ONS effect,high conc.
PLT	Propiolacetone, Beta	L	No	Yes	6.2	0.0 [9]		3	-	3	-	-	X	X	-	Yes	Yes	Experimental carcinogen [8]
PAD	Propionaldehyde	L	No	Yes	51	DNA		2	-	2	-	X	X	-	X	Yes	No	

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATI-BILITY[10]		NOTES
											RESPIRATORY			CLOTHING				
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	NS	B	P	
PNA	Propionic Acid	L	No	Yes	9.3	10		-	-	2	-	X[10]	-	-	X	Yes	Yes	Animal exp. indicate low toxicity
PAH	Propionic Anhydride	L	No	Yes	3.6	DNA		-	-	(2)	-	"	-	-	X	Yes	Yes	As propionic acid [8]
PAT	n-Propyl Acetate	L	No	Yes	7	200	250	2	1	1	-	X	X	-	X	Yes	No(PVC [15]Fair)	
PAL	n-Propyl Alcohol	L	No	Yes	37	200	250	2	2	1	-	X	X	-	X	Yes	Yes	
PMN	n-Propyl Mercaptan	L	No	Yes	276	DNA		U	U	U	-	-	X	X	-	Yes	Yes	Probably toxic[8], offensive smelling liquid
PRA	n-Propylamine	L	No	Yes	410	DNA		3	-	3	-	-	X	X	-			
PPL	Propylene	G	No	Yes	> 760	4000		2	0	0	-	X	X	-	-	Yes	Yes	
PBP	Propylene Butylene Polymer	L	No	Yes	< 0.25	DNA		(2)	U	U	-	X	X	-	-			As olefins [6-8]
PPG	Propylene Glycol	L	No	Yes	0.27	DNA		-	-	1	-	-	-	-	X	Yes	Yes	Nontoxic [5]
PME	Propylene Glycol Methyl Ether	L	No	Yes	23	100	150	-	-	1	-	-	-	-	X	Yes	Yes	
POX	Propylene Oxide	L	No	Yes	> 760	100	150	2	-	2	-	X	X	-	X	Yes	Yes	
PTT	Propylene Tetramer	L	No	Yes	3.8	200 [9]		U	U	U	-	X	-	-	X	Yes	Yes	Irritant & narcotic in high conc. [8]
PII	Propyleneimine (Inhibited)	L	No	Yes	250	2		2	2	3	-	-	X	X	-	Yes	No	Experimental carcinogen [8]
PRR	Pyrethrins	L	No	-	DNA	DNA		3	-	2	-	-	X	-	X	Yes[14]		Household insecticide [5]
PRD	Pyridine	L	No	Yes	41	5	10	1	2	2	-	X	-	X	-	Yes	No(ACE [12])	
PGA	Pyrogallic Acid	S	No	Yes	< 0.25	DNA		3	3	3	-	-	X	X	-	Yes	Yes	
QNL	Quinoline	L	No	Yes[5]	0.3	DNA		3	U	U	-	-	X	-	X			May produce retinitis [8], irritates eyes & skin [9]
RSC	Resorcinol	S	No	Yes	0.0087	10	20	2	2	2	-	X	X	-	X	Yes	Yes	
SLA	Salicylic Acid	S	No	Yes	< 0.25	DNA		-	-	2	X	-	-	-	X	Yes	Yes	
SLD	Selenium Dioxide	S	No	Yes	< 0.25	0.2*(Se) [9]		(2-3)	-	(2)	-	-	X	-	X			As selenium compounds [8]
STO	Selenium Trioxide	S	No	No	< 0.25	0.2*(Se)		(2-3)	-	(2)	-	-	X	-	X	Yes	Yes	As selenium compounds [8]
STC	Silicone Tetrachloride	L	Yes	No	383	DNA		3	-	3	-	-	X	X	-	Yes	Yes	
SVA	Silver Acetate	S	No	No	< 0.25	0.01*(Ag) [9]					X	-	-	-	X	Yes	Yes	Irritates skin & eyes, harmful if swallowed [9]
SVC	Silver Carbonate	S	No	No	< 0.25	"					X	-	-	-	X	Yes	Yes	Irritates skin & eyes [9]
SVF	Silver Fluoride	S	No	No	< 0.25	"		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As fluorides [8] [8]
SVI	Silver Iodate	S	No	Yes	< 0.25	"		-	-	1	X	-	-	-	X	Yes	Yes	Similar to bromates & chlorates As chlorates[8],irr.skin & eyes[9
SVN	Silver Nitrate	S	No	No	< 0.25	DNA		(3)	U	U	-	-	X	-	X	Yes	Yes	As nitrates[8],irr.skin & eyes[9]
SVO	Silver Oxide	S	No	No	< 0.25	0.01*(Ag)		-	-	-	X	-	-	-	X	Yes	Yes	As silver compounds [8]
SVS	Silver Sulfate	S	No	No	< 0.25	"		-	-	-	X	-	-	-	X	Yes	Yes	As silver compounds[8],irritates skin & eyes [9]
SAS	Silver Alkyl Sulfates	S	No	-	< 0.25	DNA												
SAB	Sodium Alkylbenzene Sulfonates	S/L	No	No	< 0.25	DNA					-	X	-	-	X	Yes	Yes	Irr. to skin & eyes [9]
SAM	Sodium Amide	S	Yes	Yes	< 0.25	DNA		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As NaOH&NH3-reaction w/H2O [8]
SDA	Sodium Arsenate	S	No	No	< 0.25	0.5*(As)		(2)	-	(3)	-	-	X	X	-	Yes	Yes	As arsenic compounds, recognized carcinogen [8]
SAR	Sodium Arsenite	S	No	No	< 0.25	"		(2)	-	(3)	-	-	X	X	-	Yes	Yes	As arsenic cmpd, herbicide[8]
SAZ	Sodium Azide	S	No	Yes	DNA	0.1(0.3*)		(2)	-	(3)	-	-	X	X	-	Yes	Yes	As sodium hydroxide [8]
SBF	Sodium Bifluoride	S	No	No	-	2.5*(F)[5]		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As fluorides [3]
SBS	Sodium Bisulfite	S	No	No	< 0.25	DNA		(2)	-	-	X	X	-	-	-	Yes[11]	PVC) [11]	As sulfites [8]
SDB	Sodium Borate	S	No	No	< 0.25	DNA		(2)	U	U	X	X	-	-	X	Yes	Yes	As boron compounds [8]
SBH	Sodium Borohydride	S	Yes	Yes	< 0.25	2*(NaOH) [5]		(2)	U	U	X	X	-	-	X	Yes	Yes	As boron compound with moisture [8],NaOH may be present
SCD	Sodium Cacodylate	S	No	No	< 0.25	DNA		(1)	-	1	X	-	-	-	X	Yes	Yes	As cacodylic acid [8]

C	CN	S	WR	F	VP	TLV (PPM OR MG/M³)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
											RESPIRATORY			CLOTHING				
						TWA	STEL		SA	IR	PF	CC	AS	SS	NS	B	P	
SDC	Sodium Chlorate	S	No	No	<0.25	DNA		2	-	1	X	X	-	-	X	Yes	Yes	
SCH	Sodium Chromate	S	No	No	<0.25	0.1*		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As chromium cmpd.,carcinogen[8]
SCN	Sodium Cyanide	S	Yes	No	<0.25	5*(CN)[5]		(3)	(3)	(1)	-	-	X	X	-	Yes[11]	Yes[12] (PVC)[11]	As cyanides [8]
SDT	Sodium Dichloro-s-Triazinetrione	S	No	No	<0.25	DNA					X	-	-	-	X	Yes	Yes	Irritates skin & eyes [9]
SCR	Sodium Dichromate	S	No	No	<0.25	DNA		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As chromium compounds,carcinogen [8]
SFC	Sodium Ferrocyanide	S	No	No	<0.25	DNA		-	-	(1)	X[6]	-	-	-	X	Yes	Yes	As ferrocyanides[8]avoid acid contact
SDF	Sodium Fluoride	S	No	No	<0.25	DNA		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As fluorides [8]
SDH	Sodium Hydride	S	Yes	Yes	DNA	DNA		(2)	-	(3)	-	-	X	X	-	Yes	Yes	As sodium hydroxide [8]
SHS	Sodium Hydrosulfide Solution	L	No	No	<0.25	DNA					-	-	X	X	-	Yes	Yes	As sulfides(skin irritant)irritates skin & eyes[9]
SHD	Sodium Hydroxide	S	Yes	No	<0.25	2*/15 min [2]		2	-	3	-	-	X	X	-	Yes	No(PVC) [12]	
SHC	Sodium Hypochlorite	L	Yes	No	<0.25	DNA		(2)	-	(2)	-	X	X	-	X	Yes	Yes	As hypochlorites [8]
SML	Sodium Methylate	S	Yes	Yes	<0.25	200(CH_3OH)		U	U	U	-	-	X	X	-	Yes	Yes	Toxic & corr.to tissues [5]
SDN	Sodium Nitrate	S	No	Yes	<0.25	DNA		(2)	-	-	X	X	-	-	X	Yes[11]	Yes[12] PVC[11]	Toxic rating as nitrates
SNT	Sodium Nitrite	S	No	Yes	<0.25	DNA		(3)	-	-	-	-	X	-	X	Yes	Yes	Toxic rating as nitrates, irritating to skin & eyes [9]
SOX	Sodium Oxalate	S	No	No	<0.25	DNA		-	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as oxalates
SPP	Sodium Phosphate	S	No	No	<0.25	DNA					X	-	-	-	X	Yes[11]	Yes[12]	Mild irritant;skin & eyes [9]
SSE	Sodium Selenite	S	No	No		0.2*(Se)[5]		(2-3)	-	(2)	-	-	X	X	-			Toxic rating as selenium,recognized carcinogen
SSC	Sodium Silicate	L	No	No	<0.25	DNA		-	-	-	-	-	-	-	-	Yes	Yes	Nontoxic [5]
SFR	Sodium Silicofluoride	S	No	No	DNA	2.5*		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as fluosilicates
SDS	Sodium Sulfide	S	No	Yes	<0.25	DNA					-	-	X	X	-	Yes	Yes	Strong irrit. to skin & tissue [5],unstable H_2S produced
SSF	Sodium Sulfite	S	No	No	<0.25	DNA		(2)	-	-	X	X	-	-	-	Yes	Yes	Toxic rating as sulfites
SCY	Sodium Thiocyanate	S	No	No	<0.25	DNA					X	-	-	-	X	Yes	Yes	Low toxicity[8],toxic by ingestion,irrit.skin,eyes,nose,throat. [9]
SDU	Sodium, Metallic	S	Yes	Yes	<0.25	DNA		3	-	3	-	-	X	Fire	Suit	No		Reacts with moisture, burns
SBT	Sorbitol	S	No	No	<0.25	DNA					X	-	-	-	-	Yes	Yes	Little toxicity [8]
STF	Stannous Fluoride	S	No	-	2*(Sn)[5]			(3)	-	(3)	-	-	X	X	-			As fluorides [8]
SRA	Stearic Acid	S	No	Yes	<0.25	DNA					X	-	-	-	X	Yes	Yes	Slight toxicity[8],nontoxic[5]
SCM	Strontium Chromate	S	No	-		0.5*(Cr)		(3)	-	(3)	-	-	-	X	-			As chromium compounds [3]
STR	Strychnine	S	No	-	DNA	0.15*	0.45*	3	-	-	-	-	X	X	-			Toxic by inhalation & ingestion [5],extremely toxic
STY	Styrene	L	No	Yes	13	100	125	2	-	2	-	X	X	-	X	No		
SRS	Sucrose	S	No	Yes	<0.25	DNA					X	-	-	-	-	Yes	Yes	Nontoxic nuisance dust [8]
SFL	Sulfolane	L	No	Yes	<0.25	DNA										Yes	Yes	Solvent
SXX	Sulfur(Liquid) @ 113 to 120°C	L	No	Yes	<0.10	10(H_2S)	15(H_2S)	(3)	-	(3)	-	-	X	X	-	Yes	Yes	Can accumulate H_2S. Toxic rating as H_2S
SFD	Sulfur Dioxide	G/L	Yes	No	>760	5		3	-	3	-	-	X	X	-	Yes	Yes	
SFM	Sulfur Monochloride	L	Yes	Yes	~22	1		3	-	3	-	-	X	X	-	Yes(No [11])	No	
SFA	Sulfuric Acid	L	Yes	No	<0.25	1*		3	-	3	-	-	X	X	-	No(PVC [17])	PVC[17]	75% H_2SO_4 - butyl OK @ 100F
SAC	Sulfuric Acid, Spent	L	Yes	No	<0.25	DNA		3	-	3	-	-	X	X	-	Yes	Yes	
SCL	Sulfuryl Chloride	L	Yes	No	~5	5(HCl)[8]		(3)	-	(3)	-	-	X	X	-	Yes	No	As HCl or H_2SO_4 [8] [8]
TES	2,4,5-T Esters	S	No	No	<0.25	10*	20				-	-	X	X	-	Yes	Yes	Highly toxic selective herbicide
TLO	Tallow	L	No	Yes	<0.25	DNA					-	-	-	-	-	Yes	Yes	Nontoxic[5],not harmful [9]
TFA	Tallow Fatty Alcohol	S	No	Yes	<0.25	DNA					-	-	-	-	-	Yes	Yes	Nontoxic [10], not harmful [9]

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	CLOTHING AS	CLOTHING SS	CLOTHING NS	B	P	
TNA	Tannic Acid	S	No	Yes	<0.25	DNA		2	-	1	X	X	-	-	X	Yes	Yes	
TBT	Tetrabutyl Titanate	L	Yes	Yes	<0.25	DNA		(1)	-	-	-	X	-	-	X	Yes [16]		As titanium cmpd[8],toxic, irritates skin & eyes[9]
TEC	Tetrachloroethane	L	Yes	No	18	5	10	3	3	2	-	-	X	X	-	Yes	No	
TTE	Tetrachloroethylene	L	No	No	37.2	100	150	2	2	2	-	X	X	-	X	Yes	No	
TTN	Tetradecanol	L	No	Yes	<0.25	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Irritates skin & eyes [9]
TTD	1-Tetradecene	L	No	Yes	<0.25	DNA		U	U	U	-	X		-	X	Yes	Yes	Probably irritant & narcoti in high conc;eye irrit.[9]
TDB	Tetradecylbenzene	L	-	Yes	<0.25	DNA					-	X	-	-	X			Irritates skin & eyes [9]
TED	Tetraethyl Dithiopyrophosphate	S	No	No	<0.25	0.2*	0.6*	(3)	(3)	-	-	-	X	X	-	Yes	Yes	As parathion cholinesterace inhib.
TEL	Tetraethyl Lead	L	No	Yes	82.7	0.007		3	-	-	-	-	X	X	-	No,Yes [14]	No [12]	Intoxification via skin absorption [8]
TEP	Tetraehty; Pyrophosphate	L	No	No	<0.25	0.0039		3	3	-	-	-	X	X	-	Yes	Yes	
TTG	Tetraethylene Glycol	L	No	Yes	<0.25	DNA					-	X	-	-	X	Yes	Yes	Low toxicity[5],no respirator required[10]
TTP	Tetraethylenepentamine	L	No	Yes	<0.01	DNA					-	-	X	X				Toxic,irrit.eyes & skin[5]
TFE	Tetrafluoroethylene (Inhibited)	G	No	Yes	>760	DNA					-	-	X	-	X	Yes	Yes	Asphyxiant, may be toxic[8] irritates skin & eyes [9]
THF	Tetrahydrofuran	L	No	Yes	263	200	250	3	-	3	-	-	X	X	-	Yes	No	
THN	Tetrahydronaphthalene	L	No	Yes	1.3	25		2	-	2	-	X	X	-	X	Yes	Yes	
TML	Tetramethyl Lead	L	No	Yes	75	0.009		3	-	-	-	-	X	X	-	No		Like tetraethyl lead [8] skin absorption occurs
TPG	Thiophosgene	L	Yes	Yes	160	0.1		(3)	-	(3)	-	-	X	X	-	Yes	Yes	As phosgene [8]
THR	Thiram	S	No	No	<0.25	5*		2	-	1	X	X	-	-	X	Yes	Yes	
TRN	Thorium Nitrate	S	No	Yes	<0.25	DNA												Recognized carcinogen[8], low chemical toxicity
TTT	Titanium Tetrachloride	L	Yes	No	~5	5		3	-	3	-	-	X	X	-	No		
TOL	Toluene	L	No	Yes	51.7	100	150	2	1	1	-	X	X	-	X	No	No[12] PVC[11]	
TDI	Toluene 2,4-Diisocyanade	L	Yes	Yes	0.07	0.02		3	-	3	-	-	X	X	-	Yes	Yes	
TAP	p-Toluene Sulfonic Acid	S	No	Yes	<0.25	DNA		(3)	-	(3)	-	-	X	X	-			Toxicity as o-toluene-sulfonic acid
TLI	o-Toluidine	L	No	Yes	8	5	10	3	1	2	-	-	X	-	X	No		
TXP	Toxaphene	S	No	No	<0.25	0.5*		3	3	2	-	-	X	X	-	Yes	Yes	
TRC	Trichlorfun	S	No	-		DNA		(3)	(3)	-	-	-	X	X	-			Toxic rating as parathion, highly toxic [5]
TCT	Trichloro-s-Triazinetrione	S	No	No	<0.1	DNA		-	-	2	X[9]	X[9]	-	-	X	Yes	Yes	
TCE	Trichloroethane	L	Yes	Yes	212	350	440	2	2	1	-	X	X	-	X	Yes	No	
TCL	Trichloroethylene	L	No	No[5]	129	100	150	3	-	1	-	-	X	X	-	No[14]	No[12]	Causes cancer in mice,carcinogen
TCF	Trichlorofluoromethane	L	No	No	1190	1000		(2)	(1)	(1)	-	X	X	-	X	No		Toxic rating as fluotrichloromethane
TPH	Trichlorophenol	S	No	No	<0.25	DNA		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as chlor.pheno
TCA	2,4,5-Trichlorophenoxy Acetic Acid	S	No	Yes	<0.01	DNA					-	-	X	X	-			Toxic selective herbicide[8]
TCS	Trichlorosilane	L	Yes	Yes	<760	(5)(HCl)		2	-	2	-	X	X	-	X	Yes	No	
TCP	Tricresyl Phosphate	L	No	Yes	<0.25	0.1*(2)		2	2	2	-	X	X	-	X	Yes	No	
TDN	Tridecanol	L	No	Yes	<0.25	DNA		U	U	U	-	X	-	-	X	Yes	Yes	Animal expmts. indicate low toxicity [8]
TDC	1-Tridecene	L	No	Yes	0.14	DNA					-	X	-	-	-	No		Low toxicity [5], eye irritant [9]
TEA	Triethanolamine	L	No	Yes	<0.1	DNA		-	1	1	-	X	-	-	X	Yes	No	Low toxicity [5]
TAL	Triethylaluminum	L	Yes	Yes	0.11	DNA					-	-	X	Fire	Suit	No		Ignites spontaneously in air
TEN	Triethylamine	L	No	Yes	119	25	40	3	-	3	-	-	X	X	-	Yes	No	highly toxic & irritant
TEB	Triethylbenzene	L	No	Yes	1.6	DNA		U	U	U	-	-	X	X	-	Yes	Yes	Animal expmts. indicate high toxicity [8]

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATIBILITY [10]		NOTES
											RESPIRATORY			CLOTHING				
						TWA	STEL	IN	SA	IR	PF	CC	AS	SS	NS	B	P	
TEG	Triethylene Glycol	L	No	Yes	<0.25	DNA					-	X	-	-	-	Yes	Yes	Low toxicity [5]
TET	Triethylenetetramine	L	No	Yes	<0.25	DNA		3	-	3	-	-	X	X	-	Yes	No	Strong irritant to tissue, causes skin burns [5]
TFC	Trifluorochloroethylene	G	Yes	Yes	<760	20		1	U	U	-	-	X	-	X			An asphyxiant, moderately toxic[5]
TFR	Trifluralin	S	No	Yes	<0.25	DNA		U	U	U	X	-	-	-	X			Animal expmts indicate low toxicity [8]
TIA	Triisobutylaluminum	L	Yes	Yes	0.4	DNA					-	-	X	Fire	Suit	Yes	Yes	Ignites spontaneously in air[5] toxic, destructive living tissue[8]
TMA	Trimethylamine	G	Yes	Yes	>760	(5) (HCl)		2	-	-	-	-	X	X	-	Yes	Yes	Toxic by inhal. burns skin [5]
TMC	Trimethylchlorosilane	L	Yes	Yes[5]	375	(5) (HCl)		(3)	-	(3)	-	-	X	X	-			Toxic rating as silanes. Strong irritant to tissues [5]
TGC	Tripropylene Glycol	L	No	Yes	<0.25	DNA					-	-	-	-	-			Low toxicity[5], not harmful
TPO	Tris(Aziridinyl) Phosphine Ox	S	-	-	DNA	DNA					-	-	X	X	-			Irritating skin & eyes, protect skin[9], highly toxic[8]
TPT	Turpentine	L	No	Yes	14	100	150	2	2	2	-	X	X	-	X	Yes	Yes	
UND	Undecane, (1-)	L	No	Yes	<0.25	DNA					-	-	-	-	-	Yes	Yes	Low toxicity[5], eye irrit.[9]
UDC	1-Undecene	L	No	Yes	1.2	DNA					-	X	-	-	X	Yes	Yes	Irritating skin & eyes [9]
UDB	n-Undecylbenzene	L	-	Yes	<0.25	DNA												
URP	Uranium Peroxide	S		Yes		0.2*	0.6*				-	-	X	X	-			Recognized carcinogen, as uranium highly acute toxicity [8]
URA	Uranyl Acetate	S	No	Yes	<0.25	3*										Yes	Yes	
UAN	Uranyl Nitrate	S	No	Yes	<0.25	05*					-	-	X	X	-	Yes	Yes	Highly toxic [5]
URS	Uranyl Sulfate	S	No	Yes	<0.25	0.2*(U)					-	-	X	X	-	Yes	Yes	See uranium oxysulfide
URE	Urea	S	No	No	DNA	DNA					-	-	-	-	-	Yes	Yes	Essentially nontoxic[8], not harmful [9]
UPO	Urea Peroxide	S	No	Yes	DNA	DNA		-	-	2	X	X	-	-	X	Yes	Yes	Decomposed by moisture at temp. above 40°C [5]
VAL	Valeraldehyde	L	No	Yes	69	50		2	-	1	-	X	X	-	X	Yes	No	Low toxicity
VOT	Vanadium Oxitrichloride	L	Yes	No	~40	5 (HCl)		(3)	-	(3)	-	-	X	X	-	Yes	No	Hydrolyzes [5,8], toxic rating as HCl
VOX	Vanadium Pentoxide	S	No	No	<0.25	DNA					-	-	X	X	-	Yes	Yes	Toxic rating as vanadium, toxic by inhalation, variable toxicity
VSF	Vanadyl Sulfate	S	No	No	<0.25	DNA					-	-	X	X	-	Yes	Yes	May be toxic & irritant [5]
VAM	Vinyl Acetate	L	No	Yes	207	10	20	1	-	1	-	X	-	-	X	Yes	No	
VCM	Vinyl Chloride	G/L	No	Yes	>760	0		2	-	2	-	-	X	X	-	Yes	Yes	Carcinogen; no allowable exposure
VEE	Vinyl Ethyl Ether	L/G	No	Yes	>760	DNA		2	U	U								Toxic rating ethers; acute effects high conc. [8]
VFI	Vinyl Fluoride (Inhibited)	G	No	Yes	>760	2.5*[F](F)		(3)	-	(3)	-	-	X	Y	-			Toxic rating as fluorides
VME	Vinyl Methyl Ether (Inhibited	L/G	No	Yes[5]	>760	DNA		U	U	U	-	-	X	-	X			Irritates eyes, nose, throat, liquid causes frostbite [9]
VCI	Vinylidenechloride (Inhibited	L	No	Yes	~760	10	20	(2)	-	(2)	-	-	X	X	-	Yes	No	Toxic rating as vinyl chloride [8], burns skin [9]
VNT	Vinyl Toluene	L	No	Yes	3.5	100	150				-	-	X	-	X	No		Mod. toxic [5], chronic exp. damages kidneys & liver [8,9]
VTS	Vinyl Trichlorosilane	L	Yes	Yes	146	5 (HCl)		3	-	3	-	-	X	X	-	Yes	No	Fuming liquid
WCA	Wax: Carnuba	L	No	Yes	<0.25	DNA		0	0	0	-	-	-	-	-	Yes	Yes	
WPF	Wax: Paraffin	S/L	No	Yes	<0.25	2*		0	0	0	-	-	-	-	-	Yes	Yes	Fumes, carcinogen of stomach
XLM	Xylene (M-)	L	No	Yes	17	100	150	2	2	1	-	X	X	-	X	No(PVC) [11]	No[12] ACE[12]	
XLO	Xylene (O-)	L	No	Yes	14	100	150	2	2	1	-	X	X	-	X	"	"	
XLP	Xylene (P-)	L	No	Yes	18	100	150	2	2	1	-	X	X	-	X	"	"	
XYL	Xylenol	S	No	Yes	0.47	45		(3)	(3)	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as phenol
ZEC	Zectran	S	No	No	<<0.1	DNA					-	-	X	X	-			Insecticide
ZNA	Zinc Acetate	S	No	No	<0.25	DNA					X	-	-	-	X	Yes	Yes	Toxic rating as Zn cmpd. Low toxicity[8], irrit. eyes, nose, eye
ZAC	Zinc Ammonium Chloride	S	No	No	< 0.25	DNA					X	-	-	-	X			Irrit. skin, eyes, nose, throat[9]

C	CN	S	WR	F	VP	TLV (PPM OR MG/M3)*		SAX-TOXIC HAZARD RATING			LEVELS OF PROTECTION					MATERIAL COMPATI-BILITY [10]		NOTES
						TWA	STEL	IN	SA	IR	RESPIRATORY PF	RESPIRATORY CC	RESPIRATORY AS	CLOTHING SS	CLOTHING NS	B	P	
ZAR	Zinc Arsenate	S	No	No	<0.25	0.013		(3)	-	(2)	-	-	X	X	-	Yes	Yes	Carcinogen [8],toxic rating as arsenic
ZBC	Zinc Bichromate	S	No	No		0.1*		(3)	-	(3)	-	-	X	X	-			Carcinogen,toxic rating as Cr cmpd
ZBO	Zinc Borate	S	No	No	<0.25	10*		(2)	U	U	X	X	-	-	-	Yes	Yes	Toxic rating as boron cmpds; low toxicity
ZBR	Zinc Bromide	S	No	No	<0.25	DNA		(2)	-	(1)	X	X	-	-	X	Yes	Yes	Low toxicity[5],toxic rating as bromides
ZCB	Zinc Carbonate	S	No	No		DNA					X	-	-	-	-			Nontoxic [5],traces added to animal feeds
ZCL	Zinc Chloride	S	No	No	<0.25	1*					-	-	X	X	-	Yes	Yes	Fumes highly toxic. Soln. irrit.
ZCR	Zinc Chromate	S	No	No	<0.25	0.05*		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Carcinogen,toxic rating as Cr cmpd
ZCN	Zinc Cyanide	S	No	No		DNA		(3)	(3)	(1)	-	-	X	X	-			Toxic by inhal.& ingest.[5], toxic rating as Cn.
ZDP	Zinc Dialkyldithiophosphate	L	No	Yes	<0.25	DNA												Lube oil additive[5],skin & tissue irritant [9]
ZFB	Zinc Fluoborate	L	No	No	<0.25	DNA		(3)	-	(3)	-	-	X	X	-			Toxic rating as fluorides [8]
ZFX	Zinc Fluoride	S	No	No	<0.25	2.5* (F)		(3)	-	(3)	-	-	X	X	-			" " "
ZFM	Zinc Formate	S	No	-		DNA		(2)	-	(2)	X	X	-	-	X			May be toxic by ingestion [5] toxic rating as formic acid
ZHS	Zinc Hydrosulfite	S	No	-	DNA	DNA		(2)	U	U	X	-	-	-	X			Zinc compounds low toxicity, toxic rating as sulfites[8]
ZNT	Zinc Nitrate	S	No	No	<0.25	DNA		(2)	-	-	X	X	-	-	X	Yes	Yes	Mod. toxic[5],toxic rating as nitrate
ZPS	Zinc Phenolsulfonate	S	No	No	<0.25	DNA					X	-	-	-	X	Yes	Yes	Toxic by ingest.[5],eye,skin irrit
ZPP	Zinc Phosphide	S	Yes	No	<0.25	DNA		(3)	-	(2)	-	-	X	-	X	Yes	Yes	Toxic rating as phosphine
ZPC	Zinc Potassium Chromate	S	No	-	DNA	DNA					-	-	X	-	X			Toxic by ingest. Zinc chromate is carcinogen
ZSL	Zinc Silicofluoride	S	No	No	DNA	2.5%		(3)	-	(3)	-	-	X	X	-	Yes	Yes	Toxic rating as fluosilicates
ZSF	Zinc Sulfate	S	No	No	<0.25	DNA					X	-	-	-	X	Yes	Yes	Low toxicity[5],skin tissue irrit
ZCA	Zinc Acetate	S	No	No	<0.25	5* (Zr)					X	-	-	-	X	Yes	No	Toxic by inhalation [5]. skin, tissue irritant [9]
ZIR	Zirconium Nitrate	S	No	No	<0.25	5* (Zr)		(2)			X	-	-	-	X	Yes	Yes	Toxic rating as nitrates, skin, tissue irritant [9]
ZCO	Zirconium Oxychloride	S	No	No	DNA	5* (Zr)					X	-	-	-	X	Yes	Yes	No toxic data [5,8]
ZPF	Zirconium Potassium Fluoride	S	No	-	DNA	2.5*[5](F)		(3)	-	(3)	-	-	X	X	-			Toxic & irritant [5], toxic rating as fluorides
ZCS	Zirconium Sulfate	S	No	No	<0.25	5* (Zr)					X	-	-	-	X	Yes	Yes	TLV as Zr, eye, skin irrit. [9]
ZCT	Zirconium Tetrachloride	S	Yes	-	DNA	5*[5] (Zr)		(3)	-	(3)	-	-	X	X	-			Toxic rating as HCl acid, toxic & irritant [5]

APPENDIX B

MANUFACTURERS AND SUPPLIERS OF PROTECTIVE EQUIPMENT

PROTECTIVE CLOTHING

HOODS/GOGGLES/FACESHIELDS

Name and Part No.	Manufacturer	Material
Hood #460-625 (Air Supplied)	Fabohio, Inc.	Vinyl
Hood #420-620	" "	Vinyl
Helmet (Acid Helmet) 15836	Wheeler Protective Apparel, Inc.	Fiberglass with Vinyl window
Hood Three Piece Style F-100-80	Norton Safety Products Div.	Neoprene/Nylon
Hood, Three Piece Style 98-300	" " "	Polyurethane/Nylon
Hood, Two Piece Style NSVP-80	" " "	Vinyl/Nylon
Hood, Three Piece Style 58-00	" " "	Vinyl/Nylon 14-15 oz
Goggle, Flexible Frame Style 1022 (Chemical Splash-High Humidity)	" " "	--
Faceshield, Model 7-10	" " "	Acetate
Chemgard Acid Hood (Air Line Supply Type) Cat. No. 79168	Mine Safety Appliances Co.	Vinyl/Cotton
Chemgard Acid Hood Cat. No. 38022	" " "	Vinyl/Cotton
A-1-A Firefighter Hood Cat. No. 75514	" " "	Glass Fiber
Skullgard Faceshield Frame	" " "	Cellulose Acetate
Chemical Splash Goggle Cat. No.791079,clear Cat. No.791082,yellow	Mine Safety Appliances Co.	Polycarbonate Polycarbonate
Wide Vision Goggle Cat.No. 791081	" "	Polycarbonate
Rubber Frame Goggle Cat. No.791072,clear Cat. No.791072,with breathing vent	" "	Polycarbonate Polycarbonate

Goggles, Encon 160	Encon Manufacturing Co.	Vinyl
EN Fog Lens-0.06" Polycarbonate, Pt. No. 01-4000-51	" " "	Vinyl/Neoprene Strap
Regular Lens-0.06" Polycarbonate, Pt. No. 01-400-55	" " "	Vinyl/Neoprene Strap
Hood, Air Supplied Series 6000	Rich Industries	Vinyl
Acid Hood	Rich Industries	Vinyl
Splashproof Hood #H-516(Cape Style)	Jomac Products, Inc.	Vinyl/Fiberglass
Hood, SD-3672 Series	Standard Safety Equipment Co.	Gralite
Hood, Self Ventilating SD-3884	" " "	Gralite
Hood, Shoulder Mounted SD-5424	" " "	Gralite
Mounted Hood SD-4196	" " "	Gralite
Hood, SD-3943 (for Scottoramic Face Mask)	" " "	Gralite
Acid Hood with Hard Cap,SD-4435, SD-4432, SD-4107	" " "	Gralite
Airborne Dust Hood SD-3478,SD-5308	" " "	Gralite
Hood, Shoulder Length #186-11	Encon Manufacturing Co.	Neoprene/Nomex
Style Hood #5361-11	" " "	Neoprene/Nomex
Style Hood/Safety Cap #6410-11	" " "	Neoprene/Nomex

PROTECTIVE CLOTHING
BOOTS/SHOE COVERS

Name and Part No.	Manufacturer	Material
"TV" (TRI-VAC) 2TV04010(16") Steel Toe	Boss Manufacturing Company	Natural Rubber Neoprene or Vinyl
Rubber Knee 2TV-4010(16") Steel Toe	Boss Manufacturing Co.	" "
Industrial Rubber Hip 2HS-6231 Steel Toe	Boss Manufacturing Company	Black Rubber
Boots 320-840	Fabchio, Inc.	Vinyl
Overshoe 68974	Wheeler Protective Apparel Inc.	Vinyl
Leggings/Spats Leggings, Style 57-00 (Hip Length) Spats, Style 57-01	Norton Safety Products Div.	Neoprene/Cotton Neoprene/Cotton
Shoe Cover,Booties Series 1000	Rich Industries	Vinyl
Leggings, Hip Length Cat.No. 37690(29") Cat.No. 37691(30") Cat.No. 37692(31")	Mine Safety Appliances Co.	Neoprene Latex/Cotton
Spats, #37689	Mine Safety Appliances Co.	Neoprene Latex/Cotton
Seal-Tight Boots (with steel toe, for use with Standard Safety complete enclosure garments)	Standard Safety Equipment Co.	Neoprene
Gralite Boots SD-3528	" " "	Gralite
Gralite Waders SD-4139	" " "	Gralite-20

PROTECTIVE CLOTHING

Gloves/Guantlets/Sleeves

Name and Part No.	Manufacturer	Material
Tyvek Sleeve No.08-004518 (Throw-Away)	Singer Safety Products	Tyvek (Polyethylene)
Disposable Polyethylene Glove 36-001151(small) 36-001152(medium) 36-001153(large)	" " "	Tyvek (Polyethylene)
Black Stanzoils IUN-0054(.030 gage) 14 in. long	Boss Manufacturing Co.	Neoprene Coated
Heavy Weight Safety Cuff ISP-5115	" " "	Vinyl Coated
Tough Wear IUH-0343(.024 gage) 12 3/4 in. long	" " "	Nitrile Rubber
Interlocking Glove/ Ring Assembly,Acidwear 150000 (Sleevlets,rings,gloves)	Wheeler Protective Apparel, Inc.	Vinyl
Sleeves, 55-00	Norton Safety Products Div.	Neoprene/cotton
Glove, Super Flexible Knitwrist Cat.No. 37642 12" Gauntlett Cat.No. 37643	Mine Safety Appliances Co.	Vinyl/Jersey Lining
Glove, Python Knitwrist Cat.No. 37993 Gauntlett(14")Cat.No.37994	" " "	Neoprene/Canton Flannel Lining
Glove, Butyl Rubber,14" Cat.No. 38554(size 9) Cat.No. 38555(size 10) Cat.No. 38556(size 11)	" " "	Butyl

Redmont Gauntlet (Heavy Duty Line)	Edmont-Wilson Div. Bechton, Dickinson & Co.	Neoprene
Grappler, 14" Gauntlet Premium PVC Line #05619	" " "	Vinyl Coated
PVA, 14" Gauntlet Fully Coated, #14306	" " "	Polyvinyl Coated Alcohol
Coated Gloves, PVC Heavy Duty #9112,12" Gauntlet #9114,14" Gauntlet #9116,16" Gauntlet #9118,18" Gauntlet	Jomac Products, Inc.	Vinyl
Gloves, SD4313, SD5525	Standard Safety Equipment Co.	Graylite

PROTECTIVE CLOTHING

JACKETS/SHOP COATS

Name	Manufacturer	Material
TYVEK 40" Shop Coat (Disposable) No-08-004701-Small through No.08-004704-XLarge (Knee Length)	Singer Safety Products	Tyvek (Polyethylene)
Coat, Acidwear 30036	Wheeler Protective Apparel, Inc.	Vinyl
Jacket Style F-100-05 Tufflon F-100	Norton Safety Products Div.	Neoprene/Nylon
Coat, Style F-100-2310 Tufflon F-100	" " "	Neoprene/Nylon
Coat, 49" Style 92-348 Super Rhino-Lite	" " "	Polyurethane/Nylon
Jacket, 30" Sewn on Hood Style 90-344	" " "	Polyurethane/Nylon
Hooded Jacket Style NSPV-107	" " "	Vinyl/Nylon
Coat, 49" Style NSVP-2348-1	" " "	Vinyl/Nylon
Laboratory Smock Series 3680	Rich Industries	Vinyl
Shop Coat/Splash Resistant, Heavy Duty, Style 55-415	Edmont-Wilson Div. Becton, Dickinson & Co.	--
Jacket 32", No. J-340 with zipper, #3 Fabric	Jomac Products, Inc.	Vinyl/Cotton
Coat, basic, 44" No. C-440, Series 610	" " "	Vinyl/Nylon
Fireman's Bunker Coat 60Z, #7500-5	Encon Manufacturing Co.	Neoprene/Nomex
Jacket, Style 5600 #5600-11	" " "	Neoprene, Polyfoam, Nomex-Cotton Lined

Open Back Jacket SD-4499 (Seal tight sleeves) SD-4178	Standard Safety Equipment Co.	Gralite 20 Hi-Glo
Chemical Jacket(30") SD-4354	" " "	Hi-Glo
Coats/Jackets, Side Closure, SD-3109 SD-4390	" " "	Gralite-20 Hi-Glo
Coats/Jackets, Front Closure, SD-4354 (Seal tight sleeves)	" " "	Hi-Glo
P.O.M (Pyrophoric organic materials) Jacket, SD-4364	" " "	Gralite-20
Switch Pullers Jacket SD-4300 SD-5532	" " "	Gralite-20 Winter Glo-20

PROTECTIVE CLOTHING

Coveralls/Overalls/Pants

Name and Part No.	Manufacturer	Material
Tyvek Coverall (Disposable) No.08-004071-74 small-extra large (full length)	Singer Products Co.	Tyvek (Polyethylene)
Overalls (bib) 3PN-0871	Boss Manufacturing Co.	Vinyl/Nylon
Coverall with Sewn in Body Harness 47073E	Wheeler Protective Apparel, Inc.	
Overall, Acidwear 48536	" " "	Vinyl
Coverall Style F-100-615, Tufflon F-100	Norton Safety Products Div.	Neoprene/Nylon
Overall, Bib, Style F-100-12	" " "	Neoprene/Nylon
Overall, Bib, Style 91-325, Super Rhino-Lite	" " "	Polyurethane/Nylon
Waist Pant, Style 91-360	" " "	Polyurethane/Nylon
Overall,Style NSPV-12	" " "	Vinyl/Nylon
Coverall, Style 56-15	" " "	Vinyl/Nylon 14-15 oz
JFA Heavy Duty Coverall Style No. 55-510	Edmont-Wilson Div. Bechton, Dickinson & Do.	Polyolefin
Pants, Bib P-010 #3 Fabric	Jomac Products, Inc.	Vinyl/Cotton
Coverall, CO-040 #3 Fabric	" "	Vinyl/Nylon
Coverall, Style 5500 #5500-11	Encon Manufacturing Co.	Neoprene/Polyfoam Nylon/Cotton Lined

Pants, Style 5610 #5610-11	Encon Manufacturing Co.	Neoprene/Nylon
Coveralls SD-3981(seal-tight sleeves) SD-4178	Standard Safety Equipment Co.	 Gralite-20 Hi-Glo
Anti-Contamination Coverall,SD-574	" " "	Cotton
Air Supplied Coverall 8 Mil, SD-600	" " "	Plastic (Vinyl)
Bib Overall SD-3110 SD-4046	" " "	 Gralite-20 Hi-Glo
Rocket Fuel Handler's Coverall SD-3663	" " "	Gralite-20

PROTECTIVE CLOTHING

Aprons

Name and Part No.	Manufacturer	Material
Bib Apron No. 08-004136	Singer Safety Products, Inc.	Tyvek (Polyethylene)
Apron, Frost Clear	Fabohio, Inc.	Vinyl
Apron (Bib Type) 40136	Wheeler Protective Apparel, Inc.	Vinyl
Apron, Style 54-10	Norton Safety Products Div.	Neoprene/Cotton
Apron, Style 54-30	" " "	Neoprene/Nylon
Apron, Style 34-40	" " "	Hycar Rubber/Cotton
Apron, Style 64-30	" " "	Vinyl/Nylon
Chemgard Plastic Apron Cat. No. 73124 (Med.Weight, 0.008")	Mine Safety Appliances Co.	Vinyl
Synthetic Rubber Coated Apron Cat. No. 37668 (Med. Weight)	" "	Hycar Rubber/Cotton
Synthetic Rubber Coated Apron Cat. No. 31049 (Heavy Weight)	" " "	Buna S Rubber/Cotton
Synthetic Rubber Coated Apron Cat. No. 33441	" " "	Neoprene Rubber/Cotton
Vinyl Coated Apron Cat. No. 37673 (Med. Weight)	" " "	Vinyl/Cotton
Apron, Series 1000	Rich Industries	Vinyl
Heavy Duty 20 Mil Vinyl Apron, 45 #73640, Style 54-733	Edmont Wilson Div. Bector, Dickinson & Co.	Vinyl
Reinforced Heavy Duty Apron, 23 Mil, #72261, Style 54-367	" " "	Hycar

Apron, Bib Style AW-3-36, #3 Fabric	Jomac Products, Inc.	Vinyl
Apron, Bib Style	Standard Safety Equipment Co.	Hi-Glo
Apron, Split-Type	" " "	Hi-Glo

PROTECTIVE CLOTHING

Suits, Unencapsulating

Name and Part No.	Manufacturer	Material
Fire Chemical Suit (new, no part no.)	Fyrepel Products, Inc.	Butyl with aluminized oversuit
Disposable Suit #237 (one piece)	Fabohio, Inc.	Polyethylene, Spun bonded or extended polyethylene
Acid Suit #212 (one piece)	" "	Vinyl
Coverall #47036 (with 15836 Hood)	Wheeler Protective Apparel, Inc.	Vinyl
Two Piece Suit Series 3900	Rich Industries	Vinyl
Acid Suit, Two Piece Series 3675	" "	Vinyl
Heavy Duty Overall JFA	Edmont-Wilson	Polyolefin
Sun-Ray Suit(Two-Piece) Cat.No. 37107 (small) Cat.No. 37108 (medium) Cat.No. 37109 (large)	Mine Safety Appliances Co.	Vinyl/Nylon
Rubber Utility Suit (Two Piece) Cat.No. 32605 (small) Cat.No. 31934 (medium) Cat.No. 32606 (large)	" " "	Synthetic Rubber
Rubberized Protection Suit (One Piece) Cat.No. 33495 (small) Cat.No. 33496 (medium) Cat.No. 33497 (large) Hood for above, Cat.No. 33370	" " "	Neoprene
POM Suit, #7550	Encon Manufacturing Co.	Aluminized Nomex

Dust Suit SD-2632 SD-4475	Standard Safety Equipment Co.			Cotton Dacron/Rayon
Liquid Oxygen Suit,SD-3779	"	"	"	Whiteside
Two Piece Disposable Plastic Suit SD-602	"	"	"	Plastic

PROTECTIVE CLOTHING

Encapsulating Suit
(Air Supply/Air Respirator Req'd)

Name and Part No.	Manufacturer	Material
Basic Coverall #CO-910 #2 Chemical Cloth	Jomac Products, Inc.	Vinyl/Nylon
One Piece Suit Zipper, 0.020" Tk. Series 4000	Rich Industries	Vinyl
Rocket Fuel Handler Suit Cat.No. 92682 (Air Supply) Cat.No. 38590 (Air Mask)	Mine Safety Appliances Co.	Vinyl
ChemPruf Suit with Hood Cat. No. 75096(small) Cat. No. 75097(medium) Cat. No. 75098(large)	Mine Safety Appliances Co.	Butyl/Nylon
Disposable Suit,Airfed Cat. No. 91783 (large) Cat. No. 91784 (medium)	" " "	Vinyl
Acid King #47836C(with back pouch) #47836H(without pouch)	Wheeler Protective Apparel, Inc.	Vinyl/Betacloth
One Piece Air Supplied Suit #13-20(0.020")	Fabohio, Inc.	Vinyl
One Piece Air Supplied Suit #13-10,10OZ Nylon	" "	Vinyl/Nylon
Two Piece Air Supplied #15-6,0.006" Vinyl #15-12, 0.012" Vinyl #15-10, 10OZ Nylon	" "	Vinyl Vinyl Vinyl Vinyl/Nylon
Proximity Suit #FD-7599-V	Encon Manufacturing Co.	Neoprene/Nylon
Standard Acidmaster Suit, SD-3711 SD-5520	Standard Safety Equipment Co.	Gralite-20 (Vinyl) Winter Glo-20

Standard Compressed Air Suit	Standard Safety Equipment Co.	
SD-3896		Gralite-20 (Vinyl)
SD-5542(seal-tight boots)		Winter Glo-20
Standard Accordian Suit	" " "	
SD-5196		Gralite 20 (Vinyl)
(Vinyl Overboots)		
SD-5256 (Neoprene Steel Toe Boots)		Gralite 20 (Vinyl)
SD-5563 (Neoprene Steel Toe Boots)		Winter Glo-20

APPENDIX C

MATERIAL COMPATIBILITY TEST DATA
(Task V)

(References listed by number in the tables are included in the Bibliography)

Legend:

L	- Liquid
S	- Solid and soluble
G	- Gas
M	- Slightly soluble
I	- Insoluble
-	- Dash indicates no testing performed
BD	- Below detection
[ ]	- Water reactive, pertains to parent compound, literature data
R	- Performance rating based on literature review
T	- Performance rating based on laboratory tests of parent compound or water reaction product
T-D	- Performance rating based on inability to decontaminate
ND	- No data

INTRODUCTION

A literature search revealed that at least 403 chemicals on the CHRIS list would require a fully encapsulating suit/and or a supplied air or self-contained breathing apparatus. A further review of the literature was conducted to determine whether butyl rubber and polycarbonate, materials used in the Hazardous Chemical Protective Clothing Outfit (HCPCO), were compatible with those chemicals requiring a fully encapsulating suit.

Data on the compatibility of polycarbonate with the chemicals was accepted without further consideration, and compatibility testing was limited to those chemicals for which no compatibility data was available. In the case of butyl rubber, a rating of incompatible was accepted. Additional compatibility testing was conducted when a compatible rating was listed, due to the uncertainty of the test methods used in the past, or when no data was available.

Butyl rubber and polycarbonate were both subjected to 3 hr swatch immersion tests. If gross degradation was observed after the 3 hrs, the materials were judged to be incompatible with the chemical and no further testing was done. When the materials showed no degradation after 3 hrs, they were reexposed for a total of 20 hrs. If no degradation was observed after 20 hrs exposure, polycarbonate was deemed compatible, and butyl rubber was subjected to penetration testing. Decontamination effectiveness of a detergent-water solution (butyl only) was also evaluated.

This Appendix contains information which will be useful for decision making by the On-Site Coordinator in selecting appropriate protective gear for Strike Team personnel. A few examples are given to assist the user in interpreting the information.

Acetaldehyde is a liquid and is not water reactive. Review of the literature (R) indicates that polycarbonate is not compatible with acetaldehyde. Laboratory tests (T) showed that acetaldehyde penetrates butyl rubber in less than 3 hrs exposure. Neither polycarbonate nor butyl rubber is recommended for use with acetaldehyde.

Acetic anhydride is a liquid and reacts with water to form acetic acid. The literature (R) indicates that polycarbonate is compatible with acetic anhydride. The literature also indicates that polycarbonate is compatible with acetic acid, a water reaction product of acetic anhydride. The survey revealed that butyl rubber

is compatible with acetic acid. Polycarbonate and butyl rubber can be used with the parent material, acetic anhydride, and its water reaction product acetic acid.

Acetonitrile is liquid and is not water reactive. Polycarbonate is compatible with acetonitrile according to the literature (R). Butyl rubber was found, in laboratory tests (T), to resist penetration for 6 hrs, but penetration did occur in less than 20 hrs. Polycarbonate can be used with acetonitrile, but butyl rubber will have limited usage, e.g., a single spill cleanup.

Acrylic acid is a liquid and is not water reactive. According to the literature (R), polycarbonate is compatible with acrylic acid. Laboratory tests showed that butyl rubber resisted penetration for up to 20 hrs, but decontamination with a water-detergent solution was ineffective (T-D) in removing acrylic acid from butyl rubber. Polycarbonate and butyl rubber can be used as protective gear during clean up of acrylic acid spills, but due to decontamination problems the butyl suit would be limited to single usage.

Appropriate materials of construction for a protective garment could not be assigned for all 403 chemicals. Additional research is being conducted to determine alternate materials which could be used for a protective garment. As this information becomes available, it is anticipated that the information contained herein will be updated. Meanwhile, On-Site Coordinators and Strike Team personnel should find this information of value in assessing applications of the present HCPCO protective gear.

CHRIS CODE	CHEMICAL NAME	STATE	WATER SOLUB.	WATER REACTIVE	SWATCH TEST POLYCARB WEIGHT CHANGE (%) 3 hr	POLYCARB WEIGHT CHANGE (%) 20 hr	BUTYL WEIGHT CHANGE (%) 3 hr	BUTYL WEIGHT CHANGE (%) 20 hr	BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tensile	BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tear	PENETRATION TEST ppm or mg* 3 hr	PENETRATION TEST ppm or mg* 20 hr	SINGLE DECON TEST	MULTIPLE DECON TEST CYCLES 1 3 hr	MULTIPLE DECON TEST CYCLES 8 2 hr	TEST PERFORMANCE RATING POLYCARBONATE	TEST PERFORMANCE RATING BUTYL
AAD	Acetaldehyde	L	-	N	-	-	-	-	-	-	0.4	-	-	-	-	FAIL(R)	FAIL(T)
AAC	Acetic Acid	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
ACA	Acetic Anhydride	L	-	Y	-		FORMS ACETIC ACID			-	BD	BD	PASS	-	-	[PASS](R)	[PASS](T)
ACY	Acetone Cyanohydrin	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
ATN	Acetonitrile	L	-	N	-	-	-	-	-	-	BD	0.9	-	-	-	PASS(R)	>6<20 hr(T)
ABM	Acetyl Bromide	L	-	Y			FORMS HYDROBROMIC ACID				67	-	-	-	-	[PASS](R)	FAIL(T)
ACC	Acetyl Chloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				12	-	-	-	-	[FAIL](R)	FAIL(T)
ARL	Acrolein	L	-	N	-	-	-	-	-	-	1.1	-	-	FAIL	-	PASS(R)	FAIL(T)
AAM	Acrylamide	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
ACR	Acrylic Acid	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	PASS	FAIL	PASS(R)	FAIL(T-D)
ACN	Acrylonitrile	L	-	N	-	-	-	-	-	-	0.4	-	-	-	-	PASS(R)	FAIL(T)
ADN	Adiponitrile	L	-	N	-	-	-	-	-	-	5	-	-	-	-	PASS(R)	FAIL(T)
ALD	Aldrin	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(T)
ALA	Allyl Alcohol	L	-	N	-	-	-	-	-	-	0.2	-	-	-	-	PASS(R)	FAIL(T)
ALC	Allyl Chloride	L	-	N	-	-	-	-	-	-	0.2	-	-	-	-	FAIL(R)	FAIL(T)
ATC	Allyl Trichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				BD	1.4	-	-	-	[FAIL](R)	FAIL(T)
ACF	Allyl Chloroformate	L	-	Y	-	-	REACTS SLOWLY IN H_2O to HCl				83	-	-	-	-	[FAIL](R)	FAIL(T)
ACL	Aluminum Chloride	S	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
ALF	Aluminum Fluoride	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
ALM	Aluminum Sulfate	S	S	Y	0.0	+0.2	0.0	+0.3	0.0	0.0	-	-	-	-	-	PASS(T)	[PASS](R)
AMA	Ammonia Anhydrous	G	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
ABF	Ammonium Bifluoride	S	S	N	-0.1	+0.1	+4.7	+16.1	-8.7	-1.6	-	BD	FAIL	-	-	PASS(T)	FAIL(T-D)
ASU	Ammonium Bisulfite	S	S	Y	+0.2	+0.5	+0.9	+8.0	-2.0	-1.2	-	BD	FAIL	-	-	PASS(T)	FAIL(T)
ACM	Ammonium Carbamate	S	S	Y	+0.2	+1.8	+0.7	+0.9	+2.2	+7.3	-	BD	PASS	-	-	PASS(T)	PASS(T-D)
ACH	Ammonium Chromate	S	S	N	0.0	+0.1	0.0	+0.5	-2.3	-4.5	-	9D	PASS	-	-	PASS(T)	PASS(T)

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AMD	Ammonium Dichromate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
AFB	Ammonium Fluoborate	S	S	N	+0.1	+0.1	+0.2	+0.2	+1.7	+2.0	-	BD	PASS	-	-	PASS(T)	PASS(T)
AFR	Ammonium Fluoride	S	S	N	-	-	-	-	-	-	-	BD	FAIL	-	-	PASS(R)	FAIL(T-D)
AOX	Ammonium Oxalate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
ASL	Ammonium Silicofluoride	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
ASF	Ammonium Sulfide	L	-	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
ATS	N-Amyl Trichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
ANL	Aniline	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	PASS	FAIL	FAIL(R)	3 hr(T)
ASC	Anisoyl Chloride	S/L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
ATH	Anthracene	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
APC	Antimony Pentachloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
APF	Antimony Pentafluoride	L	-	Y	-	-	SEE HYDROFLUORIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
ATM	Antimony Trichloride	S	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
ATT	Antimony Trifluoride	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
AZM	Azinphosmethyl	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
BCY	Barium Cyanide	S	S	N	+0.1	+0.2	+0.1	+0.4	-3.2	+10	-	-	-	-	-	PASS(T)	FAIL(T)
BZD	Benzaldehyde	L	-	N	-	-	-	-	-	-	BD	3	FAIL	-	-	FAIL(R)	>6<20 hr(T)
BNZ	Benzene	L	-	N	FAILED		+12	-	-	-	-	-	-	-	-	FAIL(R)	FAIL(T)
BPT	Benzene Phosphorous Thiodichloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				BD	1.6	-	-	-	[FAIL]	FAIL(T)
BZN	Benzonitrile	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	FAIL(R)	FAIL(T-D)
BBR	Benzyl Bromide	L	-	Y	-	-	FORMS HYDROBROMIC ACID				1.5	-	-	-	-	[PASS](R)	FAIL(T)
BCL	Benzyl Chloride	L	-	Y	FOGGED		FORMS HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
BZM	Benzylamine	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL(R)	PASS(T)
BEC	Beryllium Chloride	S	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
BEF	Beryllium Fluoride	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)

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BEN	Beryllium Nitrate	S	-	Y	-	-	SEE NITRIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
BEO	Beryllium Oxide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
BEM	Beryllium, Metallic	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
BES	Beryllium, Sulfate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
BPA	Bisphenol A	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
BDE	Bisphenol A Diglycidyl Ether	L	-	N	-	-	-	UNAVAILABLE		-	-	-	-	-	-	ND	ND
BCP	Boiler Compound, Liquid	L	-	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
BTB	Boron Tribromide	L	-	Y	-	-	FORMS HYDROBROMIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
BRT	Boron Trichloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
BRM	Bromine	L	-	N	-	-	-	-	-	-	-	-	-	-	-	FAIL(R)	FAIL(R)
BPF	Bromine Pentafluoride	L	-	Y	-	-	SEE HYDROFLUORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
BTF	Bromine Trifluoride	L	-	Y	-	-	SEE HYDROFLUORIC ACID				-	-	-	-	-	ND	FAIL(T)
BHP	Tert-Butyl Hydroperoxide	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
BAM	N-Butyl Amine	L	-	N	-	-	-	-	-	-	800	-	-	-	-	FAIL(R)	FAIL(T)
BTO	1,2-Butylene Oxide	L	-	N	-	-	-	-	-	-	>30	-	-	-	-	PASS(R)	FAIL(T)
BCS	Butyl Trichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
BTD	1,4-Butynediol	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL(R)	PASS(T)
BAD	ISO-Butraldehyde	L	-	N	-	-	-	-		-	1.7	-	-	-	-	FAIL(R)	FAIL(T)
BTR	N-Butraldehyde	L	-	N	FOGGED		+7.7	+12.5	-	-	36	-	-	-	-	FAIL(R)	FAIL(T)
CAT	Cadmium Acetate	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
CMB	Cadmium Bromide	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
CDC	Cadmium Chloride	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
CFB	Cadmium Fluoborate	L	-	N	0.0	0.1	-0.3	-0.3	+2.9		SEE CADMIUM COMPOUNDS			-	-	PASS(R)	PASS(T)
CMN	Cadmium Nitrate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
COX	Cadmium Oxide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)

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CMS	Cadmium Sulfate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
CCA	Calcium Arsenate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
CAS	Calcium Arsenite	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
CCR	Calcium Chromate	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
CCN	Calcium Cyanide	S	-	Y	-	-	DECOMPOSES		-	-	-	-	-	-	-	[PASS](R)	[PASS](R)
CAF	Calcium Fluoride	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
CPT	Captan	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
CBO	Carbolic Oil	L	-	N	-	-	SEE PHENOL			-	-	-	-	-	-	PASS(R)	FAIL(T)
CBB	Carbon Disulfide	L	-	N	FAILED		+74	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
CTC	Catechol	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
CPS	Caustic Potash Solution	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL(R)	PASS(T)
CSS	Caustic Soda Solution	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL(R)	PASS(T)
CDM	Chlordane (liquid formulation)	L	-	N	-	-	SEE KEROSENE - INCOMPATIBLE				-	-	-	-	-	PASS(R)	FAIL(R)
CLX	Chlorine	G	-	Y	-	-	-	-	-	-	BD	BD	(DISCOLORED)		-	PASS(R)	FAIL(T)
CTF	Chlorine Trifluoride	G	-	Y	-		SEE HYDROFLUORIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
CTD	4-Chloro-O-Toluidine	S	M	N	FAILED		+0.6	+3.3	+2.3	+5.7	-	-	-	-	-	FAIL(T)	FAIL(T)
CRA	Chloroacetophenone	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
CAC	Chloroacetyl Chloride	L	-	Y	-	-	SEE HYDROFLUORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
CAP	P-Chloroaniline	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
CBN	4-Chlorobutronitrile	L	-	N	FAILED		+2.5	+5.7	+1.1	+3.7	BD	BD	PASS	-	-	FAIL(T)	PASS(T)
CRF	Chloroform	L	-	N	FAILED		+9.0	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
CHD	Chlorohydrin (Crude)	L	-	N	+0.2	+0.1	+0.6	+1.6	+8.0	+4.8	BD	BD	PASS	-	-	PASS(T)	PASS(T)
CME	Chloromethyl Methyl Ether	L	-	N	FAILED		FAILED		-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
CNO	O-Chloronitrobenzene	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
CPN	P-Chlorophenol	S	M	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)

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CHN	Cyclohexanol	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS (R)	PASS (T)
CHP	Cyclohexanone Peroxide	L	-	N							BD	BD	PASS	-	-	PASS (R)	PASS (T)
CHT	Cyclohexynyltrichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL] (R)	FAIL (T)
CHA	Cyclohexylamine	L	-	N	-	-	-	-	-	-	44	-	-	-	-	FAIL (R)	FAIL (T)
DAL	Decaldehyde	L	-	N	-	-	-	-	-	-	-	-	-	-	-	FAIL (R)	FAIL (T)
DTN	Demeton (liquid formulation)	L	-	N	-	-	-	-	-	-	SEE XYLENE (INCOMPATIBLE)					FAIL (R)	FAIL (R)
DEP	DI-(2-Ethylhexyl) Phosphoric Acid	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	PASS	FAIL	PASS (R)	FAIL (T-D)
DZP	DI-(P-Chlorobenzoyl) Peroxide	L	-	N	-	-	UNAVAILABLE				-	-	-	-	-	ND	ND
DBA	DI-N-Butylamine	L	-	N	-	-	-	-	-	-	2.4	-	-	-	-	FAIL	FAIL (T)
DNA	DI-N-Propylamine	L	-	N	-0.1	FOG	+61	-	-	-	-	-	-	-	-	FAIL (T)	FAIL (T)
DZN	Diazinon	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS (R)
DBT	Bibutylphenol	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
DBO	O-Dichlorobenzene	L	-	N	FOGGED		-	-	-	-	936	-	-	-	-	FAIL (T)	FAIL (T)
DCB	Dichlorobutene	L	-	N	FOGGED		+17	+19	-5.6	+11	-	-	-	-	-	FAIL (T)	FAIL (T)
DEE	Dichloroethyl Ether	L	-	N	FOGGED		+3.8	+11.0	-2.5	+1.1	-	-	-	-	-	FAIL (T)	FAIL (T)
DCP	2,4-Dichlorophenol	S	M	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS (R)
DPP	1,2-Dichloropropane	L	-	N	-	-	-	-	-	-	>5	-	-	-	-	FAIL (R)	FAIL (T)
DCV	Dichlorvos (liquid formulation)	L	-	N	FOGGED		+42	-	-	-	-	-	-	-	-	FAIL (T)	FAIL (T)
DPT	Dicyccopentadiene	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS (R)
DED	Dieldrin	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS
DFA	Difluorophosphoric Acid(anhydrous)	L	-	Y	-	-	SEE HYDROFLUORIC ACID				-	-	-	-	-	[FAIL] (R)	FAIL (T)
DIH	Diispropylbenzene Hydroperoxide	L	-	N	FOGGED		+24	+29	-	-	-	-	-	-	-	FAIL (T)	FAIL (T)
DSF	Dimethyl Sulfate	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	PASS	PASS	PASS (R)	PASS (T)
DSL	Dimethyl Sulfide	L	-	N	-	-	-	-	-	-	27	-	-	-	-	PASS (R)	FAIL (T)

CHRIS CODE	CHEMICAL NAME	STATE	WATER SOLUB.	WATER REACTIVE	SWATCH TEST POLYCARB WEIGHT CHANGE (%) 3 hr	SWATCH TEST POLYCARB WEIGHT CHANGE (%) 20 hr	SWATCH TEST BUTYL WEIGHT CHANGE (%) 3 hr	SWATCH TEST BUTYL WEIGHT CHANGE (%) 20 hr	SWATCH TEST BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tensile	SWATCH TEST BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tear	PENETRATION TEST ppm or mg* 3 hr	PENETRATION TEST ppm or mg* 20 hr	SINGLE DECON TEST	MULTIPLE DECON TEST CYCLES 1 3 hr	MULTIPLE DECON TEST CYCLES 8 2 hr	TEST PERFORMANCE RATING POLYCARBONATE	TEST PERFORMANCE RATING BUTYL
CPL	Chloropicrin	L	-	N	-	-	-	-	-	-	10	-	-	-	-	PASS (R)	
CRP	Chloroprene	L	-	N	-	-	-	-	-	-	-	-	-	-	-	ND	[illegible](R)
CSA	Chlorosulfonic Acid	L	-	Y	FAILED		FAILED		FORMS ACID MIXTURES		-	-	-	-	-	FAIL (T)	FAIL(T)
CRT	Chromic Acetate	S	S	N	+0.1	+0.2	+1.5	+1.1	0.0	0.0	-	BD	PASS	-	-	PASS (T)	PASS(T)
CMA	Chromic Anhydride (wet)	S	I	N	-	-	-	-	-	-	(BLISTERS)		-	-	-	PASS (R)	FAIL(T)
CHS	Chromic Sulfate	S	S	N	-	-	-	-	-	-	SEE CHROMIC ACETATE			-	-		
CRC	Chromous Chloride	S	S	N	0.0	+0.1	+0.1	+1.0	-3.7	-4.9	BD	BD	PASS	-	-	FAIL (T)	PASS(T)
CMC	Chromyl Chloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	PASS (T)	PASS(T)
COF	Cobalt Fluoride(ous)	S	S	N	+0.2	+0.2	+0.2	+0.7	-1.1	+1.4	BD	BD	PASS	-	-	ND	FAIL(T)
CAA	Copper Acetoarsenite(ic)	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (T)	PASS(T)
CPA	Copper Arsenite(ic)	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS(R)
CCY	Copper Cyanide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS(R)
CPF	Copper Fluoborate(ic)	L	-	N	-0.6	-0.6	-1.2	-1.1	-0.5	+1.0	SEE FLUOBORATES			-	-	PASS (R)	PASS(R)
COL	Copper Oxalate(ic)	S	I	N	-	-	-	-	-	-						PASS (T)	PASS(T)
CSN	Copper Sulfate(ic)Ammoniated	S	S	N	+0.1	+0.2	0.0	+0.3	0.0	+1.1	BD	BD	PASS	-	-	PASS (R)	PASS(R)
																PASS (T)	PASS(T)
COU	Coumaphos	S	I	N	-	-	-	-	-	-	-	-	-	-	-		
CCT	Creosote, Coal Tar	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	ND	ND
CTA	Crotonaldehyde	L	-	N	-	-	-	-	-	-	BD	6.8	-	-	-	PASS (R)	FAIL(T-D)
CUM	Cumene	L	-	N	-	-	-	-	-	-	195	-	-	-	-	FAIL (R)	<3 1/4 hr (T)
CMH	Cumene Hydroperoxide	L	-	N	-	-	SEE CUMENE		-	-						PASS (R)	FAIL(T)
CES	Cupriethylenediamine Solution	L	-	N	0.0	0.0	+3.3	+6.8	-9.5	-10.3	-	-	-	-	-	PASS (R)	FAIL(T)
CYA	Cyanoacetic Acid	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS (T)	FAIL(T)
CYG	Cyanogen	G	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS (R)	PASS(T)
CBR	Cyanogen Bromide	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS(T)
CCL	Cyanogen Chloride	G	-	Y	-	-	SEE HYDROCHLORIC ACID				0.7	-	-	-	-	PASS (R)	PASS(R)
																[PASS](R)	FAIL(T)

CHRIS CODE	CHEMICAL NAME	STATE	WATER SOLUB.	WATER REACTIVE	SWATCH TEST POLYCARB WEIGHT CHANGE (%) 3 hr	SWATCH TEST POLYCARB WEIGHT CHANGE (%) 20 hr	SWATCH TEST BUTYL WEIGHT CHANGE (%) 3 hr	SWATCH TEST BUTYL WEIGHT CHANGE (%) 20 hr	SWATCH TEST BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tensile	SWATCH TEST BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tear	PENETRATION TEST ppm or mg* 3 hr	PENETRATION TEST ppm or mg* 20 hr	SINGLE DECON TEST	MULTIPLE DECON TEST CYCLES 1 3 hr	MULTIPLE DECON TEST CYCLES 8 2 hr	TEST PERFORMANCE RATING POLYCARBONATE	TEST PERFORMANCE RATING BUTYL
DAC	Dimethyl Acetamide	L	-	N	-	-	-	-	-	-	0.9	-	-	-	-	FAIL(R)	FAIL(T)
DDW	Dimethylhexane Dihydroperoxide, Wet	S	M	N	0.1	0.2	-	-	-	-	BD	BD	FAIL	PASS	PASS	PASS(T)	PASS(T)
DMD	Dimethyldichlorosilane	L	-	Y	SEE HYDROCHLORIC ACID						-	-	-	-	-	[FAIL](R)	FAIL(T)
DMH	1,1-Dimethyhydrazine	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	FAIL(R)	FAIL(T-D)
DNZ	Dinitrobenzene	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
DNB	Dinitrobenzene, Meta	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
DNC	Dinitrocresols	S	M	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
DNP	2,4-Dinitrophenol	S	M	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
DTT	2,4-Dinitrotoluene	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
DAM	Diphenylamine	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
DPD	Diphenyldichlorosilane	L	-	Y	FOGGED		ATTACKED		-	-	-	-	-	-	-	3 hr(T)	FAIL(T)
DPM	Diphenylmethane Diisocyanate	S	D	Y	-	-	DECOMPOSES		-	-	-	-	-	-	-	[PASS](R)	[PASS](R)
DIQ	Diquat (liquid formulation)	L	-	N	+0.1	0.1	+0.1	+3.1	-7.4	-4.0	BD	BD	FAIL	PASS	PASS	PASS(T)	PASS(T)
DIS	Disulfton (liquid formulation)	L	-	N	FOGGED		+3.9	+14	-9.0	-2.0	-	-	-	-	-	FAIL(T)	FAIL(T)
DIU	Diuron (water suspension)	L	M	N	+0.1	+1.4	+1.6	+3.9	-5.7	-3.4	-	-	-	-	-	PASS(T)	FAIL(T)
DDB	Dodecylbenzene	L	-	N	0.0	0.0	82	-	-	-	-	-	-	-	-	PASS(R)	FAIL(T)
DTC	Dodecyltrichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
DUR	Dursban (liquid formulation)	L	-	N	FOGGED		+33	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
ESF	Endosulfane	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
EDR	Endrin	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
EPC	Epichlorohydrin	L	-	N	-	-	-	-	-	-	BD	1	FAIL	FAIL	-	PASS(R)	FAIL(T-D)
ETO	Ethion	L	-	N	FOGGED		+20	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
EAC	Ethyl Acrylate	L	-	N	-	-	-	-	-	-	11.3	-	-	-	-	FAIL(R)	FAIL(T)
ECF	Ethyl Chloroformate	L	-	N	-	-	-	-	-	-	54	-	-	-	-	FAIL(R)	FAIL(T)
ETM	Ethyl Methacrylate	L	-	N	-	-	-	-	-	-	300	-	-	-	-	FAIL(R)	FAIL(T)

CHRIS CODE	CHEMICAL NAME	STATE	WATER SOLUB.	WATER REACTIVE	SWATCH TEST: POLYCARB WEIGHT CHANGE (%) 3 hr	SWATCH TEST: POLYCARB WEIGHT CHANGE (%) 20 hr	SWATCH TEST: BUTYL WEIGHT CHANGE (%) 3 hr	SWATCH TEST: BUTYL WEIGHT CHANGE (%) 20 hr	SWATCH TEST: BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tensile	SWATCH TEST: BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tear	PENETRATION TEST ppm or mg* 3 hr	PENETRATION TEST ppm or mg* 20 hr	SINGLE DECON TEST	MULTIPLE DECON TEST CYCLES 1 3 hr	MULTIPLE DECON TEST CYCLES 8 2 hr	TEST PERFORMANCE RATING POLYCARBONATE	TEST PERFORMANCE RATING BUTYL
EPD	Ethyl Phosphorothioic Dichloride Anhydrous	L	-	N	FOGGED		+79	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
EPP	Ethyl Phosphorodichloridate	L	-	N	FOGGED		+25	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
EAM	Ethyl Amine	L	-	N	-	-	-	-	-	-	27	-	-	-	-	FAIL(R)	FAIL(T)
ECS	Ethyldichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
ECH	Ethylene Chlorohydrin	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL(R)	PASS(T)
ETC	Ethylene Cyanohydrin	L	-	N	-	-	-	-	-	-	473	-	-	-	-	PASS(R)	FAIL(T)
EDB	Ethylene Dibromide	L	-	N	-	-	-	-	-	-	122	-	-	-	-	PASS(R)	FAIL(T)
EDC	Ethylene Dichloride	L	-	N	-	-	-	-	-	-	160	-	-	-	-	FAIL(R)	FAIL(T)
EOX	Ethylene Oxide	G	-	N	-	-	-	-	-	-	0.3	-	-	-	-	PASS(R)	FAIL(T)
ETI	Ethyleneimine	L	-	Y	MILD REACTION WITH WATER											[FAIL](R)	PASS(R)
EHA	Ethylhexaldehyde	L	-	N	FOGGED		+56	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
EAI	2-Ethylhexyl Acrylate	L	-	N	-	-	-	-	-	-	2.4	-	-	-	-	FAIL(R)	FAIL(T)
ENB	Ethylidenenorbornene	L	-	N	0.0	0.0	-	-	-	-	60	-	-	-	-	PASS(T)	FAIL(T)
EPS	Ethylphenyl Dichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
ETS	Ethyltrichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
FAO	Ferric Ammonium Oxalate	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
FCL	Ferric Chloride	S	S	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
FFX	Ferric Fluoride	S	M	N	-	-	-	-	-	-						ND	ND
FFB	Ferrous Fluoborate	L	-	N	0.0	+0.1	+0.1	+0.7	-2.5	+1.0	-	-	-	-	-	PASS(T)	FAIL(T)
FOX	Ferrous Oxalate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
FXX	Fluorine	G	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
FSL	Fluosilicic Acid	L	-	N	+0.1	+0.2	0.0	-1.6	-8.5	-8.6	-	-	-	-	-	PASS(T)	FAIL(T)
FSA	Fluosulfonic Acid	L	-	Y	-	-	SEE HYDROFLUORIC & SULFURIC ACID							-	-	FAIL(R)	FAIL(T)
FMS	Formaldehyde Solution	L	-	N	-	-	-	-	-	-	0.7	-	-	-	-	PASS(R)	FAIL(T)
GTA	Glutraldehyde Solution	L	-	N	+0.1	+0.1	+3.5	+6.4	-15.0	-4.5	-	-	-	-	-	PASS(T)	FAIL(T)

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GCM	Glycidyl Methacrylate	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	PASS	PASS	PASS(R)	PASS(T)
HTC	Heptachlor	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
HAC	Hexadecyltrimethyl Ammonium Chloride	L	-	N	+0.1	+0.2	+0.6	1.4	0.0	+6.1	BD	BD	PASS	-	-	PASS(T)	PASS(T)
HAL	N-Hexaldehyde	L	-	N	FOGGED		+20	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
HMD	Hexamethylenediamine	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL(R)	PASS(T)
HMI	Hexamethyleneimine	L	-	N	-16	-	FAILED		-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
HMT	Hexamethylenetetramine	S	S	N	-	-	-	-	-	-	0.9	-	-	-	-	PASS(R)	FAIL(T)
HDZ	Hydrazine	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
HCL	Hydrochloric Acid	L	S	N	0.0	0.0	+0.9	+11	-74	-67	-	-	-	-	-	PASS(T)	FAIL(T)
HFA	Hydrofluoric Acid	L	S	N	+0.3	+1.0	+123	-	-82.4	-46.0	-	-	-	-	-	PASS(T)	FAIL(T)
HBR	Hydrogen Bromide	G	S	Y	FORMS ACTIVE ACID				-	-	-	-	-	-	-	PASS(R)	FAIL(T)
HDC	Hydrogen Chloride	G	S	Y	FORMS ACTIVE ACID				-	-	-	-	-	-	-	PASS(R)	FAIL(T)
HCN	Hydrogen Cyanide	G	S	Y	FORMS ACTIVE ACID				-	-	-	-	-	-	-	PASS(R)	FAIL(T)
HFX	Hydrogen Fluoride	G	S	N	FAILED		-	-	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
HPO	Hydrogen Peroxide	L	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
HDS	Hydrogen Sulfide	G	S	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	PASS(R)	FAIL(T-D)
HAI	2-Hydroxyethyl Acrylate (inhibited)	L	-	N	0.0	0.0	+2.1	+3.9	-12.0	-2.5	BD	BD	PASS	-	-	PASS(T)	PASS(T)
HAS	Hydroxylamine Sulfate	S	S	N	0.0	0.0	+0.2	+0.3	0.0	0.0	BD	BD	PASS	-	-	PASS(T)	PASS(T)
HPA	Hydroxypropyl Acrylate	L	-	N	+0.1	+0.1	+2.9	+4.1	+0.3	+1.0	BD	BD	PASS	-	-	PASS(T)	PASS(T)
IAM	Isobutylamine	L	-	N	-	-	-	-	-	-	480	-	-	-	-	FAIL(R)	FAIL(T)
IBN	Isobutronitrile	L	-	N	FOGGED		+3.5	+5.0	-3.8	+1.2	0.4	-	-	-	-	FAIL(T)	FAIL(T)
IOC	Isooctaldehyde	L	-	N	-	-	-	-	-	-	3.7	-	-	-	-	FAIL(R)	FAIL(T)
IDA	Isodecaldehyde	L	-	N	-	-	SEE ISOOCTALDEHYDE									FAIL(R)	FAIL(T)
IAI	Isodecylacrylate, inhibited	L	-	N	+0.1	+0.1	+53	-	-	-	-	-	-	-	-	PASS(T)	FAIL(T)
IPE	Isopropylether	L	-	N	-	-	-	-	-	-	3.3	-	-	-	-	PASS(R)	FAIL(T)

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IPM	Isopropyl Mercaptan	L	-	N	-	-	-	-	-	-	1020	-	-	-	-	PASS(R)	FAIL(T)
IPP	Isopropylamine	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	PASS	PASS	FAIL(R)	PASS(T)
IVA	Isovaleraldehyde	L	-	N	-	-	-	-	-	-	0.8	-	-	-	-	FAIL(R)	FAIL(T)
KPE	Kepone	S	M	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
LPO	Lauroyl Peroxide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(K)	PASS(R)
LPM	Lauryl Mercaptan	L	-	N	-	-	-	-	-	-	ATTACKED		-	-	-	PASS(R)	FAIL(T)
LAC	Lead Acetate	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
LFB	Lead Fluoborate	L	-	N	-0.1	0.1	-0.1	+1.2	0.0	+1.1	-	-	-	-	-	PASS(T)	PASS(T)
LAR	Lead Arsenate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
LFR	Lead Fluoride	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
LSA	Lead Stearate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
LTT	Lead Tetraacetate	S	D	Y	-	-	FORMS ACETIC ACID				-	-	-	-	-	[PASS](R)	[PASS](R)
LBC	Lithium Bichromate	S	S	N	+0.1	+0.4	-0.2	+0.3	+1.0	+1.0	-	BD	FAIL	-	-	PASS(T)	FAIL (T-D)
LCR	Lithium Chromate	S	S	N	+0.1	+0.2	0.0	+0.2	+0.3	+6.0	-	BD	PASS	-	-	PASS(T)	PASS(T)
MLT	Malathion	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	PASS(R)	FAIL(T-D)
MLI	Maleic Acid	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
MLA	Maleic Anhydride	S	S	Y	-	-	-	-	-	-	BD	BD	PASS	-	-	[PASS](R)	PASS(T)
MLH	Maleic Hydrazide	S	M	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
MAT	Mercuric Acetate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
MCC	Mercuric Ammonium Chloride	S	M	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
MRC	Mercuric Chloride	S	S	N	-	-	SEE MERCURIC SALTS				-	-	-	-	-	PASS(R)	PASS(R)
MCN	Mercuric Cyanide	S	S	N	-	-	SEE MERCURIC SALTS				-	-	-	-	-	PASS(R)	PASS(R)
MID	Mercuric Iodide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
MNT	Mercuric Nitrate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
MOX	Mercuric Oxide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)

CHRIS CODE	CHEMICAL NAME	STATE	WATER SOLUB.	WATER REACTIVE	SWATCH TEST: POLYCARB WEIGHT CHANGE (%) 3 hr	POLYCARB WEIGHT CHANGE (%) 20 hr	BUTYL WEIGHT CHANGE (%) 3 hr	BUTYL WEIGHT CHANGE (%) 20 hr	BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tensile	BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tear	PENETRATION TEST ppm or mg* 3 hr	PENETRATION TEST ppm or mg* 20 hr	SINGLE DECON TEST	MULTIPLE DECON TEST CYCLES 1 3 hr	MULTIPLE DECON TEST CYCLES 8 2 hr	TEST PERFORMANCE RATING: POLYCARBONATE	TEST PERFORMANCE RATING: BUTYL
MRS	Mercuric Sulfate	S	D	Y	+0.1	+0.1	+0.5	+2.8	+0.5	+7.0	-	BD	PASS	-	-	PASS(T)	PASS (T)
MSF	Mercuric Sulfide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS (R)
MRT	Mercuric Thiocyanate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
MRR	Mercurous Chloride	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS (R)
MRN	Mercurous Nitrate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS (T)
MCR	Mercury	L	-	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS (R)
MSO	Mesityl Oxide	L	-	N	-	-	-	-	-	-	0.5	-	-	-	-	PASS(R)	FAIL (T)
MAA	Methyl Amyl Alcohol	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	PASS(R)	FAIL(T-D)
MTB	Methyl Bromide	G	M	N	FOGGED		-	-	-	-	-	-	-	-	-	FAIL(T)	FAIL (R)
MCH	Methyl Chloroformate	L	-	N	FOGGED		+11	+13	-12.0	-13.0	-	-	-	-	-	FAIL(T)	FAIL (T)
MCS	Methyl Dichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL (T)
MHZ	Methyl Hydrazine	L	-	N	FAILED		+3.4	+6.7	-4.0	-6.0	BD	BD	FAIL	-	-	FAIL(T)	FAIL(T-D)
MIC	Methyl Isobutyl Carbinol	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	PASS(R)	FAIL(T-D)
MPK	Methyisopropenyl Ketone (inhibited)	L	-	N	-	-	-	UNAVAILABLE		-	-	-	-	-	-	ND	ND
MPT	Methyl Parathion	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS (R)
MVK	Methyl Vinyl Ketone	L	-	N	FOGGED		+8.5	+8.6	STRONG ODOR - FAILED		-	-	-	-	-	FAIL(T)	FAIL (T)
MAM	Methyl Acrylate	L	-	N	-	-	-	-	-	-	1.3	-	-	-	-	PASS(R)	FAIL (T)
MTA	Methylamine (water solution)	L	S	N	-	-	-	-	-	-	BD	BD	FAIL	PASS	PASS	FAIL(R)	PASS (T)
MAN	N-Methylaniline	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	PASS(R)	FAIL(T-D)
MCT	Methylcyclopentadienylmanganese Tricarbonyl	L	I	N	-	-	-	UNAVAILABLE		-	-	-	-	-	-	ND	ND
MPD	Methylphosponothioic Dichloride Anhydrous	L	-	Y	FAILED		+32	-	-	-	-	-	-	-	-	FAIL(T)	FAIL (T)
MPY	1-Methylpyrrolidone	L	-	N	FOGGED		+5.8	+15	-	-	-	-	-	-	-	FAIL(T)	FAIL (T)
MTS	Methyltrichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL (T)
MRX	Mirex	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
MFA	Motor Fuel AntiKnock CMPDS (PB Alkyls)	L	-	N	SEE TETRAETHYL & TETRAMETHYL LEAD						-	-	-	-	-	FAIL(T)	FAIL (T)

CHRIS CODE	CHEMICAL NAME	STATE	WATER SOLUB.	WATER REACTIVE	SWATCH TEST POLYCARB WEIGHT CHANGE (%) 3 hr	POLYCARB WEIGHT CHANGE (%) 20 hr	BUTYL WEIGHT CHANGE (%) 3 hr	BUTYL WEIGHT CHANGE (%) 20 hr	BUTYL 20 hr . HYS. PROPERTY CHANGE (%) Tensile	BUTYL 20 hr . HYS. PROPERTY CHANGE (%) Tear	PENETRATION TEST ppm or mg* 3 hr	PENETRATION TEST ppm or mg* 20 hr	SINGLE DECON TEST	MULTIPLE DECON TEST CYCLES 1 3 hr	MULTIPLE DECON TEST CYCLES 8 2 hr	TEST PERFORMANCE RATING POLYCARBONATE	TEST PERFORMANCE RATING BUTYL
NAB	Nabam (liquid formulation)	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
NLD	Naled	S	I	N	-	-	-	-	-							ND	ND
NCT	Naphtha, Coal Tar	L	-	N	+0.1	+0.1	FAILED		-	-	-	-	-	-	-	PASS(T)	FAIL(T)
NSV	Naphtha, Solvent	L	-	N	FOGGED		FAILED		-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
NAO	Naphthylamine	S	M	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
NCN	Nickel Cyanide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
NFB	Nickel Fluoborate	L	-	N	0.0	-0.4	+0.1	+0.9	-7.0	-4.0	-	BD	PASS	-	-	PASS(T)	PASS(T)
NFM	Nickel Formate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
NKH	Nickel Hydroxide	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
NNT	Nickel Nitrate	S	I	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
NKS	Nickel Sulfate	S	I	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
NIC	Nicotine	L	-	N	-	-	-	-	-	-	0.7	-	-	-	-	PASS(R)	FAIL(T)
NCS	Nicotine Sulfate	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
NTL	Nitralin	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
NAC	Nitric Acid	L	-	N	YELLOW		FAILED		-	-	-	-	-	-	-	FAIL(T)	FAIL(T)
NTX	Nitric Oxide	G	-	Y	-	-	SEE NITRIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
NAA	Nitrilotriacetic Acid and Salts	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
NTA	2-Nitroaniline	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
NAL	4-Nitroaniline	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
NTB	Nitrobenzene	L	-	N	FAILED		+4.2	+15	-10.2	+6.5	-	-	-	-	-	FAIL(T)	FAIL(T)
NOX	Nitrogen Tetroxide	G	-	Y	-	-	SEE NITRIC ACID				-	-	-	-	-	ND	FAIL(T)
NTC	Nitrosyl Chloride	G	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[PASS](R)	FAIL(T)
NPP	2-Nitropropane	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	PASS(R)	FAIL(T-8)
NTE	O-Nitrotoluene	L	-	N	FAILED		+9.9	+15.2	-	-	-	-	-	-	-	FAIL(T)	FAIL(T)

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NTT	P-Nitrotoluene	S	I	N	+0.1	+0.2	+0.2	+2.0	0.0	-4.0	-	BD	PASS	-	-	PASS(T)	PASS(T)
NNP	Nonyl Phenol	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL(R)	PASS(T)
OCR	Oil, Miscellaneous, Croton	L	-	N			-	-	-	-	-	-	-	-	-	ND	FAIL(R)
OLM	Oleum	L	-	Y	FAIL	-	SEE SULFURIC ACID				-	-	-	-	-	FAIL(T)	FAIL(T)
OXA	Oxalic Acid	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	ND
PTC	Parathion	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS(R)	PASS(T)
PCP	Pentachlorophenol	S	M	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
PAA	Peracetic Acid	L	-	N	-	-	-	-	-	-	3.6	-	-	-	-	PASS(R)	FAIL(T)
PCL	Perchloric Acid	L	-	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
PCM	Perchloromethyl Mercaptan	L	-	N	-	-	-	-	-	-	9	-	-	-	-	FAIL(R)	FAIL(T)
PTL	Petrolatum	L	-	N	-	-	-	-	-	-	ATTACKED		-	-	-	PASS(R)	FAIL(T)
PHN	Phenol	S	S	N	-	-	-	-	-	-	>0.2	-	-	-	-	FAIL(R)	FAIL(T)
PDL	Phenyldichloroarsine, Liquid	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
PHH	Phenylhydrazine Hydrochloride	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL(R)	PASS(T)
PHD	Phosdrin	L	-	N	FOGGED		+2.1	+4.4	-8.1	-8.0	BD	BD	FAIL	PASS	PASS	FAIL(T)	PASS(T)
PHG	Phosgene	G	D	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	PASS(R)	FAIL(T)
PPO	Phosphorous Oxychloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	PASS(R)	FAIL(T)
PPP	Phosphorous Pentasulfide	S	D	Y	-	-	SEE HYDROGEN SULFIDE				-	-	-	-	-	[PASS](R)	FAIL(T-D)
PBR	Phosphorous Tribromide	L	-	Y	FAILED		FAILED				-	-	-	-	-	FAIL(T)	FAIL(T)
PPT	Phosphorous Trichloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	PASS(R)	FAIL(T)
PCB	Polychlorinated Biphenyls	L	-	N	-	-	-	-	-	-	UNAVAILABLE		-	-	-	PASS(R)	PASS(R)
PBO	Potassium Binoxalate	S	S	N	-	-	-	-	-	-	UNAVAILABLE		-	-	-	PASS(R)	PASS(R)
PCH	Potassium Chromate	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
PTC	Potassium Cyanide	S	S	Y	-	-	-	-	-	-	-	BD	FAIL	-	-	PASS(R)	FAIL(T-D)

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PTD	Potassium Dichromate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
PTH	Potassium Hydroxide	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	FAIL (R)	PASS (T)
PTS	Potassium Oxalate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
PTP	Potassium Permanganate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
POP	Potassium Peroxide	S	-	Y	-	-	SEE POTASSIUM HYDROXIDE				-	-	-	-	-	[FAIL] (R)	PASS (T)
PLT	Propiolactone, Beta	L	-	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS (R)
PMN	N-Propyl Mercaptain	L	-	N	-	-	SEE ISOPROPYL MERCAPTAN				-	-	-	-	-	PASS (R)	FAIL (T)
PRA	N-Propylamine	L	-	N	FAILED		+14	+17	-	-	-	-	-	-	-	FAIL (T)	FAIL (T)
PII	Propyleneimine (inhibited)	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	FAIL (R)	FAIL (T-D)
PGA	Pyrogallic Acid	S	S	N	-	-	-	-	-	-	BD	BD	PASS	-	-	PASS (R)	PASS (T)
STC	Silicone Tetrachloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[PASS] (R)	FAIL (T)
SVF	Silver Fluoride	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
SDA	Sodium Arsenate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
SAR	Sodium Arsenite	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
SAZ	Sodium Azide	S	-	Y	-	-	-	-	-	-	-	-	-	-	-	[PASS] (R)	[PASS] (R)
SBF	Sodium Bifluoride	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS (R)
SCH	Sodium Chromate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
SCN	Sodium Cyanide	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS (R)
SCR	Sodium Dichromate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
SDF	Sodium Fluoride	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS (R)	PASS (T)
SDH	Sodium Hydride	S	D	Y	-	-	SEE SODIUM HYDROXIDE				-	-	-	-	-	FAIL (R)	PASS (T)
SHS	Sodium Hydrosulfide Solution	L	-	N	-	-	-	-	-	-	-	BD	PASS			PASS (R)	PASS (T)
SHD	Sodium Hydroxide	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	FAIL (R)	PASS (T)

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SML	Sodium Methylate	S	D	Y	-	-	DECOMPOSES			-	-	-	-	-	-	[PASS](R)	[PASS](R)
SOX	Sodium Oxalate	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
SSE	Sodium Selenite	S	S	N	+0.2	+0.3	+0.2	+1.2	-3.0	+6.0	-	BD	PASS	-	-	PASS(T)	PASS(T)
SFR	Sodium Silicofluoride	S	S	N	-	-	-	-	-	-	-	BD	PASS	-	-	PASS(R)	PASS(T)
SDS	Sodium Sulfide	S	S	N	-	-	+3.9	+5.5	-12.4	-7.8	-	-	-	-	-	PASS(R)	FAIL(T)
STF	Stannous Fluoride	S	S	N	+0.1	+0.2	+0.3	+0.7	+2.0	+7.3	-	BD	PASS	-	-	PASS(T)	PASS(T)
SCM	Strontium Chromate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
STR	Strychnine	S	M	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
SXX	Sulfur (liquid) @ 113-120°C	L	-	-	-	FIRE SUIT			-	-	-	-	-	-	-	ND	ND
SFD	Sulfur Dioxide	G	-	Y	-	-	-	-	-	-	2.5	-	-	-	-	[PASS](R)	FAIL(T)
SFM	Sulfur Monochloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
SFA	Sulfuric Acid	L	S	N	FAILED		FAILED				-	-	-	-	-	FAIL(T)	FAIL(T)
SAC	Sulfuric Acid (spent)	L	S	N	-	-	-	-	-	-	ATTACKED		-	-	-	PASS(R)	FAIL(T)
SCL	Sulfuryl Chloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	FAIL(R)	FAIL(T)
TES	2,4,5-T Esters (liquid formulation)	L	-	N	-	-	IN KEROSENE, INCOMPATIBLE				-	-	-	-	-	PASS(R)	FAIL(T)
TEC	Tetrachloroethane	L	-	N	-	-	-	-	-	-	1.8	-	-	-	-	FAIL(R)	FAIL(T)
TED	Tetraethyl Dithiopyrophosphate	L	-	Y	-	-	SLOW DECOMPOSITION			-	-	-	-	-	-	[PASS](R)	[PASS](R)
TEL	Tetraethyl Lead	L	-	N	FAILED		-	-		-	-	-	-	-	-	FAIL(T)	FAIL(R)
TEP	Tetraethyl Pyrophosphate	L	-	N	-	-	-	-	-	-	-	-	-	-	-	PASS(R)	PASS(R)
TTP	Tetraethylenepentamine	L	-	N	FOGGED		+1.5	+4.5	+4.2	-6.0	BD	BD	[illegible]		-	FAIL(T)	PASS(T)
THF	Tetrahydrofuran	L	-	N	-	-	-	-	-	-	3700	-	-	-	-	FAIL(R)	FAIL(T)
TML	Tetramethyl Lead	L	-	N	FOGGED		-	-	-	-	-	-		-	-	FAIL(T)	FAIL(R)
TPG	Thiophosgene	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-		-	-	[PASS](R)	FAIL(T)
TTT	Titanium Tetrachloride	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-			ND	FAIL(T)
TDI	Toluene 2,4-Diisocyanate	L	-	Y	-	-	SLOW DECOMPOSITION			-	-	-	-	-		[PASS](R)	FAIL(T)

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TAP	P-Toluene Sulfonic Acid	S	S	N	0.0	0.0	+4.7	+5.5	-32.2	-12	-	-	-	-	-	PASS (T)	FAIL(T)
TXP	Toxaphene	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS(R)
TRC	Trichlorfon (liquid formulation)	L	S	N	0.0	0.0	+1.9	+6.0	-6.7	-6.8	BD	BD	PASS	-	-	PASS (T)	PASS(T)
TCL	Trichloroethylene	L	-	N	FAILED		FAILED		-	-	-	-	-	-	-	FAIL (T)	FAIL(T)
TPH	Trichlorophenol	S	M	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS(R)
TCA	2,4,5-Trichlorophenoxyacetic Acid	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
TEN	Triethylamine	L	-	N	-	-	-	-	-	-	0.7	-	-	-	-	FAIL (R)	FAIL(T)
TEB	Triethylbenzene	L	-	N	-	-	-	-	-	-	3.6	-	-	-	-	PASS (R)	FAIL(T)
TET	Triethylenetetramine	L	-	N	-	-	-	-	-	-	BD	BD	PASS	-	-	FAIL (R)	PASS(T)
TMA	Trimethylamine (water solution)	G	S	N							0.6	-	-	-	-	FAIL (R)	FAIL(T)
TMC	Trimethylchlorosilane	L	-	Y	0.0	0.0	FAILED		-	-	-	-	-	-	-	PASS (T)	FAIL(T)
TPO	Tris(azididinyl)phosphine Oxide	S	S	N	-	-	NOT AVAILABLE			-	-	-	-	-	-	ND	ND
URP	Uranium Peroxide	S	I	-	-	-	-	-	-	-	-	-	-	-	-	ND	ND
UAN	Uranyl Nitrate	S	S	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
URS	Uranyl Sulfate	S	S	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
VOT	Vanadium Oxytrichloride	-	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
VSF	Vanadyl Sulfate	S	S	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	ND
VCM	Vinyl Chloride	G	-	N	-	-	-	-	UNAVAILABLE		-	-	-	-	-	PASS (R)	ND
VFI	Vinyl Fluoride (inhibited)	G	-	N	+0.1	+0.1	0.0	-0.1	+0.3	0.0	81	-	-	-	-	PASS (T)	FAIL(T)
VCI	Vinylidenechloride (inhibited)	L	-	N	-	-	-	-	-	-	>100	-	-	-	-	FAIL (R)	FAIL(T)
VIS	Vinyl Trichlorosilane	L	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	[FAIL](R)	FAIL(T)
XYL	Xylenol (2-4,)	L	-	N	-	-	-	-	-	-	BD	BD	FAIL	FAIL	-	PASS (R)	FAIL(T-D)
ZEC	Zectran	S	I	N	-	-	-	-	-	-	-	-	-	-	-	ND	ND
ZAR	Zinc Arsenate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS(R)
ZBC	Zinc Bichromate	S	S	N	+0.1	+0.1	+0.2	+1.1	-3.7	-3.7	-	BD	PASS	-	-	PASS (T)	PASS(T)

CHRIS CODE	CHEMICAL NAME	STATE	WATER SOLUB.	WATER REACTIVE	SWATCH TEST: POLYCARB WEIGHT CHANGE (%) 3 hr	SWATCH TEST: POLYCARB WEIGHT CHANGE (%) 20 hr	SWATCH TEST: BUTYL WEIGHT CHANGE (%) 3 hr	SWATCH TEST: BUTYL WEIGHT CHANGE (%) 20 hr	SWATCH TEST: BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tensile	SWATCH TEST: BUTYL 20 hr PHYS. PROPERTY CHANGE (%) Tear	PENETRATION TEST ppm or mg* 3 hr	PENETRATION TEST ppm or mg* 20 hr	SINGLE DECON TEST	MULTIPLE DECON TEST CYCLES 1 3 hr	MULTIPLE DECON TEST CYCLES 8 2 hr	TEST PERFORMANCE RATING POLYCARBONATE	TEST PERFORMANCE RATING BUTYL
ZCL	Zinc Chloride	S	S	N	-	-	-	-	-	-	-	0.1	-	-	-	PASS (R)	FAIL (T)
ZCR	Zinc Chromate	S	I	N	-	-	-	-	-	-	-	-	-	-	-	PASS (R)	PASS (R)
ZCN	Zinc Cyanide	S	I	N	-	-	-	-	-	-						ND	ND
ZPF	Zinc Fluoborate	L	-	N	+0.1	+0.1	-0.2	0.0	-10.0	-6.1	-		-	-	-	PASS (T)	FAIL (T)
ZFX	Zinc Fluoride	S	S	N	+0.1	+0.2	0.1	+0.5	-3.6	-4.9	-	BD	PASS			PASS (T)	PASS (T)
ZCL	Zinc Silicofluoride	S	S	N	+0.1	+0.2	-0.1	+0.3	+2.5	+8.1						PASS (T)	PASS (T)
ZPF	Zirconium Potassium Fluoride	S	S	N	+0.2	0.0	+0.1	+0.3	-1.9	-13.6	-	-	-	-	-	PASS (T)	FAIL (T)
ZCT	Zirconium Tetrachloride	S	-	Y	-	-	SEE HYDROCHLORIC ACID				-	-	-	-	-	ND	FAIL (T)

LEGEND

L	Liquid
S	Solid and Soluble
G	Gas
M	Slightly Soluble
I	Insoluble
-	Dash indicates no testing performed
BD	Below Detection
[ ]	Water reactive, pertains to parent compound, literature data
R	Performance rating based on literature review
T	Performance rating based on laboratory tests of parent compound or water reaction product
T-D	Performance rating based on inability to decontaminate
ND	No data

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