

Quick Selection Guide to

CHEMICAL PROTECTIVE CLOTHING

THIRD EDITIO



Quick Selection Guide to Chemical Protective Clothing *Third Edition*

Krister Forsberg Lidingo, Sweden

S.Z. Mansdorf, PhD, CIH, CSP Boston, MA



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This guide contains a compilation of chemical resistance data from a variety of published and unpublished sources collected by the authors. No attempt has been made to ensure the validity of the data as presented. John Wiley & Sons, Inc. assumes no responsibility for the accuracy or completeness of the recommendations. Users of this guide are cautioned to consult a qualified industrial hygienist or other qualified professional before implementing the recommendations from this guide.

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Important Instructions

This guidebook contains information on hazardous chemicals and recommendations for the selection of chemical protective clothing materials based on published and unpublished scientific test data. NO attempt has been made to ensure either the accuracy or precision of these compiled data. The guide also does not take into consideration the intended use or physical demands (resistance to tear, puncture resistance, etc.) of the chemical protective clothing. These factors are critical in the selection process. ALL selections based on this guide MUST be reviewed by a person competent in the selection of chemical protective clothing such as a certified industrial hygienist with training in this area.

Contents

Preface v

Acknowledgments vi

Section I Introduction 1

Background 2

Organization of the Guide 3

Overview on How to Use This Guide 3

Section II Selection and Use of Chemical Protective Clothing 5

Introduction to Some Important Terms 5

Selection and Use of Protective Clothing 6

Ten Important Considerations for the Selection and Use of

Protective Clothing 13

Section III Chemical Index 17

Chemical Class Numbers 17

Chemical Names 17

Synonyms 18

Chemical Abstract Service Number 18

Risk Code 18

Special Notes 19

Chemical Index Listings 20

Section IV Selection Recommendations 47

Barriers 47

Color Codes 48

Important Notes and Warnings 49

Selection Recommendation Tables 50

Section V Glossary 99

Section VI Standards for Chemical Protective

Clothing 109

ASTM Standards 109

NFPA Standards 110

ISO Standards 111

Section VII Manufacturers of Chemical Protective

Clothing 113

iv



Preface

The third edition of the *Quick Selection Guide to Chemical Protective Clothing* has been revised and expanded to include some significant new information when compared to the previous editions. The chemical index now includes additional synonyms and special notes listing "skin" and "caution" notations to alert the user to materials that may be of most concern for worker protection. The color-coded tables of recommendations now contain a listing of 16 representative protective barriers including trade name materials against approximately 600 chemicals of interest. These barrier listings now include glove, boot, and suit materials of construction. Other changes include an expanded discussion on the selection and use of protective clothing, inclusion of testing standards, and contact information for manufacturers and suppliers. An expanded glossary and other practical user information is also included from the prior edition.

This guide is intended for use by workers, supervisors, industrial hygiene and safety professionals, and others who select or use personal protective clothing for control of chemical exposures. Hazardous materials spill responders and other emergency response personnel should find this guide especially useful.

The recommendations presented in the guide are based on data compiled and evaluated by Krister Forsberg. He has compiled over 14,000 chemical permeation and degradation test records from 100 references on 900 chemicals/chemical mixtures and 300 different types of protective clothing. Mr. Forsberg is recognized internationally as a leading expert on and the author of several guides to protective clothing. The skin notations are from the American Conference of Governmental Industrial Hygienists Threshold Limit Values for Chemical Substances and the Occupational Safety and Health Administration Permissible Exposure Limits tables. The caution notations were developed by me based on a number of different published and unpublished sources using various toxicological and chemical data.

It is hoped by the authors that this revised edition will receive the same enthusiastic response as the prior edition in assisting to protect workers utilizing the "last line of defense."

S.Z. Mansdorf

Acknowledgments

The authors wish to acknowledge the technical assistance of Dr. Stephen Berardinelli (NIOSH) and the manufacturers or suppliers of the chemical protective garments and gloves listed in the guide.



SECTION I

Introduction

The intent of the *Quick Selection Guide to Chemical Protective Clothing* is to assist workers, supervisors, safety and health professionals, and others in the initial selection of the best protective clothing materials against specific chemical challenges on the job. This is accomplished by use of the color-coded tables that summarize the chemical breakthrough performance of 16 materials against approximately 600 chemicals.

This guide is only a summary of data and should not be the sole basis for the final selection of the chemical protective clothing. More complete and comprehensive information is contained in the following publications: GENERAL INFORMATION

• Chemical Protective Clothing, Vols. I and II, edited by J.S. Johnson, and K.J. Anderson, (1990). American Industrial Hygiene Association, Fairfax, VA. [Tel: 703-849-8888]

- Protective Gloves for Occupational Use, edited by G. Mellstrom, J. Wahlberg, and H. Maibach (1994). CRC Press, Boca Raton, FL. PERFORMANCE DATA
- Krister Forsberg's Instant Gloves + CPC Database for Windows (1997). 9th edition, includes data from 14,000 chemical permeation and degradation tests. Instant Reference Sources, Inc. 7605 Rockpoint Drive, Austin, TX 78731. [Tel: 800-301-0359]
- Chemical Protective Clothing Permeation and Degradation Compendium by Krister Forsberg & Lawrence H. Keith (1995). Lewis Publisher/CRC Press.
- Chemical Protective Clothing Performance Book by Krister Forsberg & Lawrence H. Keith. 2nd edition (1997). John Wiley & Sons, Inc.

Background

All chemicals, including water and table salt, present some level of risk to workers. In large part, this level of risk is determined by the amount of the chemical that is inhaled, absorbed, ingested, injected, or otherwise contacts or enters the body (the "dose") and the inherent toxicity of the chemical. Inhalation hazards have traditionally been of greatest concern; however, dermal (skin) hazards are much more common. There are many types and degrees of dermal hazard. Dermal hazards are presented by chemicals that can damage the skin, such as corrosives; cause a reaction, such as sensitizers and irritants; or produce toxicity by permeation through the skin. The purpose of chemical protective clothing is the prevention of contact with chemicals potentially hazardous to the skin, thus lowering the risk of injury or illness.

Risk of dermal injury from physical hazards, such as thermal burns, trauma, and radiation, may also be reduced by protective clothing. However, the focus of this book is protection from chemical hazards to the skin.

Chemical protective clothing ranges in complexity from simple finger cots to fully encapsulating gas-tight suits. Although a wide variety of well-designed and -constructed products are available,

research has shown that toxic chemicals can easily pass through or damage some of these devices and have direct contact with the skin and/or be absorbed into the blood. This has led to a considerable amount of research by chemical and protective clothing manufacturers, users of chemical protective clothing, researchers, and others to find the materials of construction best suited to specific chemical challenges. Most of this testing has been conducted using the ASTM F739-91, Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact or previous versions of this test method from the American Society for Testing and Materials (ASTM). This laboratory test method provides both a breakthrough time and a steady-state permeation rate based on direct contact of the challenge liquid or gas with the normal outside surface of the protective material. The breakthrough time is the time to the first indication of the presence of the test liquid or gas in the collection media on the other side (normal inside surface) of the test material. Thus, the data given in this guide are based on laboratory tests of permeation. The recommendations are not based on actual use of the materials as protective clothing. Nevertheless, if the glove, boot, or suit is not damaged and has no defects, the laboratory test data is likely to be equal to the worst-case chemical challenge in the work environment.

2

Organization of the Guide

This guide is divided into seven major sections. The last part of this introductory section is a quick overview on how to use the guide. The next section in the guide, SELECTION AND USE OF PROTECTIVE CLOTHING, provides a quick review of the permeation process and other factors that adversely affect protective clothing. This is followed by a brief discussion on the selection and use of protective clothing. Finally, some suggestions to users are presented.

The third section of the guide, CHEMICAL INDEX, contains the chemical class numbers, chemical names and synonyms, chemical abstract service (CAS) numbers, risk codes, and special notes. It is organized alphabetically by chemical name.

The fourth section of the guide contains the color coded SELECTION RECOMMENDATIONS organized numerically by chemical class. Within each chemical class specific chemicals are listed alphabetically. The fifth section of the guide contains a GLOSSARY of terms common to chemical protective clothing and related health and safety terminology. The sixth section contains a

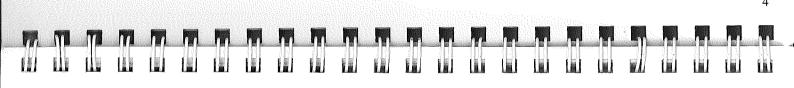
list of relevant STANDARDS FOR CHEMICAL PROTECTIVE CLOTHING, while the seventh and last section gives contact information for many of the MANUFACTURERS OF CHEMICAL PROTECTIVE CLOTHING.

Overview on How to Use This Guide

The selection of the barriers offering the best chemical resistance is completed by a three-step process in this guide. First, the chemical name or synonym is found in the alphabetically sorted CHEMICAL INDEX. The second step is to use the class number that appears to the left of the chemical name to search the SELECTION RECOMMENDATIONS. This section is in numerical order by chemical class. The final step is to find the chemical within the class listing and note the color-coded recommendations by barrier. For example, to find the recommendations for protection from acetone, the user must first find the chemical class number in the chemical index section. We find the chemical acetone listed on the first page of the CHEMICAL INDEX. This listing shows a class number of 391. This is the general class for Ketones (aliphatic or alicyclic) under the ASTM F-1186, Guide for Classification of

Chemicals According to Functional Groups. This listing also shows the chemical abstract service (CAS) number assigned to acetone as 67-64-1. The main purpose for listing the unique CAS number is to be sure that this chemical is the one that we are interested in and not another chemical by a similar name. The next column under acetone lists the "Risk Code." For acetone, it is listed as "V." This means that the chemical has received a designation of "potentially harmful" based on the Official Gazette of the European Community's "Guide to Classification and Marking of Hazardous Substances." This is the lowest level of warning under this classification scheme (i.e., least potentially hazardous). There are no special notes for acetone.

The next step is to go to the SELECTION RECOMMENDATIONS section and find chemical class number 391. Acetone is listed first within this group. Reading the color codes from left to right, we find eight recommended barriers (color coded green) with eight barriers that are not recommended (color coded red). Natural rubber, Neoprene, Nitrile rubber, Polyethylene, Polyvinyl alcohol, Polyvinyl chloride (PVC), Viton, and Saranex are not recommended for use against acetone. Butyl rubber, Teflon, 4H, Barricade, CPF3, Responder, Trellchem HPS, and Tychem 10, 000 are recommended for use.



Selection and Use of Chemical Protective Clothing

SECTION II

Introduction to Some Important Terms

The guide includes information based on permeation data. *Permeation* is the diffusion of a chemical on a molecular basis through chemical protective clothing. This movement of the chemical through the protective material may not be readily noticeable since it occurs on a molecular or microscopic level. This process is represented by the illustration shown in Figure 1. The time it takes the chemical to pass through the protective material until it is first detected by an analytical instrument is called the *breakthrough time*. The test for permeation and breakthrough time is represented by the illustration in Figure 2. The mass flux (rate in mass per unit area per unit time) of the chemical through the

protective material once it has broken through is called the *permeation rate*. The effect the chemical has as it interacts with the material can range from no effect to an effect as severe as dissolving the material. The change in the physical properties of the material as a result of adverse effects of the chemical is called *degradation*. A representation of degradation is shown in Figure 3.

The guide does not include any consideration of manufacturer defects or user-caused damages. Tears, rips, pinholes, and other damage or manufacturing defects can result in penetration of the chemical through these openings no matter how resistant the material is to the chemical challenge. *Penetration* is defined as the bulk flow of chemical through the protective material. A

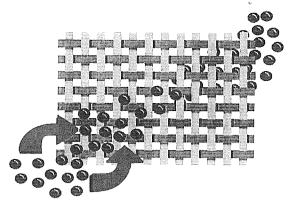


Figure 1 Permeation

representation of penetration is shown in Figure 4. Penetration may not be visible to the naked eye.

Selection and Use of Protective Clothing

Chemical protective clothing (CPC) selection is a process that normally should be based on a number of factors. Some uses of protective clothing that involve unique situations or very serious

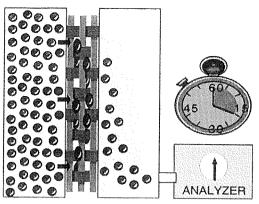


Figure 2 Permeation test

hazards will require a detailed analysis of the tasks to be completed and perhaps expert assistance. However, the general process for selection can be simply stated. There are eight key factors to be determined in the selection process:

- 1. Determining if the job can be done without CPC
- 2. Determining the type of exposure most likely to occur
- 3. Determining the adverse effects of contact with the chemical



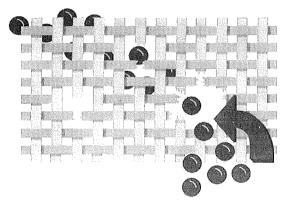


Figure 3 Degradation

- 4. Determining the physical resistance properties required of the CPC
- 5. Determining the chemical resistance properties required of the CPC
- 6. Determining the need for decontamination of the CPC
- 7. Determining the ergonomic restrictions
- 8. Determining the cost of use

The first important question to be answered in the selection process is whether or not CPC even needs to be used. This includes a

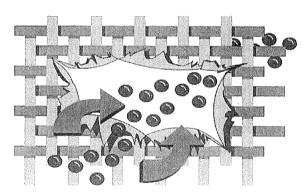


Figure 4 Penetration

consideration of other options, such as the replacement of the chemical with a less harmful one, the use of tools or other techniques to reduce or eliminate the need to be in close proximity to the chemical(s), a redesign of the job, or the use of robotics, to name a few examples. Even if CPC must be used for economic, feasibility, or other reasons, it may still be possible to reduce the level of risk that the situation presents through a combination of administrative, engineering, or other control methods along with the use of CPC.

- Immersion (continuous or intermittent)
- Spray (pressurized or nonpressurized)
- Splash (continuous, intermittent, or not expected)
- Surface contact (continuous or intermittent)
- Mist (continuous or intermittent)
- Vapors (gaseous contact)

In all cases, the CPC should protect the user from the effects of contact with the chemical. For example, job tasks with the potential for contact in the form of a pressurized spray (from a source under pressure) should include the requirement for sealing all exposed surfaces against penetration, including any mist or vapor penetration.

An assessment of the adverse health effects from chemical contact is the most important factor in the determination of the right CPC to use once it is decided that CPC should be used. This should include the general toxicity and hazards from use of the chemical (e.g., fire hazard) with an emphasis on the local effects on the skin (e.g., effects of skin contact such as chemical burns, corrosion, staining, irritation, etc.), and the systemic effects of chemicals that might permeate the skin and enter the blood stream. As a general rule of thumb, those chemicals that are both water- and fat-soluble are most likely to be skin-permeable.

Obviously, the more harmful the effects of chemical contact, the more protection the user needs and the more important the proper selection becomes. The Environmental Protection Agency (EPA) and several other agencies such as the National Institute for Occupational Safety and Health (NIOSH) have developed a selection scheme for personal protective equipment for hazardous waste operations and emergency response by level of protection required. Their scheme consists of four levels designated by the letters A, B, C, and D. The following list summarizes this scheme.

Level A: Self Contained Breathing Apparatus (SCBA) or Positive Pressure Airline System (PPAS) with escape SCBA and totally encapsulating chemical protective

8

suit, gloves (double layer), chemically resistant boots, plus other safety equipment.

Level B: Same respirator as level A and hooded chemicalresistant suit, gloves (double layer), chemically resistant boots, plus other safety equipment.

Level C: Full face or half-mask air purifying respirator and protective clothing as in level B, plus other safety equipment.

Level D: No respiratory protection, and "coveralls" with an option for gloves, boots, boot coverings, and other related safety equipment.

It should be noted that while level A requires a gas-tight totally encapsulating suit, levels B and C are basically the same splash suit, and level D has essentially no chemical protective clothing requirement (other than optional gloves and boots). Therefore, these standard ensembles represent only two major options in terms of chemical protective clothing: totally encapsulating suits and other chemically protective clothing. Most industrial situations require a

much more specific selection of protective clothing. This is usually much easier to accomplish for industrial processes since the chemicals and exposure situations are better known.

The physical resistance and properties required must be determined. As stated earlier, the best chemically resistant material will be ineffective if torn, cut, punctured, or otherwise damaged. Additionally, contamination within protective clothing can actually present more risk than normal contact since the chemical can be held against the skin for long periods of time. Many of the materials that offer excellent chemical resistance may offer poor resistance to abrasion, cuts, and puncture. Using gloves as an example, possible solutions to this problem are double gloving (use of two different or the same gloves worn over each other on the same hand), the use of gloves composed of more than one compound (e.g., dipped gloves), or the use of multilayered gloves. Some of the physical resistance factors to consider before evaluating chemical resistance needed are:

- Abrasion resistance
- Cut resistance
- Puncture resistance

- Tear strength
- Tensile strength
- Flammability
- Resistance to the effects of heat and cold

Some other physical properties to consider for articles of protective clothing are closure strength (zippers, etc.), seam strength, bursting strength, flexibility, weight, fire resistance, and thermal insulation. The exact properties desired will depend on the hazards of the work and the requirements of the job to be performed.

Recommendations in this guide do not include thermal insulation or fire/flame resistance factors. Many of the polymers cited in the guide will support combustion. For those special applications where there is a need for fire/flame resistance (resistance to burning or supporting combustion), the manufacturers or suppliers should be contacted. It should be noted that fire/flame resistance will not directly protect the user from the effects of heat unless the material also provides thermal insulation (directly related to thickness). It should also be noted that there are limited options available for ensembles that provide both fire resistance and/or thermal insulation and chemical resistance.

Determining the chemical resistance required from the protective clothing is necessary. This guide provides recommendations based on breakthrough data reported by researchers including those of the manufacturer of the CPC. As stated earlier, the ASTM method is a test of the barrier against direct liquid or gaseous contact and for most situations represents a "worst case" scenario. Secondly, very little is known about the relationship between the breakthrough of protective clothing and human toxicity, given that most permeation rates are extremely low (micrograms per square meter per minute). For protection against most potentially hazardous materials, select and use CPC that offers at least four hours of breakthrough resistance. In some cases, finding a barrier that offers breakthrough resistance of at least four hours will not be possible. In this situation, a low permeation rate may be the best choice of the options immediately available (e.g., a yellow block). In these situations, it is best to review actual permeation data to make the choice of the most chemically resistant CPC. Vendors of CPC are usually a good source of current information on the chemical and physical resistance of their products. For those chemicals that have not been tested, some generalizations can be made about their ability to permeate various barriers based on their chemical class. However, caution must be exercised since the only way to be sure of the

10

performance of CPC is to test it against the chemical of interest. Mixtures are another complicating factor. These are commonly encountered, but little data exists on the performance of protective materials against mixtures. They do not always behave as might be expected in terms of permeation behavior. Again, the best approach to this problem is to have the mixture actually tested.

Chemical protective clothing can become contaminated. When contaminated, it can present the potential for inadvertent exposures to the wearer through cross-contamination during removal (doffing) or through the continued delivery of contaminant through the barrier even after outside surface contact ceases. Consideration of the potential for contamination and a means subsequently to decontaminate the protective clothing is an integral part of the selection process. There are essentially three types of contamination that can occur, classified as surface contamination, pore contamination, and matrix contamination. Surface contamination can occur when the hazardous material is not permeable through the protective clothing but simply clings to the outer surface. This typically can happen with greases, oils, and particulate, and can also occur with acids and bases. In this situation, removal or decontamination can usually be accomplished by mechanical

removal using techniques such as washing, brushing, and the like. For acids and bases, the protective clothing may need to be rinsed with a neutralizing agent. The second type of contamination, pore contamination, is unusual and difficult to resolve. It occurs when the contaminant enters the pores or fibers of the protective material and is trapped. Hence, it is limited to porous materials and naturalfiber products such as cotton, wool, leather, and so on (porous materials should not normally be used with liquids). In this situation, the protective clothing usually cannot be decontaminated. The third type of contamination is matrix contamination. This can occur when the contaminant permeates into the matrix of the polymer, which can then act as a reservoir. Once the matrix is contaminated, releases will continue at a very low level even after the protective garment is removed from the exposure situation. One example of this phenomena is the continued outgassing for long periods of ethylene oxide from elastomeric materials that have been sterilized. It is also common for breakthrough times to decrease significantly upon recontact with the challenge agent after matrix contamination has occurred. Matrix contamination occurs most frequently with organic solvents such as acetone, hexane, toluene, and so on. If the contaminant has a vapor pressure above about 10 mm Hg, hot air (approximately 100-150 degrees F)

The ergonomic (human factors) requirements or constraints of the job must also be determined. Ergonomic factors are those that affect our ability to accomplish our jobs in an efficient and effective manner. Ideally, CPC should make us more productive and our jobs easier. Unfortunately, this is rarely the case. We must be careful that the job we want to accomplish can be done while wearing CPC. In most cases, the use of CPC at any level will increase errors and decrease productivity. The CPC can even present safety hazards (e.g., get caught in machinery) that would not exist without the use of it. The axiom "one size fits all" highlights the problem. We must work to select the best mix of protection and comfort for the worker while maintaining or improving productivity. Probably the three major human factor problems in the use of CPC are proper sizing, heat stress, and the loss of the senses (tactile), such as touch and feel. Sizing is important for the clothing to be able to function properly, while heat stress is common to any article of protective clothing that offers good chemical resistance (especially suits). Finally, with increases in thickness in gloves and hence chemical resistance, there is a corresponding decrease in dexterity, touch, and feel. The best prevention for human-factor-related problems is to try several different approaches, products, and materials to determine which combination works best for the user.

The last factor listed to be determined is cost. This is not because it is least important (nor is it most important). The reason for listing cost in the factors to be considered is that it is always an important factor, but not the single most important factor. First, the "best" selection of CPC is a result of considering many factors like those previously listed in this section. The best selection may not be the most chemically resistant material. Like generic drugs, there may be materials that offer more than adequate resistance at a much lower cost than some "name brand" product. Therefore, cost should be considered and given an equal weight with the other factors listed in this section.

Many people who use this guide will not have the expertise or resources to evaluate adequately all of the factors listed in this section. For these people and others, there are several approaches to the selection of protective clothing. First, most vendors of CPC provide information on the performance of their products against national consensus tests and standards such as the ASTM standards

12

for protective clothing. Many of these vendors also offer technical assistance in the proper selection, use, and maintenance of their products without charge. Secondly, the National Fire Protection Association (NFPA) has developed minimum standards for the performance of protective clothing that is used by the fire service. These standards have application for some industrial uses as well. These standards are:

NFPA 1991, Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies

NFPA 1992, Standard on Liquid Splash Suits for Hazardous Chemical Emergencies

NFPA 1993, Standard on Single Use Splash Protective Suits for Non-Flammable Hazardous Chemical Situations

Compliance with NFPA standards requires third-party certification and independent testing. Those products meeting the battery of NFPA performance requirements are labeled as meeting the applicable standard.

In summary, there are several key factors to be considered when selecting chemical protective clothing. These include a determination as to whether other options are available for control of exposures, determining the type of exposure and toxicity of the chemicals to be used, determining the physical and chemical resistance needed, determining the need for decontamination, determining what is required from the protective clothing to be able to perform the job, and finally, considering costs in the final selection.

The following selection contains a listing of ten simple but important considerations for the selection and use of protective clothing.

Ten Important Considerations for the Selection and Use of Protective Clothing

 All chemicals pass or permeate through protective barriers sooner or later. Remember, permeation can take place without any visible evidence or change in the protective materials. Color changes or changes in texture, as well as hardening or softening of protective barriers after use, usually indicate degradation.

- 2. Even the best protective clothing products will not perform properly if they are torn, cut, or damaged. You should always inspect protective clothing before and after each use. Gloves can be checked for integrity leaks by inflation with air or even water. Most limited and single-use suits can be checked by holding them up to a strong light or window to inspect for imperfections or breaks in the barrier. Gas-tight totally encapsulated suits may require pressure testing. If your protective equipment becomes torn or damaged, replace it.
- 3. A barrier may protect against one chemical very well, but perform poorly against another or a mixture of chemicals. Each chemical and material combination must be considered. No single protective material is an absolute barrier against all chemicals.
- 4. The recommendations listed in this guide are generally based on tests that have been performed at room temperature. Higher temperatures usually decrease the breakthrough time (less time to breakthrough) of chemicals, while colder temperatures will tend to increase breakthrough times.
- 5. Generally, thicker is better. Increasing the thickness of the protective article, such as a glove, will normally increase the

- time to breakthrough, but the benefits may be offset by a decrease in tactility and dexterity. The use of multiple layers (e.g., double gloving) can increase thickness and provide desirable properties of different materials.
- 6. Protective gloves and other chemical protective clothing may all look alike. Be sure that the material you are using is the right one for the job you are doing. Do not depend only on the appearance or color of the material, since most barriers are available in many different forms and colors.
- 7. When a chemical has been absorbed by a protective clothing material, it will continue to permeate (pass through) the material. If the protective material has been contaminated to the point of breakthrough, it must be decontaminated before it may be used again. Simple soap and water washing will not be effective for matrix contamination nor for most non-water-soluble contaminants.
- 8. Some of the recommendations have been made on a generic basis. That is, the materials are shown by their common or generic name. Most of the polymer formulations vary by manufacturer and can vary from product lot to product lot. Research has shown this variation in chemical resistance can be significant for Neoprene, Nitrile, and PVC. Users should

- check with the specific manufacturer selected to confirm the performance of their products.
- 9. Some protective clothing has a shelf life and/or requires special storage measures, such as the avoidance of sunlight, ozone, or moisture. Check with the manufacturer for the proper storage, maintenance, and care. Also remember that alterations to suits
- or equipment may void the manufacturer's warranty and change the performance of the equipment.
- 10. The best way to select the proper chemical protective clothing is to have the material specifically tested under the work conditions and chemicals being used.



SECTION III

Chemical Index

This section contains the listing of chemical names and synonyms (in alphabetical order) that are used to find the chemical class number. Other information provided is the chemical abstract service (CAS) registry number, risk codes, and special notes.

Chemical Class Numbers

The chemical class numbers are shown in the first column and are used to find the recommended barriers in the SELECTION RECOMMENDATIONS section. Chemicals have been grouped together into chemical classes according to the American Society for Testing and Materials F-1186 Guide for Classification of Chemicals According to Functional Groups because chemicals of

the same family or type have similar effects on barriers. This also permits the user to estimate performance if no chemical resistance data are known.

Chemical Names

Chemical names are shown in the second column of the CHEMICAL INDEX. Even though they appear in the second column, the index is organized alphabetically by the chemical names and not by the numerical class number. In most cases, the chemical names are those most commonly used by occupational health and safety professionals or the researchers that reported the data. Common synonyms are given for many of the listings as well.

Synonyms

Common synonyms (other names) for many of the chemicals listed in the index are shown in parentheses. For example, Isopropanol (rubbing alcohol) is also called isopropyl alcohol and 2-propanol and is known by the abbreviation IPA. These are other names used to identify the same chemical. These other names are listed in alphabetical order in parentheses with a reference to the proper name to use for searching the index. Confirmation that your selection is correct can be made by matching the CAS number.

Chemical Abstract Service Number

The chemical abstract service (CAS) registry numbers are unique identifiers of chemical substances assigned and maintained by the Chemical Abstract Service. There are over seven million chemical substances assigned CAS numbers based on atomic structure, valence bonds, and stereochemistry. These numbers are routinely used by government agencies to specify chemicals being regulated to assure that there is no confusion over the identity of the substance even though it might have several commonly used names. The CAS

number is made up of three groups of numbers separated by hyphens. The first group can be up to six digits, while the second group is comprised of two digits, and the third is a single digit (e.g., XXXXXX-XX-X).

Risk Code

The column titled "Risk Code" contains a listing based on the designations published in the Official Gazette of the European Community's "Guide to Classification and Marking of Hazardous Substances." These codes are shown in the following table.

Risk Code	Hazard Rating
Tx	highly toxic
Т	toxic
Сх	highly corrosive
С	corrosive
Χ	harmful
Xi	irritant
V .	potentially harmful
-	no risk

18



These ratings are shown in descending order of severity (most hazardous at the top; least hazardous at the bottom). While risk is a relative measure dependent on many factors, some general measure of the relative risk presented by each chemical can be determined by this table. Two additional notations may also appear with the risk codes. These are a **cancer** notation for those chemicals thought to be potential carcinogens and a **sensitization** notation for those chemicals with a skin sensitization potential. A blank space would indicate no significant risk under normal use conditions or that the material is not listed. Measures that can be used to control exposure and reduce the user's risk include the use of engineering controls such as ventilation, proper work practices, and a number of other measures.

Special Notes

The last column contains **skin** and **caution** designations. The sources for the skin designation are the Threshold Limit Values for Chemical Substances and Physical Agents published by the

American Conference of Governmental Industrial Hygienists (ACGIH) and the Occupational Safety and Health Administration's (OSHA) Permissible Exposure Limits published under 29 CFR 1910.1000 table Z-1-A. The **skin** designation alerts the user to those chemicals believed to present a significant risk of skin absorption and consequent toxicity. The **caution** designation is meant to alert the user of this guide to chemicals that could cause serious skin injury (e.g., strong corrosives) or other significant adverse effects, including skin absorption reported in the literature but not noted by ACGIH or OSHA. Many materials, such as hydrofluoric acid, can cause serious and permanent injury to an unprotected or improperly protected user. Therefore, the **skin** and **caution** notations are meant to alert the reader to the need for a special emphasis on the careful selection of protective equipment for these chemicals.

Protective clothing users are cautioned that not all chemicals that can cause significant toxic or adverse effects are shown by either the skin or caution notations. Those most widely recognized in the literature or by the authors are listed.

Chen	nical Index Listings								
Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class#	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
121	Acetaldehyde (Ethanal)	75-07-0	Xi		·	(2-Aminobutane) see sec-Butylamine			
102	Acetic acid	64-19 - 7	Cx	Caution		(2-Aminoethanol) see Ethanolamine			
161	Acetic anhydride (Acetyl oxide)	108-24-7	СТ	Caution	141	2-(2-Amino ethoxy) ethanol	929-06-6	C	
	(Acetomethoxane) see Dimethoxane				148	1-(2-Aminoethyl) piperazine	140-31-8	X	
391	Acetone (2-Propanone)	67-64-1	V			(N-(beta-Aminoethyl)piperazine)			
431	Acetonitrile (Methyl cyanide)	75-05-8	T			(1-Amino-2-propanol) see Isopropanolar	nine		
392	Acetophenone (1-Phenylethanone)	98-86-2	X			(3-Aminopropylene) see Allylamine			
	(Acetylaceton) see 2,4-Pentanedione				350	Ammonia, gas	7664-41-7	TC	
111	Acetyl chloride	75-36-5	C		380	Ammonia, liquid	7664-41-7	TC	Caution
	(Acetyl oxide) see Acetic anhydride				340	Ammonium acetate, sat.	631-61-8	Xi	
121	Acrolein (Acrylaldehyde or 2-Propenal)	107-02-8	Tx	Caution	340	Ammonium carbonate, sat.	506-87-6		
135	Acrylamide (2-Propenamide)	79-06-1	T Cancer	Skin	340	Ammonium fluoride, 30-70%	12125-01-8	T	
102	Acrylic acid (2-Propenoic acid)	79-10-7	CT	Skin	380	Ammonium hydroxide, <30%	1336-21-6	X	
431	Acrylonitrile (Propenenitrile or VCN)	107-13-1	T Cancer	Skin	380	Ammonium hydroxide, 30–70%	1336-21-6	C	Caution
431	Adiponitrile	111-69-3	X	Skin	340	Ammonium nitrate	6884-52-2	Xi	Caution
223	Allyl acrylate (Allylpropenoate)	999-55-3			340	Ammonium nitrate, 30-70 %	6884-52-2		
311	Allyl alcohol (2-Propenol)	107-18-6	Tx	Skin		(n-Amyl acetate) see n-Pentyl acetate			
141	Allylamine (3-Aminopropylene)	107-11-9	T		340	Ammonium sulfide, < 30 %	12135-76-1	TC	
262	Allyl bromide (3-Bromopropene)	106-95-6	T			(Amyl alcohol) see n-Pentanol			
262	Allyl chloride (3-Chlorpropylene)	107-05-01	TC			(n-Amylamine) see n-Pentylamine			
590	Ambush®	52645-53-1	X		241	tert-Amyl methyl ether (Methyl	994-05-8		
550	9-Aminoacridine hydrochloride	90-45-9	X			tert-amyl ether)			
	(1-Aminobutane) see n-Butylamine				145	Aniline (Benzenamine or Phenylamine)	62-53-3	T	Skin

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Class#	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
370	Aqua regia (Hydrochloric acid, 25–37%	20-05-1	Cx	Caution	112	Benzoyl chloride (Benzoic acid chloride)	98-88-4	C	
	and Nitric acid, 63–75%)				222	Benzyl acetate	140-11-4	V	
	(Arochlor) see Polychlorinated biphenyls				311	Benzyl alcohol (Benzene methanol	100-51-6	Xi	
350	Arsine (Arsenic trihydride)	7784-42-1	Tx			or Phenyl cyanide)			
	(4-Azahepthamethylenediamine) see				141	Benzylamine (alpha-Aminotoluene)	100-46-9	C	
	3,3'-Iminobis(propylamine)				262	Benzyl bromide (alpha-Bromotoluene)	100-39-0	Xi	Caution
	(Azine) see Pyridine				262	Benzyl chloride (Chloromethyl benzene)	100-44-7	T	
	(Azinphos-methyl) see Guthion					(Benzyl cyanide) see Phenylacetonitrile			
	(Aziridine) see Ethyleneimine				143	n-Benzyl dimethylamine	103-83-3	C	
590	AZT®					(N,N-Dimethylbenzylamine)			
590	Battery acid	7664-93-9	C	Caution		(Benzyl nitrile) see Phenylacetonitrile			
274	Benlate® (Benomyl)	17804-35-2			224	Benzyl neocaprate (BNC)	66794-75-0	V	
122	Benzaldehyde	100-52-7	X			(Bis(2-chloroethyl)sulfide) see Mustard			
	(Benzamine) see Aniline					gas			
292	Benzene (Bensol)	71-43-2	T Cancer	Skin		(Bis(2-ethylhexyl)phthalate) see Di-			
	(Benzene methanol) see Benzyl alcohol					(2-ethylhexyl)phthalate			
	(Benzenesulfonic acid) see					(Bis-2-hydroxyethyl ether) see Diethylen	e		
	Phenolsulfonic acid					glycol			
505	Benzenesulfonyl chloride	98-09-9	C			(Bis(trimethylsilyl)amine) see 1,1,1,3,3,3	-		
550	Benzethonium chloride (Hyamine 1622)	121-54-0	Xi			Hexamethyldisilazane			
432	Benzonitrile (Phenyl cyanide)	100-47-0	Tx		275	Bisphenol A diglycidyl ether	1675-54-3	X Sensitiza	ation
162	3,3',4,4'-Benzophenonetetracarboxylic dianhydride (BDTA)	2421-28-5	X Sensitiza	ation		(Diglycidyl ether of bisphenol A or DGBA)			
410	p-Benzoquinone (Quinone)	106-51-4	T	Caution	590	Blood, human	20-05-7		

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
530	Borane pyridine complex (Pyridine borane)	110-51-0	Т	Caution	e.	(Bromoform) see Tribromoethanol (Bromomethane) see Methyl bromide			
370	Boric acid	10043-35-3	Xi		315	1-Bromo-2-propanol	19686-73-8		
360	Boron trifluoride	7637-07-2	T	Caution	315	3-Bromo-1-propanol	6271-18-9	T	
330	Bromine	7726-95-6	T Cx	Caution		(3-Bromopropene) see Allyl bromide			
	(Bromine cyanide) see Cyanogen brom	ide			103	Bromopropionic acid	590-92-1	C	
360	Bromine trifluoride	7787-71-5	Tx Cx	Caution	294	1,3-Butadiene	106-99-0	T Cancer	
431	Bromoacetonitrile	590-17-0			291	n-Butane (Butane)	106-97-8		
264	Bromobenzene (Phenyl bromide)	108-86-1	Xi			(1,4-Butanediol) see 1,4-Butyleneglycol			
	(Bromochlophos) see Naled				275	1,4-Butanediol diglycidyl ether	2425-79-8	Xi	
	(2-Bromo-2-chloro-1,1,1-trifluoroethan see Halothane	ie)			311	<i>n</i> -Butanol (<i>n</i> -Butyl alcohol or 1-Butanol)	71-36-3	X	Skin
261	Bromochloromethane (Chlorobromomethane)	74-97-5	X		312	sec-Butanol (sec-Butyl alcohol or 2-Butanol)	78-92-2	X	
261	Bromodichloromethane (Dichlorobromomethane)	75-27-4	X		313	tert-Butanol (tert-Butyl alcohol) (2-Butanone) see Methyl ethyl ketone	75-65-0	X	
	(Bromoethane) see Ethyl bromide				300	2-Butanone peroxide	1338-24-4	T	
315	2-Bromoethanol	540-51-2	Tx		294	2-Butene	107-01-7		
	(Ethylene bromohydride)					(2-Butoxyethanol) see Butyl glycol			
232	1-Bromoethylethyl carbonate (Carbonic ester, 1-Bromoethylethyl	89766-09-6				(2-Butoxyethyl acetate) see Butyl glycol acetate			
	ester)				245	Butoxypropanol	5131-66-8	X	
264	1-Bromo-4-fluorobenzene (p-Bromofluorobenzene)	460-00-4	X			(Propylene glycol monebutyl ether) (Butoxytriglycol) see Butyltriglycol			



Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
222	<i>n</i> -Butyl acetate (Butyl acetic acid) see 2-Ethylhex-	123-86-4	V		245	Butyl glycol acetate (2-Butoxyethyl acetate or Butyl cellosolve acetate)	112-07-2	Х	
	anoic acid				300	tert-Butyl hydroperoxide	75-91-2	C	
223	Butyl acrylate (Butyl-2-propenoate) (<i>n</i> -Butyl alcohol) see <i>n</i> -Butanol	141-32-2	Xi Sensitiz	ation		(tert-Butyl methyl ether) see Methyl tert-butyl ether	•		
	(sec-Butyl alcohol) see sec-Butanol				300	tert-Butyl peroxybenzoate	614-45-9	Xi	
	(tert-Butyl alcohol) see tert-Butanol					(n-Butyl phthalate) see Di-n-butyl phtha	late		
141	n-Butylamine (1-Aminobutane)	109-73-9	CX	Skin		(Butyl-2-propenoate) see Butyl acrylate			
141	sec-Butylamine (2-Aminobutane)	513-49-5	CX		292	p-tert-Butyltoluene	98-51-1	T	
141	tert-Butylamine	75-64-9	CX			(4-Methyl-tert-butylbenzene)			
226	Butylbenzylphthalate	85-68-7			245	Butyltriglycol	143-22-6	X	
	(Butyl cellosolve) see Butyl glycol (Butyl cellosolve acetate) see					(Triethylene glycol monobutyl ether of Butoxytriglycol)	T		
	Butyl glycol acetate				121	Butyraldehyde (n-Butyl aldehyde)	123-72-8	Xi	
261	n-Butyl chloride (1-Chlorobutane)	109-69-3	X		102	Butyric acid	107-92-6	C	
245	Butyldiglycol (Ethylene glycol	112-34-5	X		225	beta-Butyrolactone	3068-88-0	X	
	monobutyl ether)				225	gamma-Butyrolactone	96-48-0	X	
314	1,4-Butylene glycol (1,4-Butanediol)	110-63-4	X		340	Cadmium oxide, solid	1306-19-0	T Cancer	
	(1,2-Butylene oxide) see				340	Calcium chloride, 30-70%	10043-52-4	Xi	
	1,2-Epoxybutane				380	Calcium hydroxide	1305-62-0	CX	Caution
241	Butyl ether	142-96-1				(Caperaldehyde) see Decanal			
	(n-Butylethylamine) see Ethyl-n-butylar	nine				(Carbaryl) see Sevin 50W			
245	Butyl glycol (2-Butoxyethanol or Ethylene glycol monobutyl ether)	111-76-2	X	Skin		(Carbolic acid) see Phenol (Carbon bisulfide) see Carbon disulfide			

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
508	Carbon disulfide (Carbon bisulfide)	75-15-0	T	Skin	391	Chloroacetone (Chloro-2-propanone)	78-95-5	Т	Skin
350	Carbon monoxide	630-08-0	T		431	Chloroacetonitrile	107-14-2	T	
261	Carbon tetrachloride	56-23-5	T	Skin	392	2-Chloroacetophenone (Tear gas)	532-27-4	T Xi	Caution
	(Tetrachloromethane)				111	Chloroacetyl chloride	79-04-9	TC	Skin
	(Carbonyl chloride) see Phosgene				145	4-Chloroaniline	106-47-8	T	
102	Caprylic acid (Octanoic acid)	124-07-2	Xi		264	Chlorobenzene (Monochlorobenzene)	108-90-7	X	
590	Carmustin®	154-93-8			264	4-Chlorobenzotrifluoride	52181-51-8	X	
590	Castor oil	8001-79-4				(1-Chloro-4-(trichloromethyl)benzene)			
	(Caustic soda) see Sodium hydroxide					(Chlorobromomethane) see Bromochloro	-		
	(Cellosolve acetate) see Ethyl glycol					methane			
550	Cetyltrimethylammonium chloride	112-02-7				(2-Chloro-1,3-butadiene) see Chloropren	e		
	(Hexadecyltrimethylammonium chloride)					(Chlorodibromomethane) see Dibromo- chloromethane			
	(CFC 114) see 1,1-Dichlorotetra-				261	Chloroethane (Ethyl chloride)	75-00-3		Skin
	fluoroethane)				315	2-Chloroethanol (Ethylene chlorohydrin)	107-07-3	Tx	
	(Choline) see 2-Hydroxy ethyl-N,N,N-					(Cloroethene) see Vinyl chloride			
	trimethyl ammonium hydroxide				261	Chloroform (Trichloromethane)	67-66-3	X Cancer	Caution
	(Chloral) see Trichloroacetaldehyde					(Chloromethane) see Methyl chloride			
261	Chlordane, >70%	57-74-9	Tx	Skin		(Chloromethyl benzene) see Benzyl			
350	Chlorine, gas	7782-50-5	T	Caution		chloride			
330	Chlorine, liquid	7782-50-5	T	Caution	261	Chloromethyl methyl ether	107-30-2		
350	Chlorine dioxide	10049-04-4	T			(Chloromethoxy methane)			
103	Chloroacetic acid (Monochloroacetic acid)	79-11-8	ТСх	Caution	103	4-Chloro-2-methylphenoxyacetic acid (MCPA)	94-74-6	X	

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Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
103	2-(4-Chloro-2-methylphenoxy) propionic	93-65-2	X		264	p-Chlorotoluene (4-Chlorotoluene)	106-43-4	X	
	acid				480	Chlorotrimethylsilane	75-77-4	C	
262	3-Chloro-2-methylpropene	563-47-3	X			(Trimethylchlorosilane)			
	(2-Methallyl chloride)				370	Chromic acid (Chromium trioxide)	1308-14-1	Cx	Caution
264	1-Chloronaphtbalene (Naphthyl chloride)	91-58-7	X					Sensitization	
264	2-Chloronitrobenzene	88-73-3			170	C I Pigment Yellow 74	6358-31-2		
	(o-Nitrochlorobenzene)				104	Citric acid, 30-70%	77-92-9		
264	4-Chloronitrobenzene	100-00-5			590	Coal tar extract	65996-92-1		Caution
	(p-Nitrochlorobenzene)				340	Cobalt sulfate heptahydrate	10026-24-1	T	
442	2-Chloro-2-nitropropane	594-71-8			590	Corn oil	8001-30-7		
316	Chlorophenol, mixture of 2-,3-,4-	n/a	X		316	Creosote	8001-58-9	T Cancer	Caution
442	Chloropicrin (Trichloronitromethane)	76-06-2	Tx				:	Sensitization	
263	Chloroprene (2-Chloro-1,3-butadiene)	126-99-8	X	Skin	316	Creosote (Wood)	8021-39-4	ТC	Caution
261	1-Chloropropane (Propyl chloride)	540-54-5	X	Caution	316	m-Cresol (3-Methylphenol)	108-39-4	ТC	Skin
315	1-Chloro-2-propanol	127-00-4	X		316	p-Cresol (4-Methylphenol)	106-44-5	ТC	Skin
315	3-Chloro-1-propanol	627-30-5	X		316	Cresols, isomeric mixtures	1319-77-3	ТC	Skin
	(Chloro-2-propanone) see Chloroacetone				121	Crotonaldehyde (2-Butenal)	4170-30-3	T	Caution
	(2-Chloro-2-propenyldiethyl-dithio- carbamate) see Sulfallate				292	Cumene (Isopropyl benzene or 1-Methylethyl benzene)	98-82-8	X	Skin
	(3-Chlorpropylene) see Allyl chloride				300	Cumene hydroperoxide	80-15-9	Cx	Caution
370	Chlorosulfonic acid	7790-94-5	Cx	Caution	590	Cutting fluids	20-04-5		
	(Chlorothene VG) see 1,1,				345	Cyanogen, gas	460-19-5	Tx	Caution
	1-Trichloro ethane				345	Cyanogen bromide, gas	506-68-3	Tx	Caution
264	o-Chlorotoluene (2-Chlorotoluene)	95-49-8	X			(Bromine cyanide)			

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
345	Cyanogen chloride, gas	506-77-4	Tx	Caution		(1,2-Diaminopropane) see Propylene-			
291	Cyclohexane	110-82-7	V			diamine			
312	Cyclohexanol	108-93-0	X	Skin		(1,3-Diaminopropane) see 1,3-Propane-			
391	Cyclohexanone	108-94-1	X	Skin		diamine			
141	Cyclohexylamine	108-91-8	CX	Caution		(Di-n-amylamine) see Di-n-pentylamine			
	(Cyclohexyldimethylamine) see N,N- Dimethylcyclohexylamine				350	Diborane (1,2-Dibromoethane) see Ethylene	19287-45-7	Tx	
291	Cyclopentane (Pentamethylene)	287-92-3	V			dibromide	104 40 1	77	
391	Cyclopentanone	120-92-3	Xi		261	Dibromochloromethane	124-48-1	X	
291	Cyclopropane	75-19-4				(Chlorodibromomethane)			
590	Cymbush® (Cypermethyrin)	52315-07-8	X			(Dibromomethane) see Methylene bromio		O.W	a d
	(DBP) see Di-n-butylphthalate				142	Di-n-butylamine (Dibutylamine)	111-92-2	CX	Caution
550	2,4-D dimethylamine ammonium salt ((2,4-Dichlorophenoxy)acetic acid	94-75-7	X		226	Di-n-butyl phthalate (DBP or n-Butyl phthalate)	84-74-2	Xi	
	dimethyl ammonium salt)				111	Dichloroacetyl chloride	79-36-7	Cx	Caution
121	Decanal (Capraldehyde)	112-31-2	Xi		145	Dichloroaniline	95-76-1	T	
	(Diacetone alcohol) see 4-Hydroxy- 4-methyl-2-pentanone				264	1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	X	Skin
142	Diallylamine (Diamine) see Hydrazine	124-02-7	X		264	1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	X	
	(1,2-Diaminoethane) see Ethylenediamine				264	1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	X	
	(1,6-Diaminohexane) see 1,6- Hexane-diamine					(Dichlorobromomethane) see Bromo- dichloromethane			



Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class#	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
262	1,3-Dichloro-2-butene	926-57-8	T		262	2,3-Dichloro-1-propene	78-88-6	X	
262	1,4-Dichloro-2-butene	764-41-0		Skin	262	1,3-Dichloropropene	542-75-6	X	Skin
	(Dichlorodifluoromethane) see Freon 12				261	1,1-Dichlorotetrafluoroethane (CFC 114	374-07-2		2
	(Dichlorodimethylsilane) see				291	Diesel fuel	68474-34-6	X	
	Dimethyldichlorosilane				142	Diethanolamine	111-42-2	Xi	
261	1,1-Dichloroethane (Ethylidene dichloride)	75-34-3	X		132	Diethylacetamide (N,N-Diethylacetamide)	685-91-6	X	
	(1,2-Dichloroethane) see Ethylene				142	Diethylamine	109-89-7	СХ	Skin
	dichloride (1,1-Dichloroethylene) see Vinylidene				143	2-(Diethylamino)ethanol (N,N-Diethylethanolamine)	100-37-8	Xi	Skin
	chloride				146	N,N-Diethylaniline, crude	91-66-7	T	
263	cis-1,2-Dichloroethylene	156-59-2	X		292	Diethyl benzene	25340-17-4	X	Caution
263	trans-1,2-Dichloroethylene	156-60-5	X		232	Diethyl carbonate	105-58-8	X	
263	cis,trans-1,2-Dichloroethylene (1,2-Dichloroethylene)	540-59-0	X		480	Diethyldichlorosilane (Dichlorodiethylsilane)	1719-53-5	С	Caution
241	1,2-Dichloroethyl ether	111-44-4	T Cancer	Skin		(Diethylenediamine) see Piperazine			
	(Dichloromethane) see Methylene chloride ((2,4-Dichlorophenoxy)acetic acid				314	Diethylene glycol (Bis-2-hydroxyethyl ether) (Diethylene glycol monobutyl ether)	111-46-6	X	
	dimethyl ammonium salt) see 2,4-D dimethylamine ammonium salt					see Butyldiglycol (Diethylene glycol monoethyl ether)			
103	2-(2,4-Dichlorophenoxy)propionic acid	120-36-5	X			see Ethyldiglycol			
261	1,2-Dichloropropane (Propylene dichloride)	78-87-5	X			(Diethylene glycol monohexyl ether) see Hexyldiglycol			

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
	(Diethylene glycol monomethyl ether)					Hexamethylene-1,6-diisocyanate			
	see Methyldiglycol				226	Diisooctylphthalate	27554-26-3		
	(Diethylene glycol monopropyl ether) see Propyldiglycol					(2,4-Diisocyanate toluene) see Toluene-2,4-diisocyanate			
	(Diethylene oxide) see 1,4-Dioxane				142	Diisopropylamine	108-18-9	CX	Skin
148	Diethylenetriamine	111-40-0	X	Skin		(Diisopropyl ether) see Isopropylether			
		S	Sensitization		278	Dimethoxane (Acetomethoxane)	828-00-2		
	(N,N-Diethylethanolamine) see					(1,2-Dimethoxyethane) see Ethylene			
	2-(Diethylamino)ethanol					glycol dimethyl ether			
	(Diethyl ether) see Ethyl ether				132	Dimethylacetamide (DMAC)	127-19-5	. X	Skin
226	Di-(2-ethylhexyl)phthalate	117-81-7	X		142	Dimethylamine	124-40-3	CX	Skin
	(Bis(2-Ethylhexyl)phthalate)				143	2-(Dimethylamino)ethanol	108-01-0	Xi	
226	Diethylphthlate	84-66-2	Xi			(N,N-Dimethylethanolamine)			
	(Phthalic acid, diethylester)				148	3-(Dimethylamino)propylamine	109-55-7	X Sensitiz	ation
	(N,N-Diethylnitrosamine) see				146	N,N-Dimethylaniline (DMA)	121-69-7	T	Skin
	N-Nitrosodiethylamine					(Dimethyl benzene) see Xylene			
	(1,1-Difluorethylene) see Vinylidene					(N,N-Dimethylbenzylamine) see			
	fluoride					n-Benzyl dimethylamine			
	(Diglycidyl ether of bisphenol A) see				141	1,3-Dimethylbutylamine	108-09-8	X	
	Bisphenol A diglycidyl ether					(Cyclohexyldimethylamine)			
142	Diisobutylamine	110-96-3	X		143	N,N-Dimethylcyclohexylamine	98-94-2	Xi	Caution
391	Diisobutyl ketone	108-83-8	X		480	Dimethyldichlorosilane			
	(2,6-Dimethyl-4-heptanone)					(Dichlorodimethylsilane)	75-78-5	Xi	
	(1,6-Diisocyanatohexane) see				502	Dimethyl disulfide (Methyl disulfide)	624-92-0	T	

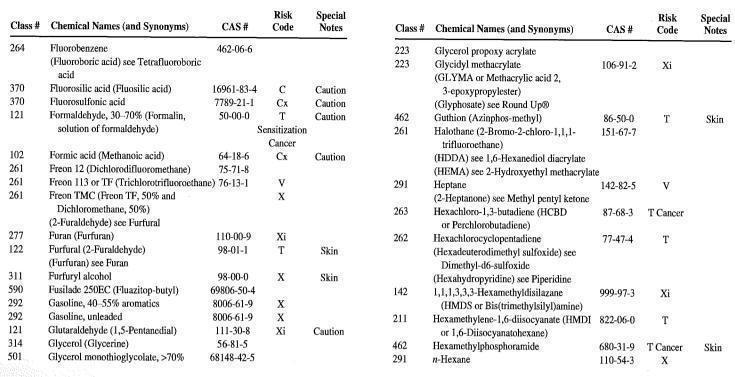


Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
	(N,N-Dimethylethanolamine) see				278	1,3-Dioxane	505-26-6	Х	
	2-(Dimethylamino)ethanol				278	1,4-Dioxane (Diethylene oxide)	123-91-1	X	Skin
241	Dimethyl ether (Methyl ether)	115-10-6	V			(Dipentene) see d,l-Limonene			
143	N,N-Dimethylethylamine	598-56-1	C		142	Di-n-pentylamine (Di-n-amylamine)	122-39-4	X	
	(N-Ethyldimethylamine)				137	1,3-Diphenylguanidine	102-06-7	X	
132	Dimethylformamide (DMF)	68-12-2	X	Skin	142	Di-n-propylamine (Dipropylamine)	142-84-7	CX	Caution
280	1,1-Dimethylhydrazine	57-14-7	ТC	Skin	314	Dipropylene glycol	25265-71-8	Xi	
	(unsym-Dimethylhydrazine)		Sensitization		274	Diquat dibromide (Reglone®)	85-00-7		Caution
142	2,6-Dimethylmorpholine	141-91-3			292	Divinyl benzene (Vinylstyrene)	1321-74-0	T	
	(N,N-Dimethylnitrosamine) see					(Divinyl sulfone) see Vinyl sulfone			
	N-Nitrosodimethylamine					(DMA) see N,N-Dimethylaniline			
	(Dimethyl phenol) see Xylenol					(DMAC) see Dimethylacetamide			
507	Dimethyl sulfate	77-78-1	T Cancer	Skin	291	Dodecane	112-40-3		
	(Methyl sulfate or DMS or Sulfuric					(DOP) see Di-n-octyl phthalate			
	acid dimethyl ester)				510	Dynamite (Ethylene glycol dinitrate,			Caution
502	Dimethyl sulfide (Methyl sulfide)	75-18-3	X			70% and Nitroglycerine, 30%)			
503	Dimethyl sulfoxide	67-68-5	X	Caution		(EHA) see 2-Ethylhexyl acrylate			
	(DMSO or Methyl sulfoxide)				275	Epibromohydrin	3132-64-7	Tx	
503	Dimethyl-d6 sulfoxide	2206-27-1	X			(1,2-Epoxy-3-bromopropane)			
	(Hexadeuterodimethyl sulfoxide)				275	Epichlorohydrin	106-89-8	T Cancer	Skin
263	Dimethylvinyl chloride	513-37-1				(1,2-Epoxy-3-chloropropane)			
	(2-Methyl-1-chloropropene)				590	Epoxy, accelerator			
441	2,4-Dinitrotoluene	121-14-2	Т	Skin	590	Epoxy, base			
226	Di-n-octyl phthalate (DOP)	117-84-0	X		275	1,2-Epoxybutane (1,2-Butylene oxide)	106-88-7	X	

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	(1,2-Epoxy-3-bromopropane)				222	Ethyl acetate	141-78-6	V	
	see Epibromohydrin				223	Ethyl acrylate (Ethylpropenoate)	140-88-5	X	Skin
	(1,2-Epoxy-3-chloropropane)					(Ethyl alcohol) see Ethanol	S	ensitization	1
	see Epichlorohydrin				141	Ethylamine (Monoethylamine)	75-04-7	CX	Caution
	(1,2-Epoxypropane) see 1,2-				292	Ethyl benzene	100-41-4	X	Skin
	Propylene oxide				261	Ethyl bromide (Bromoethane)	74-96-4	X	Skin
275	Epoxytrichloropropane (Trichloroepoxypropane)	67664-94-2			142	Ethyl- <i>n</i> -butylamine (<i>n</i> -Butylethyl-amine)	13360-63-9	T	
	(Ethanal) see Acetaldehyde					(2-Ethylcapronaldehyde) see			
291	Ethane	74-84-0				2-ethyl hexanal			
311	Ethanol (Ethyl alcohol)	64-17-5	V			(Ethyl cellosolve) see Ethyl glycol			
	(Ethane thiol) see Ethyl mercaptan					(Ethyl cellosolve acetate) see			
141	Ethanolamine (1-Aminoethanol	141-43-5	Xi	Caution		Ethyl glycol acetate			
	or Monoethanolamine)					(Ethyl chloride) see Chloroethane			
	(Ethene) see Ethylene				113	Ethyl chloroformate	541-41-3		Caution
462	Ethion 4	563-12-2	T	Skin		(Ethyl cyanide) see Propionitrile			
	(2-Ethoxyethanol) see Ethyl glycol				245	Ethyldiglycol (Diethylene glycol	111-90-0	X	
	(2-(2-Ethoxyethoxy)ethanol) see					monoethyl ether or 2-			
	Ethyldiglycol					(2-Ethoxyethyoxy) ethanol)			
	(2-Ethoxyethyl acetate) see					(N-Ethyldimethylamine) see N,N-			
	Ethyl glycol acetate					Dimethylethylamine			
245	1-Ethoxy-2-propanol (Propylene glycol	107-98-2	X		294	Ethylene (Ethene)	74-85-1		
	monoethyl ether)					(Ethylene chlorohydrin) see			
245	2-Ethoxy-1-propanol	19089-47-9	X			2-Chloroethanol			
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148	Ethylenediamine (1,2-Diaminoethane)	107-15-3	СХ	Skin	<u>. </u>	Ethylene glycol monoethyl ether)			~··
	•		Sensitization		245	Ethyl glycol acetate (2-Ethoxyethyl	111-15-9	X	Skin
261	Ethylene dibromide (1,2-Dibromoethane)	106-93-4	T Cancer	Skin		acetate, Cellosolve acetate, or Ethyl			
261	Ethylene dichloride (1,2-Dichloroethane	107-06-2	T Cancer			cellosolve acetate)		~~	
	or EDC)				121	2-Ethyl hexanal (2-Ethylcapron aldehyde)		Xi	Caution
314	Ethylene glycol (Ethanediol)	107-21-1	Xi	Skin	102	2-Ethylhexanoic acid (Butyl acetic acid)	149-57-5	ХC	
	(Ethylene glycol acrylate) see				311	2-Ethyl-1-hexanol	104-76-7	Xi	
	2-Hydroxy-ethyl acrylate				223	2-Ethylhexyl acrylate (EHA)	103-11-7	X	Caution
245	Ethylene glycol dimethyl ether (1,2-Dimethoxyethane)	110-71-4	X			(Ethylidene dichloride) see 1,1- Dichloroethane			
	(Ethylene glycol monobutyl ether)				501	Ethyl mercaptan (Ethanethiol)	75-08-1	X	
	see Butyl glycol (Ethylene glycol monoethyl ether)				223	Ethyl methacrylate (Ethyl 2-methylpropenoate)	97-63-2	X Sensitiza	ation
	see Ethyl glycol				462	Ethyl parathion (Parathion) (Ethyl phenyl ketone) see Propio phenone	56-38-2	T	Skin
	(Ethylene glycol monohexyl ether)					(Ethylpropenoate) see Ethyl acrylate			
	see Hexyl glycol (Ethylene glycol monomethyl ether) see Methyl glycol				245	Ethyltriglycol (Triethylene glycol monoethyl ether or Ethoxytriglycol)	112-50-5	X	
	(Ethylene glycol monopropyl ether)				246	Ethyl vinyl ether	109-92-2	V	
	see Propyl glycol				391	Ethyl vinyl ketone (1-Penten-3-one)	1629-58-9		
274	Ethyleneimine (Aziridine)	151-56-4	Tx Cancer	Skin	340	Ferric chloride (Ferric trichloride)	7705-08-0	C	Caution
275	Ethylene oxide (Oxirane)	75-21-8	T C Cancer		340	Ferrous chloride	7758-94-3	C	Caution
241	Ethyl ether (Diethyl ether)	60-29-70	X			(Fluazitop-butyl) see Fusilade 250EC			
241	Ethyl glycol (2-Ethoxyethanol or	110-80-5	X	Skin	350	Fluorine	7782-41-4	Tx Cx	Caution

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148	1.6-Hexanediamine (1.6-Diaminohexane) 124-09-4	X		350	Hydrogen sulfide	7783-06-4	Tx	
223	1,6-Hexanediol diacrylate (HDDA)	13048-33-4			480	Hydrogentrichlorosilane	133775-79-8		Caution
294	1-Hexene	592-41-6			316	Hydroquinone	123-31-9	X Sensitiza	ation
245	Hexyldiglycol (Diethylene glycol monohexyl ether)	112-59-4	X			(Hydroxybenzenesulfonic acid) see Phenolsulfonic acid	•		
245	Hexyl glycol (Ethylene glycol monohexyl ether)	1559-35-9	X		223	2-Hydroxyethyl acrylate (Ethylene glycol acrylate)	818-61-1	Xi	
	(HMDI) see Hexamethylene-1,				223	2-Hydroxyethyl methacrylate (HEMA)	868-77-9	Xi	
	6-diisocyanate (HMDS) see 1,1,1,3,3,3-				550	2-Hydroxy ethyl-N,N,N-trimethyl ammonium hydroxide (Choline)	62-49-7	Xi	
590	Hexamethyldisilazane Hydraulic oil				391	4-Hydroxy-4-methyl-2-pentanone (Diacetone alcohol)	123-42-2	X	
280	Hydrazine (Diamine)	302-01-2	T C Cancer	Skin	148	3,3'-Iminobis(propylamine)	56-18-8	CX	
280	Hydrazine hydrate	7803-57-8	Tx C Cancer	Caution		(Azahepthamethylenediamine)			
370	Hydrobromic acid, 30–70%	10035-10-6	C	Caution		(IDI) see Isophorone diisocyanate			
370	Hydrochloric acid, 37% (Muriatic acid)	7647-01-0	C	Caution	330	Iodine, solid	7553-56-2	X	Caution
370	Hydrochloric acid, <30%	7647-01-0	Xi			(Iodomethane) see Methyl iodide			
370	Hydrofluoric acid, 30–70%	7664-39-3	Tx Cx	Caution	391	beta-Ionone	79-77-6	V	
350	Hydrogen bromide	10035-10-6	Cx	Caution		(IPA) see Isopropanol			
350	Hydrogen chloride	7647-01-0	Cx	Caution		(Isoamyl acetate) see Isopentyl acetate			
345	Hydrogen cyanide	74-90-8	Tx	Skin		(Isoamyl alcohol) see Isopentyl alcohol			
350	Hydrogen fluoride (HF)	7664-39-3	Tx Cx	Caution		(Isoamylnitrite) see Isopentylnitrite			
300	Hydrogen peroxide, 30-70%	7722-84-1	C	Caution	291	Isobutane (2-Methylpropane)	75-28-5		
	(Hydrogen phosphide) see Phosphine				311	Isobutanol (Isobutyl alcohol)	78-83-1	X	

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223	Isobutyl acrylate (Isobutylpropenoate) (Isobutyl alcohol) see Isobutanol	106-63-8	X Sensitiz	ation	241	Isopropyl ether (Diisopropyl ether) (Isopropylidene acetone) see Mesityl	108-20-3	V	
141	Isobutylamine (2-Methylpropylamine)	78-81-9	C			oxide			
292	Isobutylbenzene (2-Methyl-1- phenylpropane)	538-93-2	V		223	Isopropyl methacrylate (Isopropyl- propenoate)	4655-34-9		
510	Isobutylnitrite	542-56-3			510	Isopropylnitrite	1712-64-7		
121	Isobutyraldehyde	78-84-2	Xi		121	Isovaleraldehyde (3-Methyl-	590-86-3	Xi	Caution
431	Isobutyronitrile	78-82-0	T	Caution		butyraldehyde)			
291	Isooctane	26635-64-3	V		291	Jet fuel, <30% aromatics (73-248°C) (3	IP-4)	X	
222	Isopentyl acetate (Isoamyl acetate)	123-92-2	V			(Kerb 50®) see Propyzamide	•		
311	Isopentyl alcohol (Isoamyl alcohol or 3-Methyl-1-butanol)	123-51-3	X		291	Kerosene (Naphtha, 15–20% aromatics, 180–260°C)	8008-20-6	X	
510	Isopentylnitrite (Isoamylnitrite or 3-Methylbutylnitrite)	110-46-3			103	Lactic acid, >70% (Lannate) see Methomyl	50-21-5	С	
391	Isophorone	78-59-1	Xi		102	Lauric acid	143-07-7		
211	Isophorone diisocyanate (IDI)	4098-71-9	T Sensitizatio	Skin	294	d,l-Limonene (Menthadiene or Dipentene)	5989-27-5	T	
294	Isoprene (2-Methyl-1,3-butadiene)	78-79-5	Xi		590	Lubricating oil	64742-52-5		
312	Isopropanol (Isopropyl alcohol	67-63-0	V		462	Malathion, 30–70%	121-75-5		Skin
	or 2-Propanol or IPA)	0, 00 0	,		104	Maleic acid	110-16-7	Xi	OMIII
141	Isopropanolamine (Monoisopro-	78-96-6	Xi		161	Maleic anhydride	108-31-6	Xi	Caution
	panolamine)					(MCPA) see 4-Chloro-2-methyl-	100 51 0	711	Caution
141	Isopropylamine (Monoisopropylamine) (Isopropyl benzene) see Cumene	75-31-0	СХ	Caution		phenoxyacetic acid (MDA) see 4,4'-Methylenedianiline			

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	(MDI) see Methylene bisphenyl-4,4'-diisocyanate			activos.		(2-Methoxyethyl acetate) see Methyl glycol acetate			
	(Menthadiene) see <i>d,l</i> -Limonene				391	4-Methoxy-4-methyl-2-pentanone	107-70-0	V	
	(Menthane thiol) see Methyl mercaptan				245	1-Methoxy-2-propylacetate	41448-83-3	X	
103	Mercaptoacetic acid (Thioglycolic acid)	68-11-1	ТС		245	1-Methoxy-2-propanol (Propylene	107-98-2		
501	2-Mercaptoethanol	60-24-2	T			glycol monomethyl ether)			
340	Mercuric chloride, sat.	7487-94-7		Skin	222	Methyl acetate	79-20-9	V	
330	Mercury (Quicksilver)	7439-97-6	T	Skin	223	Methyl acrylate (Methylpropenoate)	96-33-3	X	Skin
391	Mesityl oxide (Isopropylidene acetone)	141-79-7				(Methyl alcohol) see Methanol			
102	Methacrylic acid (2-Methylpropanoic acid) (Methacrylic acid 2, 3-epoxy-	79-41-4	C	Caution	102	Methylacrylic acid (2-Methylpropenoic acid)	79-41-4	С	
	propylester) see Glycidyl methacrylat	е				(2-Methylallyl chloride) see 3-Chloro-			
431	Methacrylonitrile (2-Methyl-		T Sensitiz	ation		2-methylpropene			
	propennitrile)				141	Methylamine (Monomethylamine)	74-89-5	CX	Caution
291	Methane	74-82-8				(2-(Methylamino)ethanol) see			
	(Methanoic acid) see Formic acid					N-Methylethanolamine			
504	Methanesulfonic acid	75-75-2	ХC		148	3-Methylaminopropylamine	6291-84 - 5	X	
	(2-Methallyl chloride) see 3-Chloro-2-					(Methylbenzene) see Toluene			
	methylpropene				261	Methyl bromide (Bromomethane)	74-83-9	TC	Skin
311	Methanol (Methyl alcohol)	67-56-1	T	Skin		(2-Methyl-1,3-butadiene) see Isoprene			
233	Methomyl (Lannate)	16752-77-5	T			(3-Methyl-1-butanol) see Isopentyl alcol	hol		
	(2-Methoxyethanol) see Methyl glycol					(3-Methylbutylnitrite) see Isopentylnitri	te		
	(2-(2-methoxyethoxy)ethanol) see					(3-Methylbutyraldehyde) see Isovalerald	dehyde		
	Methyldiglycol					(Methyl carbitol®) see Methyldiglycol			

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	(Methyl cellosolve) see Methyl glycol				-	(Methyl ether) see Dimethyl ether			
	(Methyl cellosolve acetate) see Methyl glycol acetate					(2-Methylethanol acetate) see Methyl glycol acetate			
261	Methyl chloride (Chloromethane)	74-87-3	X	Skin		(1-Methylethyl benzene) see Cumene			
224	Methyl chloroacetate (Methyl chloroform) see 1,1,	96-34-4	T		391	Methyl ethyl ketone (2-Butanone or MEK)	78-93-3	V	
	1-Trichloroethane				242	Methyl eugenol	93-15-2		
113	Methylchloroformate	79-22-1	T	Caution	245	Methyl glycol (2-Methoxyethanol,	109-86-4	X	Skin
	(2-Methyl-1-chloropropene) see Dimethylvinyl chloride					Ethylene glycol monomethyl ether, or Methyl cellosolve)			
245	(Methyl cyanide) see Acetonitrile Methyldiglycol (Diethylene glycol	111-77-3	X		245	Methyl glycol acetate (2-Methylethanol acetate or Methyl cellosolve acetate)	110-49-6	X	Skin
	monomethyl ether or Methyl carbitol®) (Methyl disulfide) see Dimethyl disulfide				391	5-Methyl-2-hexanone (Methyl isopentyl ketone)	110-12-3	Xi	
145	4,4'-Methylene bis(2-chloroaniline)	101-14-4		Skin	280	Methylhydrazine	60-34-4	Т	Skin
	(MOCA)				480	Methylhydrogendichlorosilane	75-54-7	•	Caution
212	Methylene bisphenyl-4,4'-diisocyanate	101-68-8	X Sensitizat	ion	261	Methyl iodide (Iodomethane)	74-88-4	T C Cancer	Skin
	(MDI)				391	Methyl isobutyl ketone (4-Methyl-	108-10-1	V	DKIII
261	Methylene bromide (Dibromomethane)	74-95-3	X			2-pentanone or MIBK)	100 10 1	•	
261	Methylene chloride (Dichloromethane)	75-09-2	X		211	Methyl isocyanate (MIC)	624-83-9	Tx	Skin
145	4,4'-Methylenedianiline (MDA or <i>p,p</i> '-Diaminodiphenylmethane)	101-77-9	X Sensitizat	ion Skin		(Methyl isopentyl ketone) see 5-Methyl- 2-hexanone	021 03 7		DKIII
142	N-Methylethanolamine	109-83-1	Xi		501	Methyl mercaptan (Methane thiol)	74-93-1	X	
	(2-(Methylamino)ethanol)				135	N-Methylmethacrylamide	3887-02-3	11	
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223	Methyl methacrylate (Methyl 2-methylpropenoate)	80-62-6	X Sensitization	On .	241	Methyl <i>tert</i> -butyl ether (<i>tert</i> -Butyl methyl ether or MTBE)	1634-04-4		
161	Methylnadic anhydride (Methyl-5-norbornene-2,3-decarboxylic anhydride or Nadic methyl anhydride)	25134-21-8	Xi			(Methyl 2-methyl-2-butyl ether) see tert-Amyl methyl ether (Methyl propyl ketone) see 2-Pentanone			
462	Methyl parathion, 30–70% (4-Methyl-2-pentanone) see Methyl	298-00-0	T	Skin	480	Methyl trichlorosilane (Trichloromethylsilane)	75-79-6	Xi	
391	isobutyl ketone Methyl pentyl ketone (2-Heptanone)	110-43-0	v		245	Methyltriglycol (Triethylene glycol monomethyl ether)	112-35-6		
-71	(2-Methyl-1-phenylpropane) see				246	Methyl vinyl ether (Methoxyethylene)	107-25-5		
	Isobutylbenzene (2-Methylpropane) see Isobutane (2-Methylpropenoic acid) see Methyl acrylic acid (Methylpropenoate) see Methyl acrylate				391	Methyl vinyl ketone (3-butene-one) (MIBK) see Methyl isobutyl ketone (MIC) see Methyl isocyanate (Mineral Spirit) see Naphtha, 15–20% (MOCA) see 4,4'-Methylene	78-94-4	Tx	
	(2-Methylpropylamine) see Isobutylamine					bis(2-chloroaniline)			
	(Methylpyridine) see beta-Picoline					(Monobutylamine) see n-Butylamine			
132	N-Methyl-2-pyrrolidone (NMP)	872-50-4	Xi			(Monochloroacetic acid) see Chloroacetic			
292	alpha-Methylstyrene	98-83-9	Xi			acid			
	(Methyl sulfate) see Dimethyl sulphate					(Monochlorobenzene) see Chlorobenzene			
	(Methyl sulfide) see Dimethylsulfide					(Monoethanolamine) see Ethanolamine			
	(Methyl sulfoxide) see Dimethyl sulfoxide	;				(Monoethylamine) see Ethylamine			
	(Methyl tert-amyl ether) see tert-Amyl methyl ether					(Monoisopropanolamine) see Isopropanol amine			

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	(Monoisopropylamine) see Isopropylami	ine			370	Nitric acid, <30%	7697-37-2	Xi	
	(Monomethylamine) see Methylamine				350	Nitric oxide (Nitrogen monoxide)	10102-43-9	T	
	(Muriatic acid) see Hydrochloric acid, 37	7%			441	Nitrobenzene	98-95-3	T	Skin
142	Morpholine (Tetrahydro-1,4-oxazine)	110-91-8	CX	Skin		(o-Nitrochlorobenzene) see			
502	Mustard gas (Bis(2-chloroethyl)sulfide)	505-60-2	Tx	Caution		2-Chloronitrobenzene			
	(Nadic methyl anhydride) see Methylnad anhydride	lic				(p-Nitrochlorobenzene) see 4-Chloromitrobenzene			
462	Naled® (Bromochlophos)	300-76-5	T	Skin	146	4-Nitrodiphenylamine	836-30-6		
291	Naphtha, <3% aromatics, 150-200°C	64741-65-7	X			(p-Nitrodephenylamine)			
291	Naphtha, 10-15% aromatics, 120-140°C	8030-30-6	X		441	Nitroethane	79-24-3	X	
	(Naphtha V.M.&P)				350	Nitrogen dioxide	10102-44-0	Tx	
291	Naphtha, 15-20% aromatics,	8052-41-3	X			(Nitrogen monoxide) see Nitric oxide			
	150-200°C (Mineral spirits)				350	Nitrogen tetroxide	10544-72-6	Tx	Caution
	(Naphtha, 15-20% aromatics,	8008-20-6			510	Nitroglycerol (Nitroglycerin)	55-63-0		Skin
	180–260°C) see Kerosene				510	Nitroglycol	628-96-6		Caution
293	Naphthalene	91-20-3	X		441	Nitromethane	75-52-5	X	
	(Naphthol methyl carbamate) see Sevin 5	50W			441	1-Nitropropane	108-03-2	X	
	(Naphthyl chloride) see 1-Chloro-naphth	alene			441	2-Nitropropane	79-46-9	T Cancer	
470	Nickel carbonyl (Nickel tetracarbonyl)	13463-39-3			450	N-Nitrosodiethylamine	55-18-5	X	
380	Nickel subsulfide	11113-75-0	T Cancer	Caution		(N,N-Diethylmitrosamine)			
271	Nicotine	54-11-5	Tx	Skin	450	N-Nitrosodimethylamine	62-75-9	Tx Cancer	Skin
370	Nitric acid, red fuming	8007-58-7	Cx	Caution		(N,N-Dimethylnitrosamine)			
370	Nitric acid, >70%	7697-37-2	Cx	Caution	441	2-Nitrotoluene (o-Nitrotoluene)	88-72-2	Т	Skin
370	Nitric acid, 30–70%	7697-37-2	Cx	Caution	441	4-Nitrotoluene (<i>p</i> -Nitrotoluene)	99-99-0	T	 ASSA.

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
141	Nonylamine	112-20-9			294	n-Pentene (Pentene or 1-Pentene)	109-67-1		
316	Nonylphenol	25154-52-3	ТC		431	2-Pentenenitrile	13284-42-9	T	
291	n-Octane	111-65-9	V		431	3-Pentenenitrile	4635-87-4	T	
	(Octanoic acid) see Caprylic acid				222	n-Pentyl acetate (Amyl acetate)	628-63-7	V	
311	n-Octanol (Octyl alcohol)	29063-28-3	X			(Pentyl alcohol) see n-Pentanol			
102	Oleic acid	112-80-1			141	n-Pentylamine (n-Amylamine)	110-58-7	CX	Caution
590	(Oleum) see Sulfuric acid, fuming Orthocid 83®	133-06-2			480	Pentyltrichlorosilane (Trichloropentylsilane)	107-72-2		Caution
104	Oxalic acid	144-62-7	X	Caution	370	Perchloric acid, 30-70%	7601-90-3	Cx	Caution
145	4,4'-Oxidianiline (Oxirane) see Ethylene oxide	101-80-4	X			(Perchlorobutadiene) see Hexachloro-1, 3-butadiene			
102	Palmitic acid	57-10-3		Caution	263	Perchloroethylene (Tetrachloro-ethylene)	127-18-4	X Cancer	
	(p-Bromofluorobenzene) see 1-Bromo- 4-fluorobenzene					(Perchloromethane) see Carbon tetrachloride			
	(Parathion) see Ethyl parathion (PCB) see Polychlorinated biphenyls					(Perfluoroacetic acid) see Trifluoro acetic acid			
316	Pentachlorophenol	87-86-5	T	Skin	300	Peroxyacetic acid	79-21-0	C	Caution
291	<i>n</i> -Pentane (1,5-Pentanedial) see Glutaraldehyde	109-66-0	V		291	Petroleum ethers, 80–110°C (Petroleum ethers, <1% aromatics)	8032-32-4	V	
391	2,4-Pentanedione (Acetylacetone)	123-54-6	X		316	Phenol, >70% (Carbolic acid)	108-95-2	TC	Skin
	(1-Pentanonitrile) see Valeronitrile				316	Phenolphthalein	77-09-8		
311	n-Pentanol (Pentyl alcohol or Amyl alcohol)	71-41-0	X		504	Phenolsulfonic acid (Hydroxybenzenesulfonic acid)	1333-39-7	Xi	
391	2-Pentanone (Methyl propyl ketone)	107-87-9	X		431	Phenylacetomitrile (Benzyl nitrile)	140-29-4	T	

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
	(Phenylamine) see Aniline				380	Potassium hydroxide, 30–70%	1310-58-3	С	Caution
	(Phenyl cyanide) see Benzyl alcohol				340	Potassium iodide	7681-11-0		
350	Phosgene (Carbonyl chloride)	75-44-5	Tx		340	Potassium permanganate, sat.	7722-64-7	X	Caution
350	Phosphine (Hydrogen phosphide)	7803-51-2	Tx		590	Pramitol®	1610-18-0		
370	Phosphoric acid, >70%	7664-38-2	C	Caution	550	Promethazine hydrochloride	583-33-3		
360	Phosphorus oxychloride (Phosphoryl	10025-87-3	Cx	Caution		(Propanal) see Propionaldehyde			
	chloride)				291	Propane	74-98-6		
360	Phosphorus tribromide	7789-60-8	C		148	1,3-Propanediamine	109-76-2	C	
360	Phosphorus trichloride	7719-12-2	Cx	Caution		(1,3-Diaminopropane)			
	(Phosphoryl chloride) see Phosphorus					(1,2-Propanediol) see Propylene glycol			
	oxychloride				311	n-Propanol (n-Propyl alcohol)	71-23-8	X	Skin
161	Phthalic acid anhydride	85-44-9	Xi	Caution		(2-Propanol) see Isopropanol			
	(Phthalic acid diethylester) see					(2-Propanone) see Acetone			
	Diethylphthalate					(2-Propeneamide) see Acrylamide			
271	beta-Picoline (3-Picoline or Methyl-	109-06-8	X			(Propenenitrile) see Acrylonitrile			
	pyridine)					(2-Propenoic acid) see Acrylic acid			
442	Picric acid (2,4,6-Trinitrophenol)	88-89-1	T	Skin		(2-Propenol) see Allyl alcohol			
148	Piperazine (Diethylenediamine)	110-85-0	C		225	beta-Propiolactone	57-57-8	Tx Cancer	Caution
142	Piperidine (Hexahydropyridine)	110-89-4	TC	Caution	121	Propionaldehyde (Propanal)	123-38-6	Xi	
264	Polychlorinated biphenyls (PCB)	1336-36-3	T Cancer	Skin	102	Propionic acid	79-09-4	C	
314	Polyethylene glycol	25322-68-3			431	Propionitrile (Ethyl cyanide)	107-12-0	T	Caution
340	Potassium acetate, sat.	127-08-2			392	Propiophenone (Ethyl phenyl ketone)	70-69-9		
340	Potassium chromate, sat.	7789-00-6	Xi	Caution	245	Propoxyethanol (Propylene glycol	1569-01-3		
345	Potassium cyanide	151-50-8	Tx	Caution		monopropyl ether)			
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Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
222	Propyl acetate	109-60-4	V		133	Propyzamide, <30% (Kerb 50®)	23950-58-5	X	
	(n-Propyl alcohol) see n-Propanol					(Pseudocumene) see 1,2,4-			
141	n-Propylamine (Monopropylamine)	107-10-8	Xi			Trimethylbenzene			
	(Propyl chloride) see 1-Chloropropane				271	Pyridine (Azine)	110-86-1	X	
245	Propyldiglycol (Diethylene glycol monopropyl ether)	6881-94-3	X			(Pyridine borane) see Borane pyridine complex			
148	Propylenediamine (1,2-Diaminopropane)	78-90-0	C		274	Pyrrolidine (Tetramethyleneimine)	123-75-1	C	
314	Propylene glycol (1,2-Propanediol)	57-55-6	V			(Quicksilver) see Mercury			
	(Propylene glycol monobutyl ether)				274	Quinoline	91-22-5	X	
	see Butoxy propanol					(Quinone) see p-Benzoquinone			
	(Propylene glycol monoethyl ether)					(Reglone®) see Diquat dibromide			
	see 1-Ethoxy-2-propanol				462	Round Up® (Glyphosate)	1071-83-6	X	
	(Propylene glycol monomethyl ether) see 1-Methoxy-2-propanol				233	Sevin 50W (Carbaryl or Naphthol methyl carbamate)	63-25-2	T	Caution
	(Propylene glycol monopropyl ether)				590	Shale oil	68308-34-9		
	see Propoxyethanol				590	Silicon etch			
245	Propylene glycol monoethyl ether	19234-20-9	X		360	Silicon tetrachloride	10026-04-7	Xi	Caution
	acetate (1,2-Propanediol monomethyl				480	Silicon tetrachloride (Tetrachlorosilane)	10026-04-7	Xi	Caution
	ether acetate)				345	Silver cyanide, <30%	506-64-9		
275	1,2-Propylene oxide (1,2-Epoxypropane)	75-56-9	X Cancer		340	Sodium carbonate	497-19-8	Xi	
245	Propyl glycol (Ethylene glycol	57-55-6	X		340	Sodium chloride, sat.	7647-14-5		
	monopropyl ether)				345	Sodium cyanide, solid	143-33-9	Tx C	
223	Propyl methacrylate (Propyl	2210-28-8			345	Sodium cyanide, >70%	143-33-9	Tx C	Caution
	2-methylpropenoate)				345	Sodium cyamide, <30%	143-33-9	Tx C	

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
340	Sodium dichromate, <30% (Sodium dimethylbenzene sulfonate) see Xylenesulphonic acid sodium salt	10588-01-9	Xi Sensitization Cancer	Caution	264	1,2,4,5-Tetrachlorobenzene (TDI) see Toluene-2,4-diisocyanate (TEA) see Triethanolamine (TEL) see Tetraethyl lead (TETA) see Triethylenetetraamine	95-94-3	Х	
340	Sodium fluoride, sat.	7681-49-4	T	Caution	261	1,1,1,2-Tetrachloroethane	630-20-6	T	
340	Sodium hydrogen sulfide	16721-80-5	C	Caution	261	1,1,2,2-Tetrachloroethane	79-34-5	T	Skin
380	Sodium hydroxide, 30–70% (Caustic soda)	1310-73-2	Cx	Caution		(Tetrachloroethylene) see Perchloroethylene			
380	Sodium hydroxide, >70% (Caustic soda)	1310-73-2	Cx	Caution		(Tetrachloromethane) see Carbon			
340	Sodium hypochlorite, 30–70%	7681-52-9	C	Caution		tetrachloride			
340	Sodium thiosulfate (Sodium hyposulfite)	7772-98-7	V			(Tetrachlorosilane) see Silicon			
292	Styrene (Vinylbenzene)	100-42-5	X	Skin		tetrachloride			
233	Sulfallate (2-Chloro-2-propenyl	95-06-7			148	Tetraethylenepentamine	112-57-2	X Sensitiz	ation
	diethyldithiocarbamate)				470	Tetraethyl lead (TEL)	78-00-2		
370	Sulfuric acid, >70%	7664-93-9	Cx	Caution	263	Tetrafluorethylene	116-14-3	Xi	
370	Sulfuric acid, 30-70%	7664-93-9	Cx	Caution	370	Tetrafluoroboric acid, 30-70%	16872-11-0	C	Caution
370	Sulfuric acid, <30%	7664-93-9	C			(Fluoroboric acid)			
370	Sulfuric acid, fuming (Oleum)	8014-95-7	T Cx	Caution	241	Tetrahydrofuran (THF)	109-99-9	X	
350	Sulfur dioxide	7446-09-5	T			(Tetrahydro-1,4-oxazine) see Morpholi	ne		
365	Sulfur trioxide	7446-11-9	Cx	Caution	391	beta-Tetralone	529-34-0	T	
360	Sulfuryl chloride	7791-25-5	C	Caution	550	Tetramethyl ammonium hydroxide	75-59-2	Xi	Caution
316	Tannic acid	1401-55-4	T Cancer		148	N,N,N',N'-Tetramethylenediamine	110-18-9	Xi	
	(Tear gas) see 2-Chloroacetophenone					(TMEDA)			



Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
137	(THF) see Tetrahydrofuran Thiocarbamide, <30% (Isothiourea)	62-56-6	х		470	Tributyltin oxide (Bis(tributyltin)oxide or TBTO)	56-35-9	Т	Caution
	(Thioglycolic acid) see Mercaptoacetic				121	Trichloroacetaldehyde (Chloral)	95-87-6		
	acid				103	Trichloroacetic acid	76-03-9	CX	Caution
501	Thionyl chloride	7719-09-7	C	Caution	431	Trichloroacetonitrile (Trichloromethyl	545-06-2	T	
279	Thiophene (Thiofuran)	110-02-1	X			cyanide)			
	(Thiourea) see Thiocarbamide				264	1,2,4-Trichlorobenzene	120-82-1	X	
360	Titanium tetrachloride (TMEDA) see N,N,N',N'-	7550-45-0	С			(Trichloroepoxypropane) see Epoxy trichloropropane			
	Tetramethylene diamine				261	1,1,1-Trichloroethane (Methyl chloroform)	71-55-6	X	
	(TMPTA) see Trimethylolpropane				261	1,1,2-Trichloroethane (Chlorothene V6)	79-00-5	X	Skin
	triacrylate				315	2,2,2-Trichloroethanol	115-20-8	T	
292	Toluene (Methylbenzene)	108-88-3	X	Skin		(Trichloroethene) see Trichloroethylene			
212	Toluene-2,4-diisocyanate (2,4-Diisocyanate toluene or TDI)	584-84-9	Tx Sensiti	zation	263	Trichloroethylene (Trichloroethene) (Trichloromethane) see Chloroform	79-01-6	X	
504	p-Toluenesulfonic acid	104-15-4	ХC			(Trichloromethylsilane) see Methyl			
145	m-Toluidine (3-Methylaniline)	108-44-1	T			trichlorosilane			
145	o-Toluidine (2-Methylaniline)	95-53-4	T	Skin		(Trichloronitromethane) see Chloropicrin			
146	Treflan EC (Trifluralin)	1582-09-8	X			(Trichloropentylsilane) see			
143	Triallylamine	102-70-5	Xi			Pentyltrichlorosilane			
261	Tribromomethane (Bromoform)	75-25-2	T	Skin	261	1,2,3-Trichloropropane	96-18-4	X	Skin
316	2,4,6-Tribromophenol (2,4,6-Tribromohydroxybenzene)	118-79-6	X	Caution		(1,1,2-Trichloro-1,2,2-trifluoroethane) see Freon 113 (TF)			
462	Tributyl phosphate (TBP)	126-73-8	X	Caution		(Trichlorovinylsilane) see Vinyltrichlorosil	ane		*

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class#	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
462	Tricresyl phosphate (Tritolyl	95-95-4	T			(2,4,6-Trinitrophenol) see Picric acid			
	phosphate or TCP)				462	Triphenylphosphite	101-02-0	Xi	Caution
143	Triethanolamine (TEA)	102-71-6	Xi		143	Tri-n-propylamine (Tripropylamine)	102-69-2	CX	Caution
480	Triethoxysilane	998-30-1	X	Caution	223	Tripropylene glycol diacrylate	42978-66-5		
143	Triethylamine	121-44-8	CX	Skin	462	Tris(1,3-dichloroisopropyl)phosphate	126-72-7		
143	Triethylenediamine (TED) (Triethylene glycol monobutyl ether)	280-57-9	СХ	Caution		(Tritolyl phosphate) see Tricresyl phosphate			
	see Butyltriglycol				294	Turpentine	8006-64-2	X Sensitiza	tion
	(Triethylene glycol monoethyl ether)				431	Valeronitrile (1-Pentanonitrile)	110-59-8	T	
	see Ethyltriglycol				222	Vinyl acetate	108-05-4	V	Caution
	(Triethylene glycol monomethyl ether)					(Vinylbenzene) see Styrene			
	see Methyltriglycol				263	Vinyl chloride (Chloroethene)	75-01-4	T Cancer	Caution
148	Triethylenetetraamine (TETA)	112-24-3	X Sensitiz	ation		(Vinyl cyanide) see Acrylonitrile			
103	Trifluoroacetic acid (Perfluoroacetic acid)	76-05-1	C	Caution		(VCN) see Acrylonitrile	,		
111	Trifluoroacetylchloride	354-32-5	C	Caution	294	4-Vinyl-1-cyclohexane	100-40-3	V	Skin
315	2,2,2-Trifluoroethanol	75-89-8	X		263	Vinyl fluoride	75-02-5		
	(Trifluralin) see Treflan EC					(Vinylstyrene) see Divinyl benzene			
143	Trimethylamine	75-50-3	CX	Caution	263	Vinylidene chloride	75-35-4	X	
292	1,2,4-Trimethylbenzene (Pseudocumene)	95-63-6	Xi			(1,1-Dichloroethylene)			
223	Trimethylolpropane triacrylate (TMPTA)	15625-89-5			263	Vinylidene fluoride (1,1-Difluoroethylene)	75-38-7		
462	Trimethyl phosphate (Trimethylchlorosilane) see	121-45-9	X		132	N-Vinylpyrrolidone (1-Vinyl-2-pyrrolidone)	88-12-0	X	
	Chlorotrimethylsilane				503	Vinyl sulfone (Divinyl sulfone)	77 - 77-0	T	Caution

Class	s# Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
480	Vinyltrichlorosilane (Trichloro- vinylsilane)	75-94-5	С	Caution	292 550	Xylene (Dimethyl benzene) Xylenesulphonic acid sodium salt,	1330-20-7 1300-72-7	X	Caution
590	Water	7732-18-5				30-70% (Sodium dimethylbenzene			
590	Witch hazel	68916-39-2				sulfonate)	•		
	(Wood creosote) see Creosote				316	Xylenol (Dimethyl phenol)	1300-71-6	TC	

Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
462	Tricresyl phosphate (Tritolyl	95-95-4	T	···		(2,4,6-Trinitrophenol) see Picric acid	1.0110		
	phosphate or TCP)				462	Triphenylphosphite	101-02-0	Xi	Caution
143	Triethanolamine (TEA)	102-71-6	Xi		143	Tri-n-propylamine (Tripropylamine)	102-69-2	CX	Caution
480	Triethoxysilane	998-30-1	X	Caution	223	Tripropylene glycol diacrylate	42978-66-5		
143	Triethylamine	121-44-8	CX	Skin	462	Tris(1,3-dichloroisopropyl)phosphate	126-72-7		
143	Triethylenediamine (TED) (Triethylene glycol monobutyl ether)	280-57-9	СХ	Caution		(Tritolyl phosphate) see Tricresyl phosphate			
	see Butyltriglycol				294	Turpentine	8006-64-2	X Sensitiza	tion
	(Triethylene glycol monoethyl ether)				431	Valeromitrile (1-Pentanonitrile)	110-59-8	T	
	see Ethyltriglycol				222	Vinyl acetate	108-05-4	V	Caution
	(Triethylene glycol monomethyl ether)					(Vinylbenzene) see Styrene			
	see Methyltriglycol				263	Vinyl chloride (Chloroethene)	75-01-4	T Cancer	Caution
148	Triethylenetetraamine (TETA)	112-24-3	X Sensitiz	ation		(Vinyl cyanide) see Acrylonitrile			
103	Trifluoroacetic acid (Perfluoroacetic acid)	76-05-1	C	Caution		(VCN) see Acrylonitrile			
111	Trifluoroacetylchloride	354-32-5	C	Caution	294	4-Vinyl-1-cyclohexane	100-40-3	V	Skin
315	2,2,2-Trifluoroethanol	75-89-8	X		263	Vinyl fluoride	75-02-5		
	(Trifluralin) see Treflan EC					(Vinylstyrene) see Divinyl benzene			
143	Trimethylamine	75-50-3	CX	Caution	263	Vinylidene chloride	75-35-4	X	
292	1,2,4-Trimethylbenzene (Pseudocumene)	95-63-6	Xi			(1,1-Dichloroethylene)			
223	Trimethylolpropane triacrylate (TMPTA)	15625-89-5			263	Vinylidene fluoride (1,1-Difluoroethylene)	75-38-7		
462	Trimethyl phosphate	121-45-9	X		132	N-Vinylpyrrolidone	88-12-0	X	
	(Trimethylchlorosilane) see					(1-Viny1-2-pyrrolidone)			
	Chlorotrimethylsilane				503	Vinyl sulfone (Divinyl sulfone)	77-77-0	T	Caution

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Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes	Class #	Chemical Names (and Synonyms)	CAS#	Risk Code	Special Notes
Vinyltrichlorosilane (Trichloro- vinylsilane)	75-94-5	С	Caution	292 550	Xylene (Dimethyl benzene) Xylenesulphonic acid sodium salt,	1330-20-7 1300-72-7	X	Caution
Water	7732-18-5				30-70% (Sodium dimethylbenzene			
Witch hazel	68916-39-2			316	,	1300-71-6	тс	
V V	inyltrichlorosilane (Trichloro- vinylsilane) Vater	inyltrichlorosilane (Trichlorovinylsilane) Vater 7732-18-5 Vitch hazel 68916-39-2	hemical Names (and Synonyms) CAS # Code inyltrichlorosilane (Trichloro- vinylsilane) Vater 7732-18-5 Vitch hazel 68916-39-2	hemical Names (and Synonyms) CAS # Code Notes inyltrichlorosilane (Trichloro- vinylsilane) Vater 7732-18-5 Vitch hazel 68916-39-2	hemical Names (and Synonyms) CAS # Code Notes Class # inyltrichlorosilane (Trichloro- vinylsilane) Vater 7732-18-5 Vitch hazel COde Notes Caution 292 550 550 7732-18-5	hemical Names (and Synonyms) CAS # Code Notes Class # Chemical Names (and Synonyms) inyltrichlorosilane (Trichloro- vinylsilane) Zater 7732-18-5 Zation 7732-18-5 Zation 7732-18-5 Zation Zater 7732-18-5 Zation Zater 7732-18-5 Zation Zater Zation Zater Zation Zation	hemical Names (and Synonyms) CAS # Code Notes Class # Chemical Names (and Synonyms) CAS # inyltrichlorosilane (Trichloro- vinylsilane) Vater 7732-18-5 Vitch hazel 68916-39-2 Code Notes Class # Chemical Names (and Synonyms) CAS # Class # Chemical Names (and Synonyms) Aylene (Dimethyl benzene) Sylene (Dimethyl benzene) 1330-20-7 Xylene sulphonic acid sodium salt, 30-70% (Sodium dimethylbenzene) sulfonate)	hemical Names (and Synonyms) CAS # Code Notes Class # Chemical Names (and Synonyms) CAS # Code inyltrichlorosilane (Trichloro- vinylsilane) Vater 7732-18-5 Vitch hazel 68916-39-2 CAS # Code Notes Class # Chemical Names (and Synonyms) All Synonyms CAS # Code 292



SECTION IV

Selection Recommendations

Barriers

This section contains the color-coded recommendations for protective barriers. Sixteen protective barriers are contained in the data tables. They represent materials used in the construction of gloves, boots, suits, and other items of protective clothing. The table below shows their principal uses as chemically resistant barriers. See also Section VII, Manufacturers of Chemical Protective Clothing, for contact information.

Barrier	Common Uses ¹
Butyl Rubber	Gloves, Boots, Suits
Natural Rubber	Gloves
Neoprene (Rubber)	Gloves, Boots, Suits
Nitrile Rubber	Gloves, Boots
Polyethylene	Suits ²
Polyvinyl Alcohol	Gloves
Polyvinyl Chloride	Gloves, Boots, Suits
Teflon	Suits ²
Viton	Gloves, Suits
Saranex	Suits
4H & Silver Shield (PE/EVAL)	Gloves
Barricade	Suits

CPF 3	Suits
Responder	Suits
Trelichem HPS	Suits
Tychem 10 000	Suits

Neoprene is a tradename and Teflon, Viton, Barricade, and Tychem 10 000 are trademarks of the DuPont Company. Saranex is a tradename of the Dow Chemical Company. 4H is a trademark of the Safety 4 Company. Silver Shield is a trademark of the Siebe North Company. CPF 3 and Responder are trademarks of the Kappler Safety Group. Trellchem HPS is a trademark of the Trelleborg Company.

Most common applications in protective clothing. In some cases this may represent a film or coating over another substrate such as polyethylene-coated spunbonded olefin.

² Limited availability in gloves and boots.

Color Codes

The tables contain fields with one of four color codes. These color codes are green, yellow, red, and white. The tables also contain three symbols. The greater than eight (>8) symbol means a greater than eight-hour resistance to breakthrough was reported. Some green fields have the letter E in them. This indicates a material that has been estimated to provide at least four hours of protection. An explanation of what each specific color code means follows:

Green fields in the datatables represent reported resistance to breakthrough of greater than four hours under conditions of continuous contact. A > 8 symbol represents greater than eight hours of resistance to breakthrough reported under continuous contact. The letter E means the material has been estimated (but not tested) to provide at least four hours of protection. This symbol has been used for suit materials with expected long-term protection, but only tested for 3.3 hours to meet a specific government testing requirement.

Yellow fields in the datatables represent barriers with reported breakthrough times of between one and four hours and relatively low permeation rates after breakthrough. Yellow fields may also represent breakthrough resistance tests that have been conducted for less than the full four (or eight) hours. The performance of protective clothing barriers in this classification may be unsuitable for use, except for those situations where only short periods of use are needed and the chemicals represent minimal dermal hazards. Yellow fields with the asterisk indicating a low permeation rate are the best choice within this category.

Red fields in the datatables represent barriers with reported

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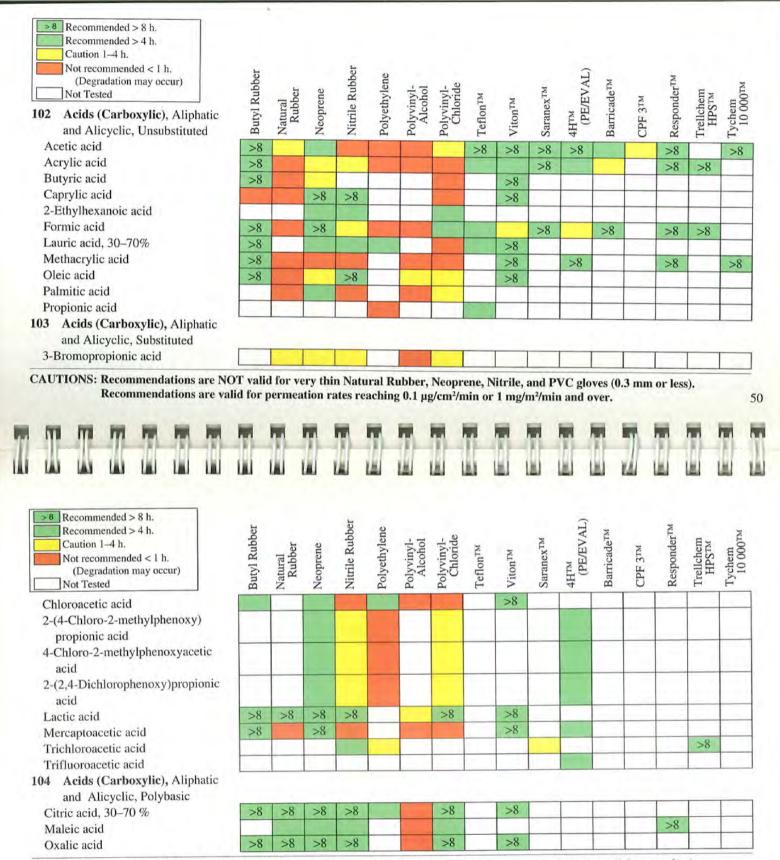
breakthrough times of less than one hour. In some cases, the rapid breakthrough may be accompanied or caused by degradation of the barrier. Barriers listed with red fields for resistance are not recommended for use.

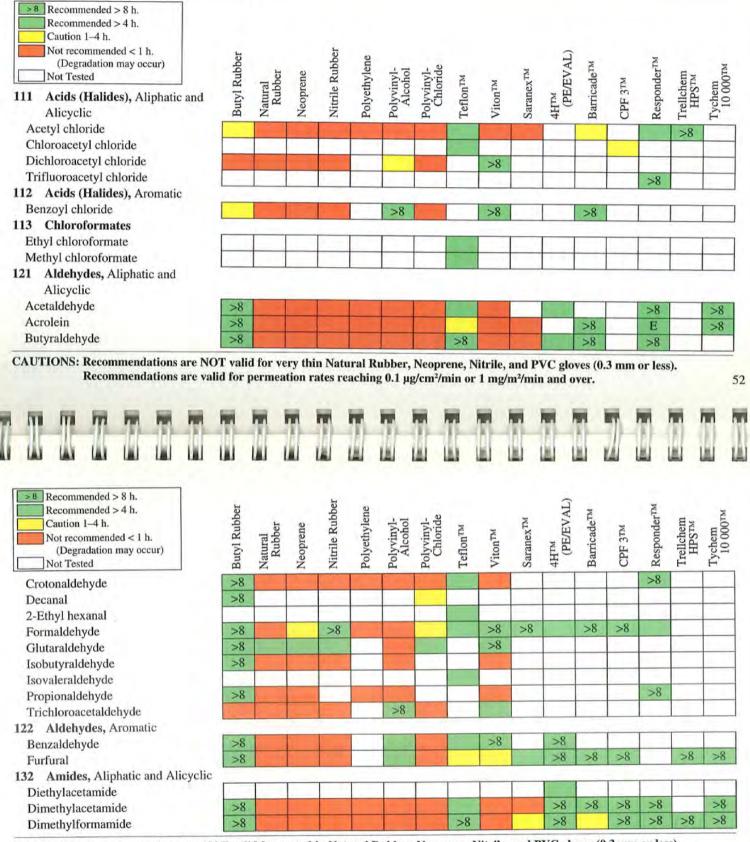
☐ White fields in the datatables represent those materials for which test data were not available. No recommendations are made for these barriers. These barriers should be tested against the challenge chemical before considering them for use.

Important Notes and Warnings

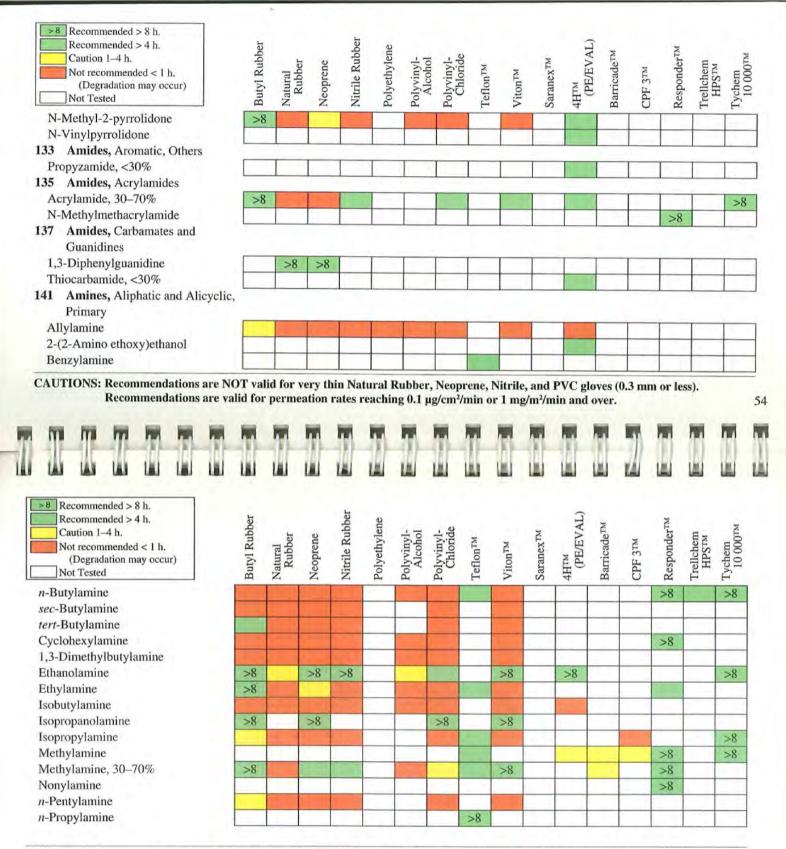
These datatables are compiled from published and unpublished results of permeation testing completed by researchers using ASTM

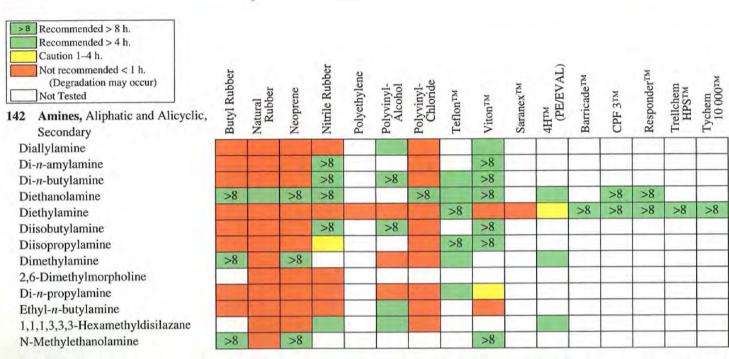
or similar methods. No testing has been done by the authors. Most of the data shown for generic barriers represent a summary of the results from more than one researcher. Most of the trade-name data are from the protective clothing manufacturers. Not all of the commercially available materials or barriers used for protective clothing are included in this guide. Their omission from this guide is not an indication of performance. For performance data on products not listed in this guide or for the most recent data, the vendors of the products should be consulted. Additionally, specific products or newer formulations of the reported products or barriers may perform differently than reported in this guide. Always check with the manufacturer for the latest test results. Finally, it is important to remember that breakthrough resistance is only one of many factors to consider in the selection of protective clothing. See the section on selection for some of the other important factors.

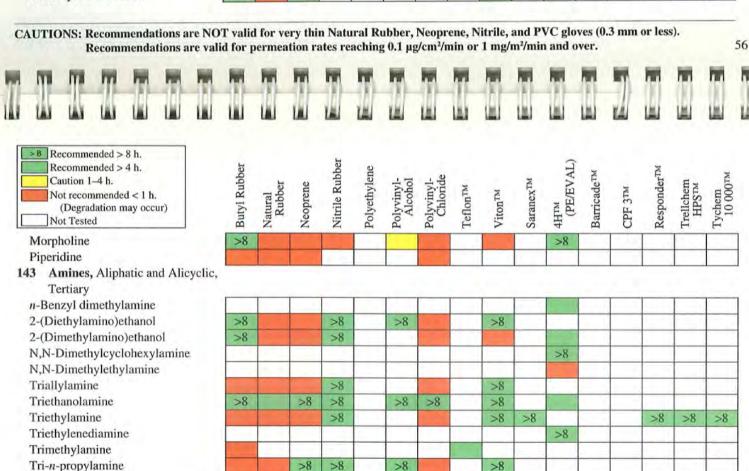


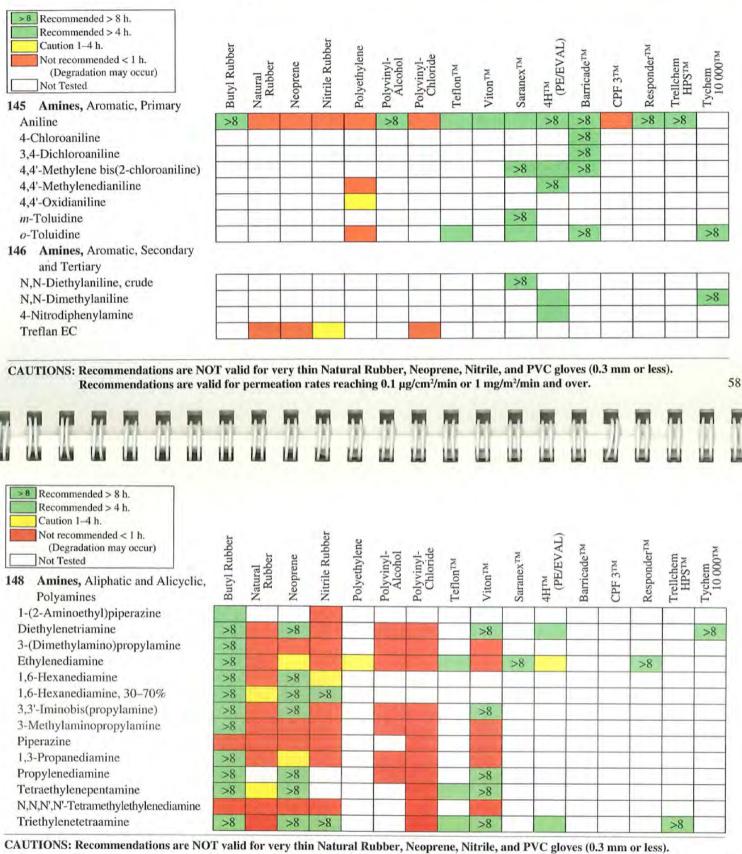


CAUTIONS: Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less). Recommendations are valid for permeation rates reaching 0.1 µg/cm²/min or 1 mg/m²/min and over.



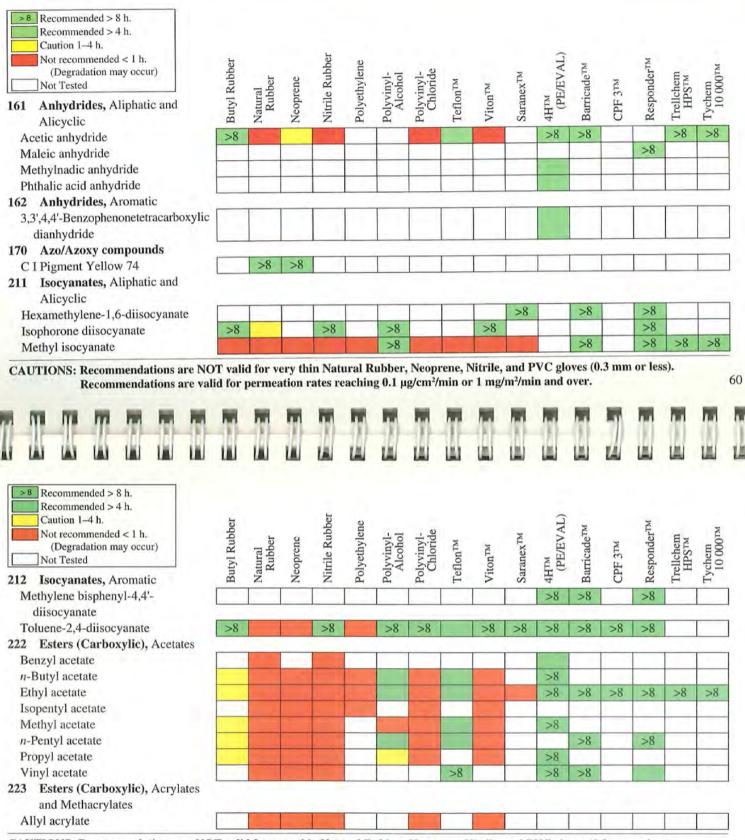






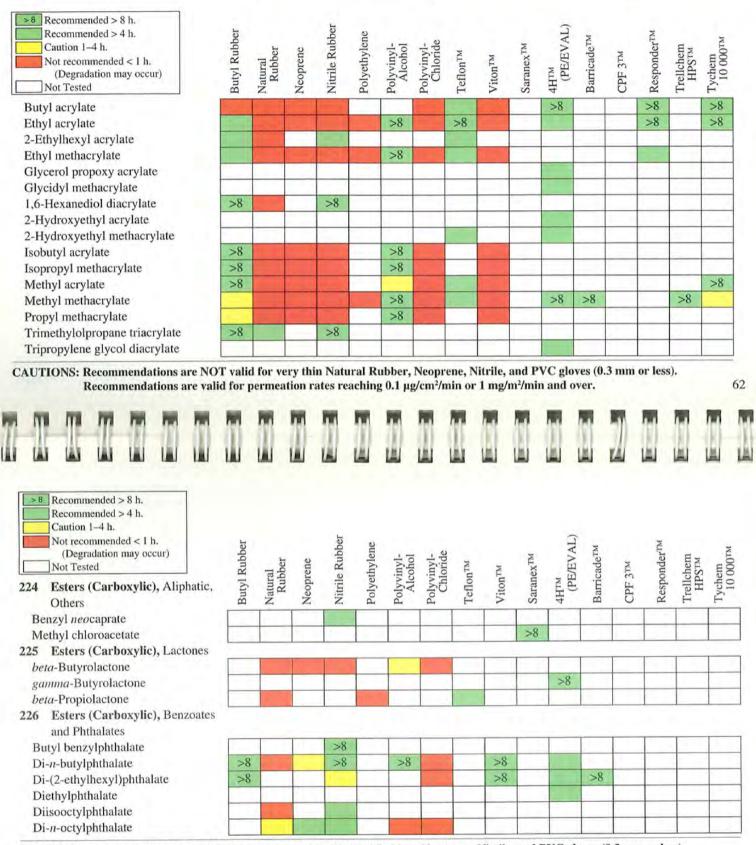
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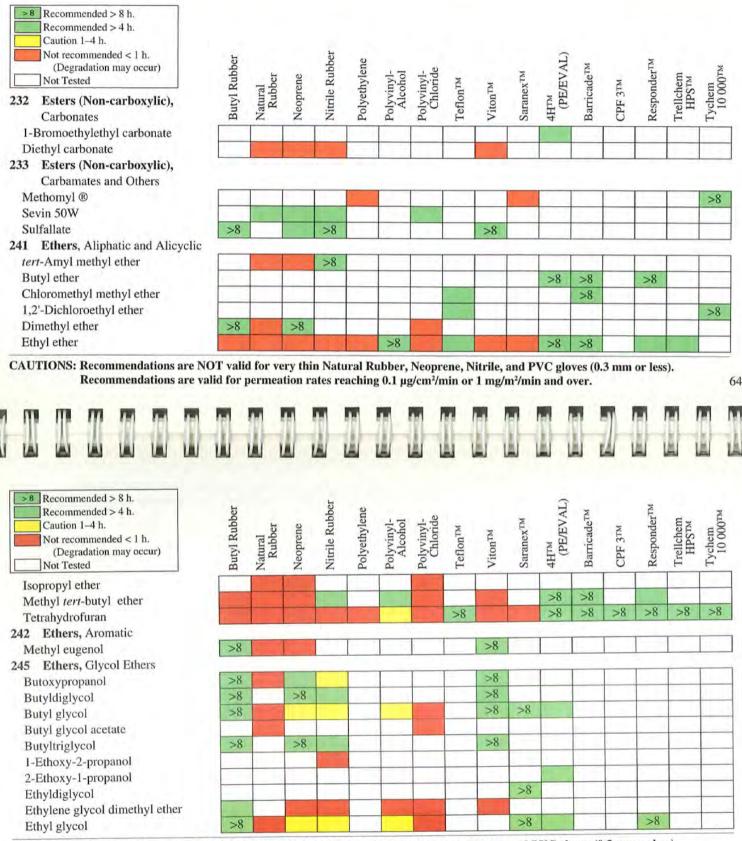
CAUTIONS: Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less).

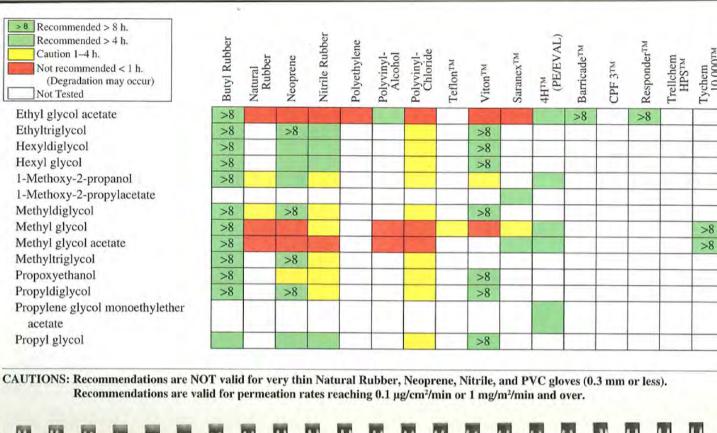
Recommendations are valid for permeation rates reaching 0.1 µg/cm²/min or 1 mg/m²/min and over.



CAUTIONS: Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less).

Recommendations are valid for permeation rates reaching 0.1 µg/cm²/min or 1 mg/m²/min and over.









Caution 1–4 h.

Not recommended < 1 h.

(Degradation may occur)

Not Tested

246 Ethers, Vinylic Ethyl vinyl ether Methyl vinyl ether

261 Halogen Compounds, Aliphatic and Alicyclic

Bromochloromethane Bromodichloromethane n-Butylchloride

Carbon tetrachloride

Chlordane, >70%

Chloroethane Chloroform

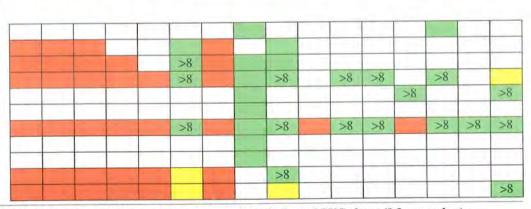
Chloromethyl methyl ether

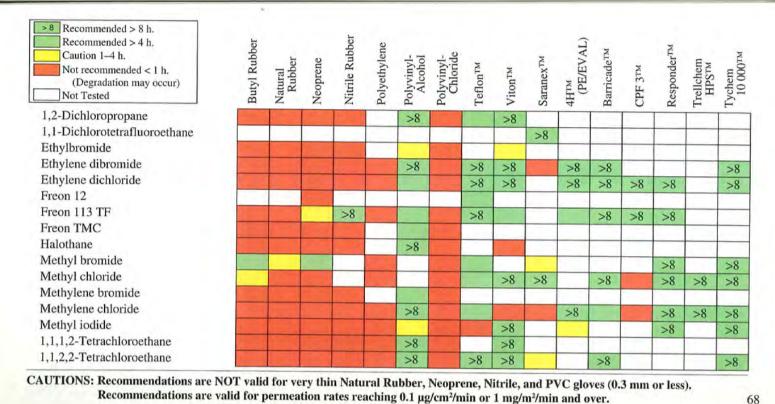
1-Chloropropane

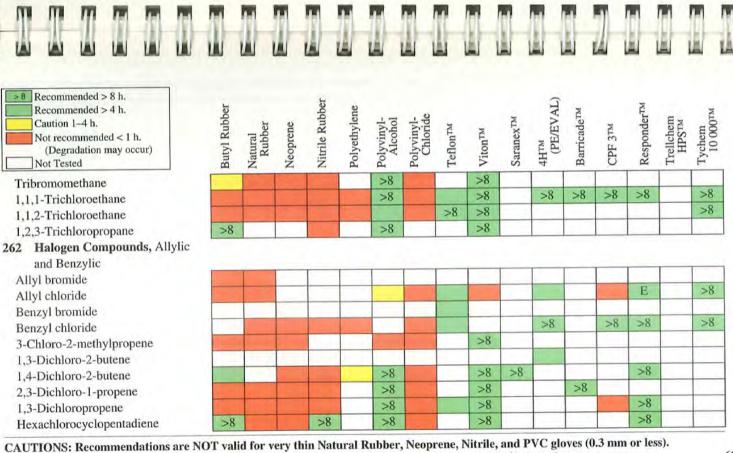
Dibromochloromethane

1,1-Dichloroethane

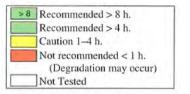
Butyl Rubber	Natural Rubber	Neoprene	Nitrile Rubber	Polyethylene	Polyvinyl- Alcohol	Polyvinyl- Chloride	TeflonTM	Viton TM	Saranex TM	4HTM (PE/EVAL)	Ватгісадетм	СРЕ 3ТМ	ResponderTM	Trellchem HPS TM	Тусhет 10 000тм
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Recommendations are valid for permeation rates reaching 0.1 µg/cm²/min or 1 mg/m²/min and over.



263 Halogen Compounds, Vinylic

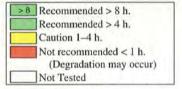
Chloroprene cis-1,2-Dichloroethylene trans-1,2-Dichloroethylene cis,trans-1,2-Dichloroethylene Dimethylvinyl chloride
Hexachloro-1,3-butadiene
Perchloroethylene
Tetrafluoroethylene
Trichloroethylene
Vinyl chloride
Vinyl fluoride
Vinylidene chloride

Vinylidene fluoride

Butyl Rubber	Natural Rubber	Neoprene	Nitrile Rubber	Polyethylene	Polyvinyl- Alcohol	Polyvinyl- Chloride	TeflonTM	Viton TM	Saranex TM	4HTM (PE/EVAL)	Ваггісадетм	СРЕ 31М	ResponderTM	Trellchem HPS TM	Тусћет 10 000тм
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													>8		>8
- 0					>8		>8	>8		>8	>8	>8	>8	>8	>8
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CAUTIONS: Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less).

Recommendations are valid for permeation rates reaching 0.1 µg/cm²/min or 1 mg/m²/min and over.



264 Halogen Compounds, Aromatic

Bromobenzene

1-Bromo-4-fluorobenzene

Chlorobenzene

4-Chlorobenzotrifluoride

1-Chloronaphthalene

2-Chloronitrobenzene

4-Chloronitrobenzene

o-Chlorotoluene

p-Chlorotoluene

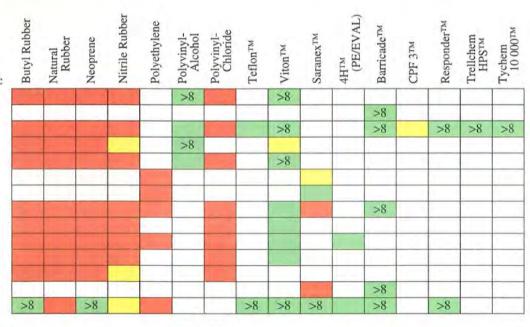
1,2-Dichlorobenzene

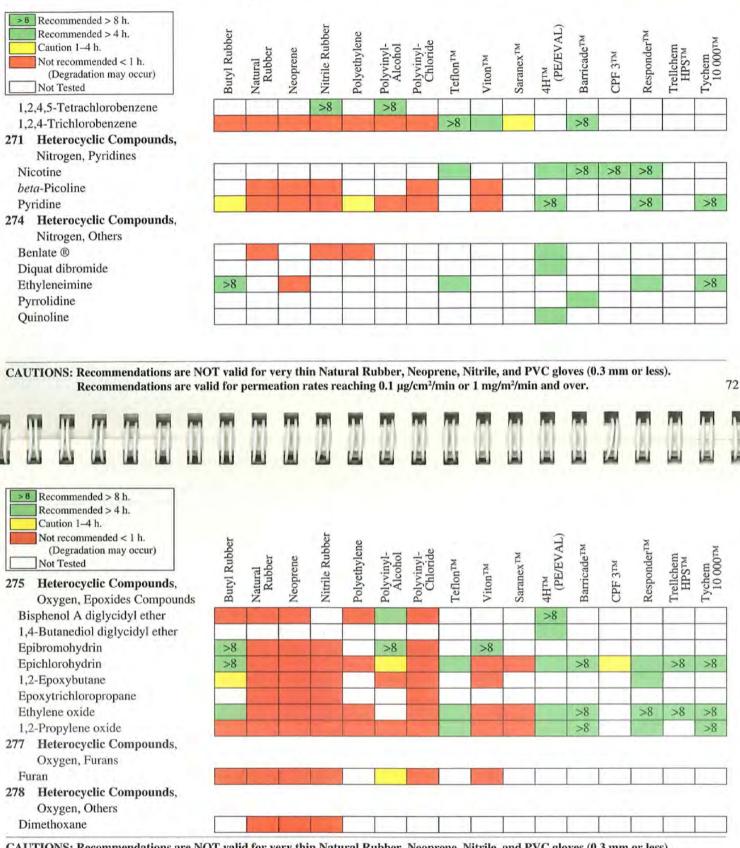
1,3-Dichlorobenzene

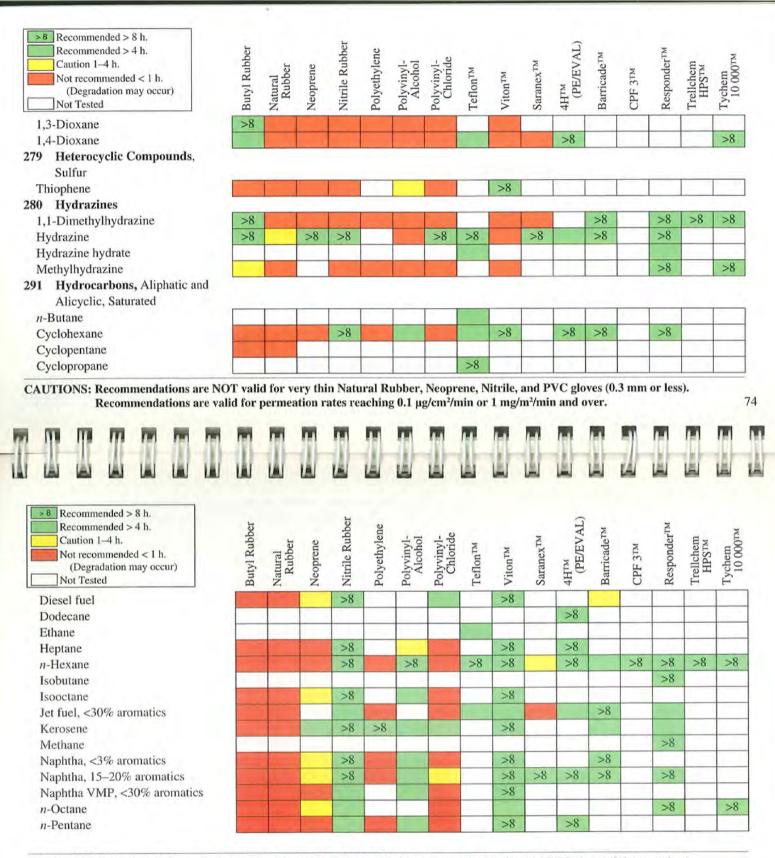
i,5 Biemorocenaene

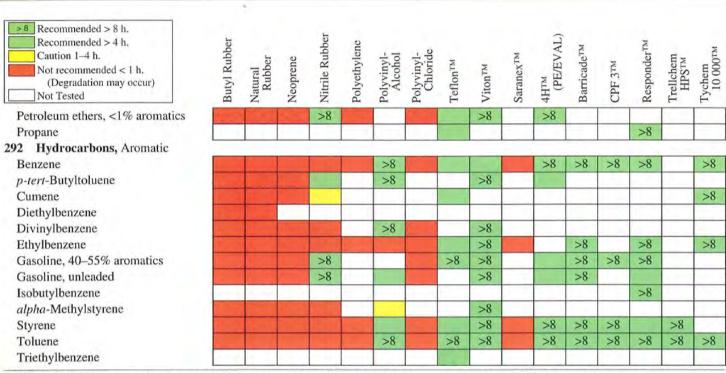
1,4-Dichlorobenzene

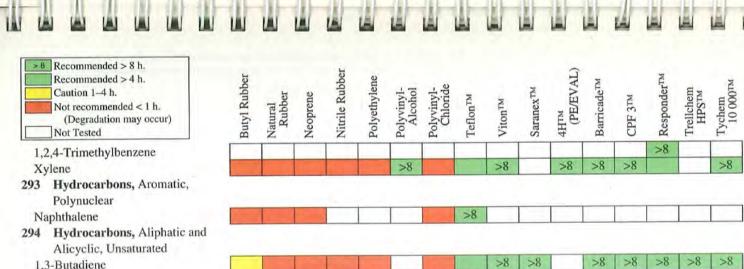
Fluorobenzene Polychlorinated biphenyls











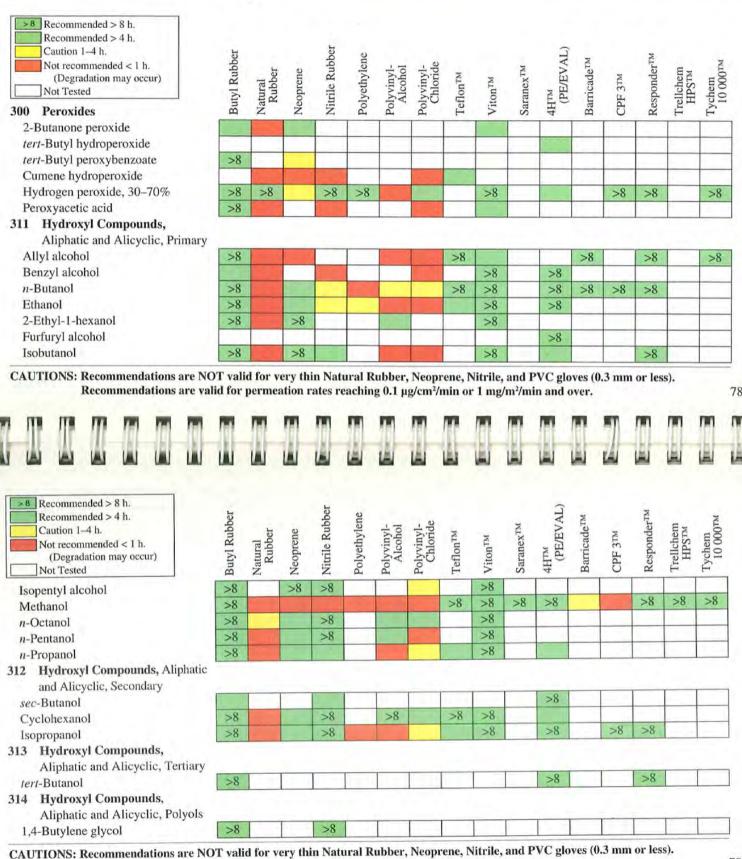
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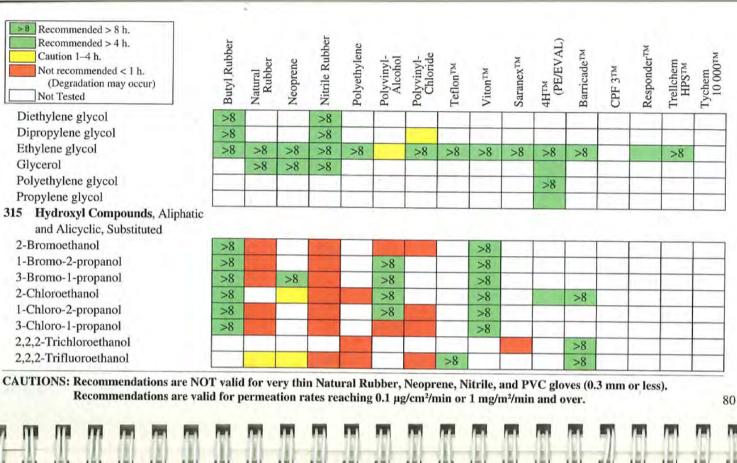
CAUTIONS: Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less).

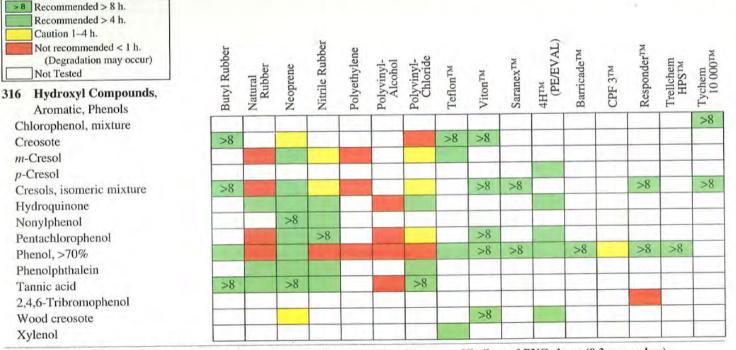
Recommendations are valid for permeation rates reaching 0.1 µg/cm²/min or 1 mg/m²/min and over.

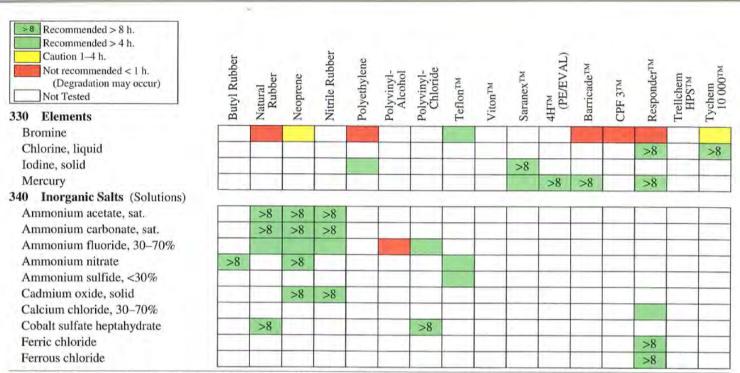
2-Butene Ethylene 1-Hexene Isoprene d,l-Limonene n-Pentene Turpentine

4-Vinyl-1-cyclohexane





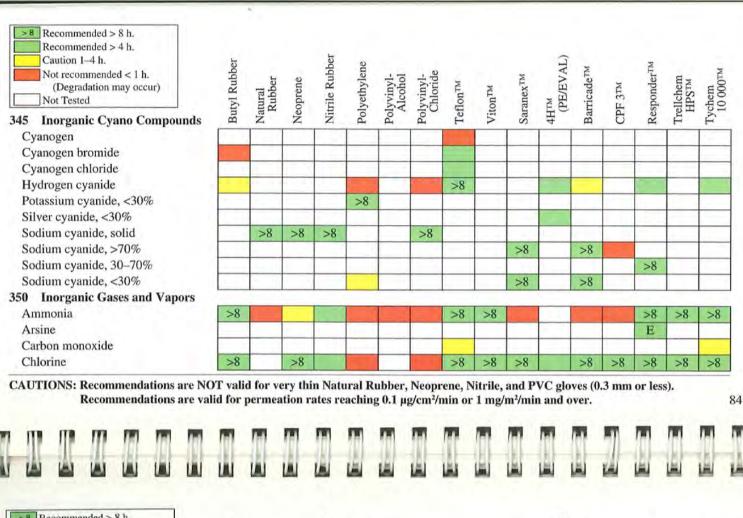


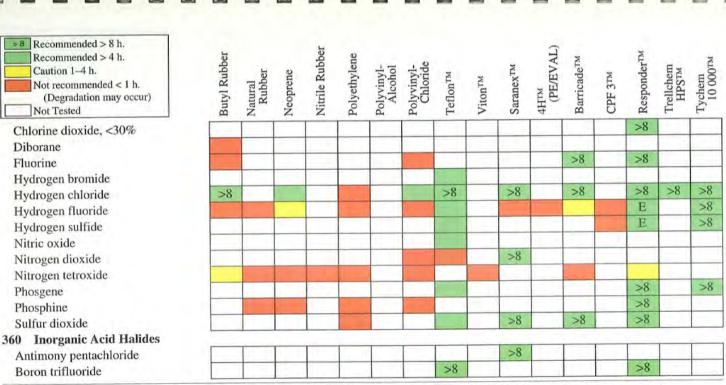


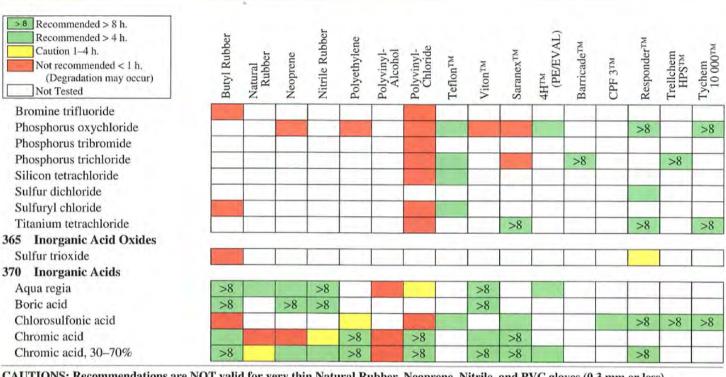
Recommended > 8 h.
Recommended > 4 h.
Caution 1-4 h.
Not recommended < 1 h.
(Degradation may occur)
Not Tested

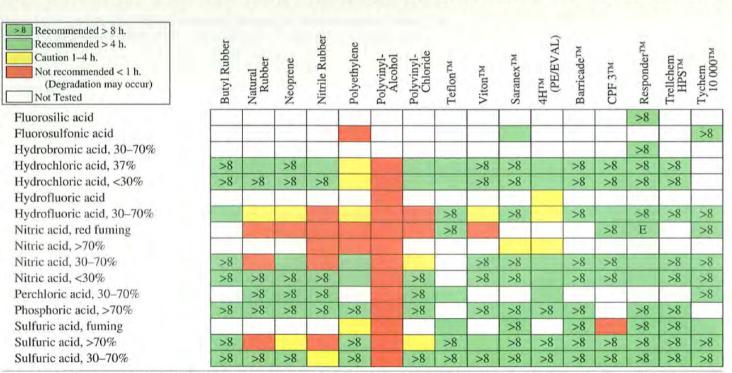
Mercuric chloride, sat.
Potassium acetate, sat.
Potassium chromate, sat.
Potassium iodide
Potassium permanganate
Sodium carbonate
Sodium chloride, sat.
Sodium dichromate
Sodium dichromate, <30%
Sodium fluoride, sat.
Sodium hydrogen sulfide
Sodium hypochlorite, 30–70%
Sodium hypochlorite, <30%
Sodium thiosulphate, sat.

Butyl Rubber	Natural Rubber	Neoprene	Nitrile Rubber	Polyethylene	Polyvinyl- Alcohol	Polyvinyl- Chloride	TeflonTM	Viton TM	Saranex TM	4HTM (PE/EVAL)	Barricade TM	СРЕ 31М	ResponderTM	Trellchem HPS TM	Туснет 10 000гм
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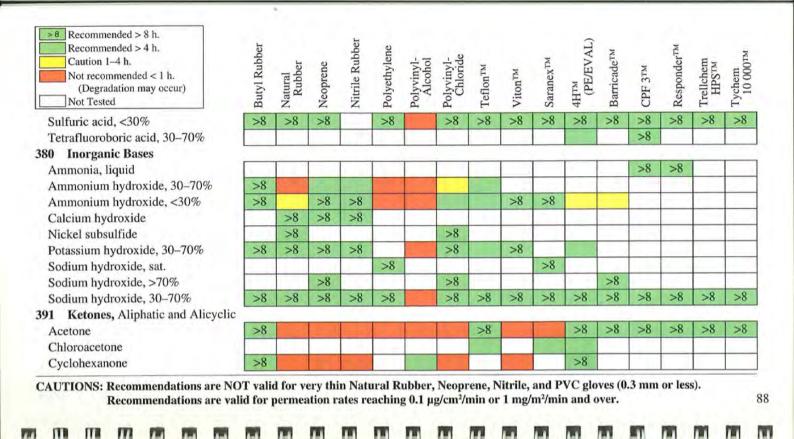


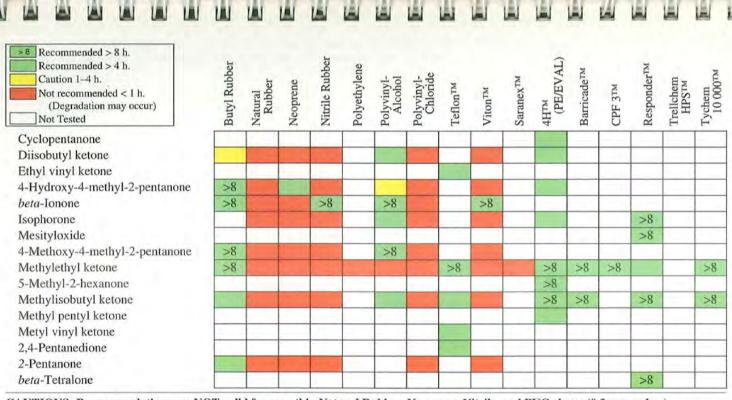


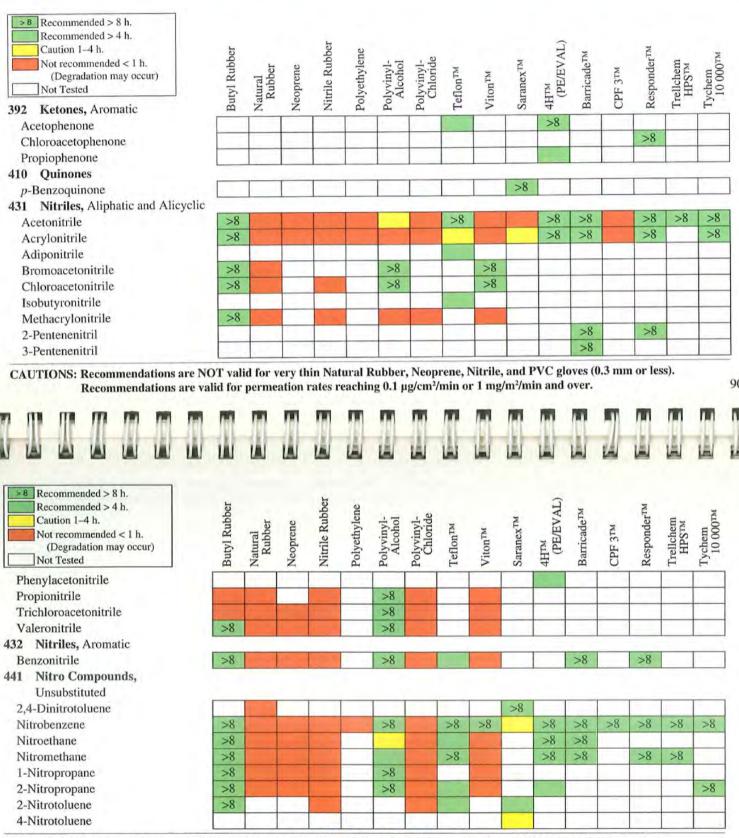


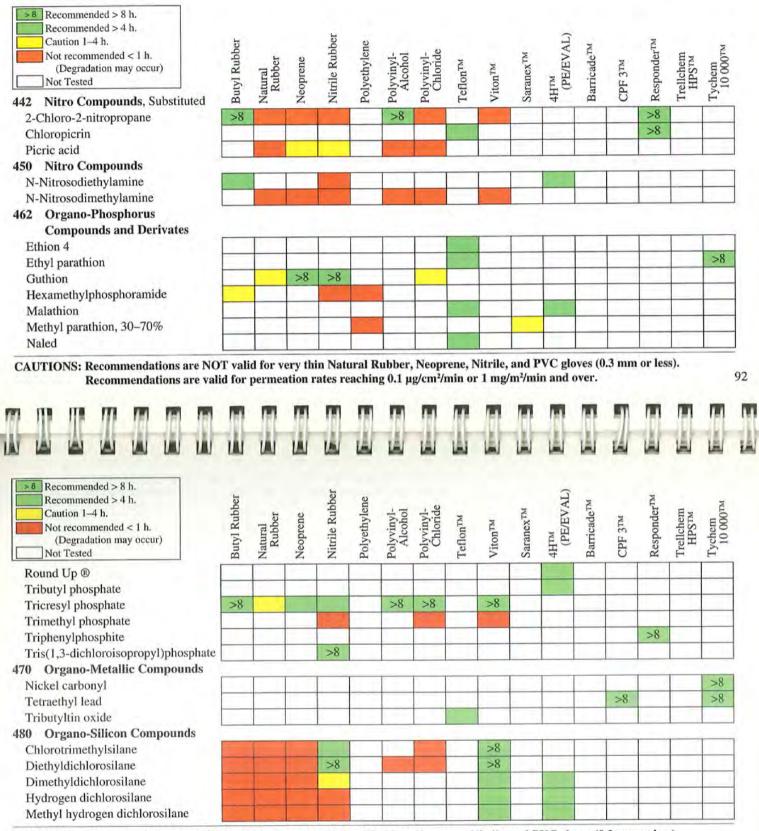
CAUTIONS: Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less).

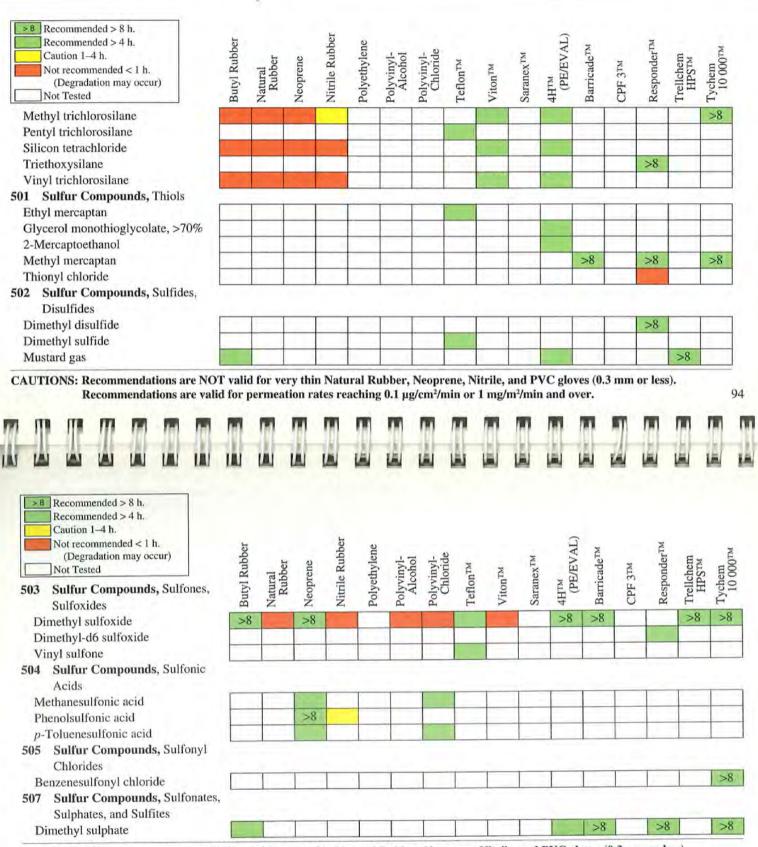
Recommendations are valid for permeation rates reaching 0.1 µg/cm²/min or 1 mg/m²/min and over.

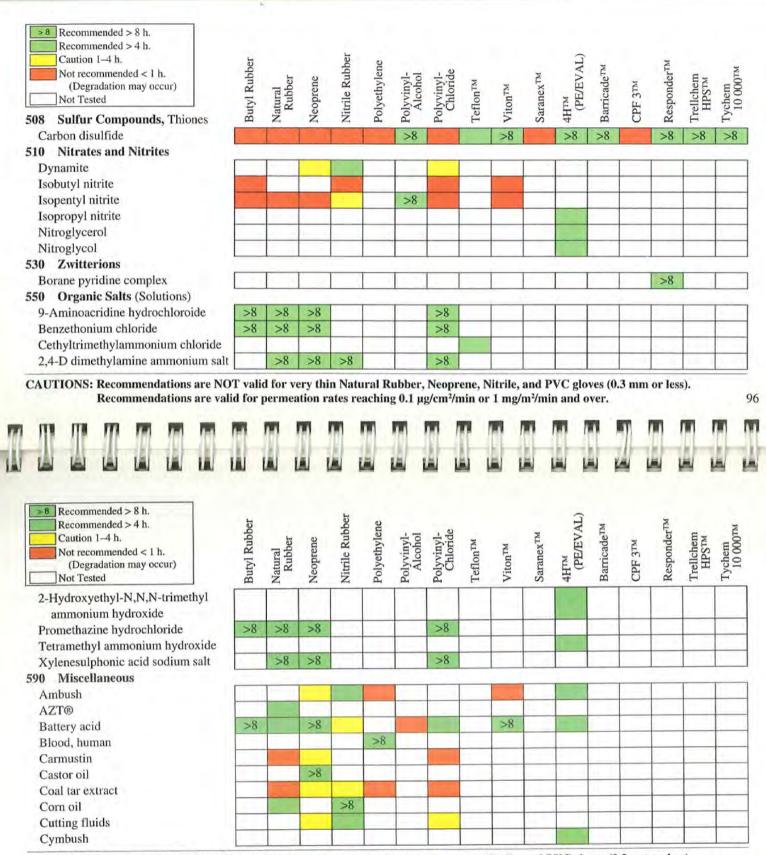




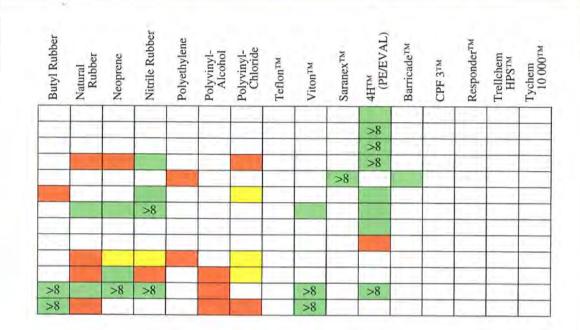








Cypermethrin
Epoxy (base)
Epoxy (accelerator)
Fusilade 250EC
Gasohol
Hydraulic oil
Lubricating oil
Orthocid 83 ®
Pramitol ®
Shale oil
Silicon etch
Water
Witch hazel



CAUTIONS: Recommendations are NOT valid for very thin Natural Rubber, Neoprene, Nitrile, and PVC gloves (0.3 mm or less).

Recommendations are valid for permeation rates reaching 0.1 µg/cm²/min or 1 mg/m²/min and over.

98

SECTION V

Glossary

This section contains the glossary of terms related to the selection and use of chemical protective clothing. The terms are in alphabetical order followed by a brief "common sense" definition in lay language where ever possible.

ABSORB: To suck in or "pick up" a liquid by capillary, osmotic, or chemical action.

ACGIH: American Conference of Governmental Industrial Hygienists. An organization of professionals who work for government or educational institutions. Not an official government body.

ACID: A compound that has a pH of less than seven. Can neutralize an alkali. Very acidic compounds have low pHs.

ACTION LEVEL: The exposure level (air concentration) at which OSHA regulations take effect. Usually one-half of the PEL.

ACUTE EFFECT: The immediate effects on a person normally from a single dose in less than a 24-hour period.

AEROSOL: A fine suspension of a liquid or solid in air with particles small enough to stay suspended.

ALKALI: Any compound that has a pH above seven when dissolved in water. Alkalies are usually oxides and hydroxides of certain metals such as sodium and potassium. Can neutralize acids. Highly alkaline compounds have high pHs.

ANHYDROUS: Without water.

AQUEOUS: Describes a water-based solution or suspension.

ASTM: An organization, founded in 1898, that develops and publishes technical information with an emphasis on consensus test methods. Within ASTM, Committee F23 on Protective Clothing is responsible for the permeation test method and related test methods. ASTM is headquartered in West Conshohocken, PA.

BARRICADETM: A trademark of the DuPont Company for a plastic-like material used in protective clothing.

BASE: Substances that have a pH above seven when dissolved in water. The opposite of an acid on the pH scale. See ALKALI.

BLUE MAXTM: A trade-name plastic laminate material of the MSA Company used in the construction of chemical protective suits.

BOILING POINT: The temperature at which a liquid boils or turns into a gas (vapor pressure equals atmospheric pressure).

BREAKTHROUGH: The movement of a chemical through a protective barrier to the other side.

BREAKTHROUGH TIME: The elapsed time from the start of the test until the first moment that breakthrough is detected.

BUTYL RUBBER: A type of synthetic rubber formed from butylene and isoprene as copolymers; used in gloves and other protective clothing because of its chemical resistance.

CARCINOGEN: A substance capable of causing cancer.

CAS NUMBER: The Chemical Abstracts Service registry number. A unique chemical designator or identifier.

CAUSTIC: See ALKALI.

CEILING EXPOSURE LIMIT: An airborne concentration that is not to be exceeded at any time.

CHALLENGE 5000 AND 6400: Trade-name materials of the Chemfab Company that are of Teflon construction and used for chemical protective suits.

CHEMICAL: Any element, chemical compound, or mixture of elements.

CHEMREL: Trademark of the Chemron Company for its plastic-like material used in protective clothing.

CHLORINATED POLYETHYLENE: Polyethylene (a plastic) that contains chlorine atoms and is used for protective clothing. Sometimes also called CPE.

CHLOROBUTYL RUBBER: A type of butyl rubber that contains chlorine atoms and is used in protective clothing.

CHRONIC EFFECT: An effect normally resulting from multiple exposures received over a period of three months or more, such as the development of sensitization.

100

COATED: Application of a different material to the substrate (e.g., PE-coated spun-bonded olefin).

CONTAMINATION: The presence of any unwanted material or substance on or in PPE, equipment, structures, or the environment.

CORROSIVE: A material that, by chemical action at the site of contact, causes visible destruction or irreversible alterations in living tissue (or that will severely corrode steel).

CPC: Chemical protective clothing.

CPF I, II, III, and IV: A trade name material of the Kappler Company used for the construction of chemical protective suits.

CRYOGENIC: Gases that are cooled to extremely cold temperatures to change them into liquids.

CUMULATIVE PERMEATION: The total amount of chemical that permeates.

DECONTAMINATION: The safe neutralization or removal of a contaminant.

DEGRADATION: A deleterious change in one or more physical properties of protective clothing or equipment due to contact with a chemical.

DERMAL: Affecting the skin (or permeation through the skin).

DETECTION LIMIT: A minimum limit of detection for the challenge chemical when doing permeation testing. For the ASTM F739-91 permeation test it is 0.1 µg/cm²/min.

DIFFUSION: The mixing of one substance into another when separated by a barrier (i.e., movement of the substance on a molecular level across the barrier to the other side).

DIPPED: Application of a liquid coating to a substrate forming another layer (e.g., elastomer-coated cotton gloves) or the method used to form the glove (e.g., latex gloves).

ELASTOMER: A rubber or plastic with elastic characteristics.

ENSEMBLE (CHEMICAL PROTECTIVE SUIT ENSEMBLE): A combination of chemical protective clothing (e.g., suits, boots, gloves) and other protective equipment such as respirators, communication devices, and cooling devices.

EPA: Environmental Protection Agency.

ETHYLENE VINYL ALCOHOL: A plastic-like film with excellent resistance to chemicals used in protective clothing. Also called EVAL.

ETIOLOGIC AGENT: Microscopic organisms (e.g., virus and bacteria) that can cause disease.

EVAL: See ETHYLENE VINYL ALCOHOL

EVAPORATION RATE: The rate at which a material vaporizes (evaporates) from the liquid or solid state. Butyl acetate is the normal standard (rate = 1.0). Fast evaporating rates are above 3.0, while slow rates are below 1.0.

EXTREMELY HAZARDOUS SUBSTANCE: Designation used by the EPA to describe materials that would be highly hazardous to a community in the event of an uncontrolled release.

FABRIC: A flat structure consisting of yarns or fibers.

FEP: Copolymer of tetrafluoroethylenene and hexafluorpropylene, which is a plastic-like material used in protective clothing because of its excellent chemical resistance. Also called Teflon-FEPTM

FIBERGLASS: Fibers of glass usually coated and woven into cloth, as a base material that is used in protective clothing.

FLAME RESISTANT: A material that will not support a flame, as determined by varying testing methods.

FLAMMABLE: A material with a flash point of less than 100°F (new DOT standard is below 140°F).

FLASH POINT: The lowest temperature at which a material will generate enough vapor to ignite, when an ignition source is present.

GAS: A perfectly mobile substance that can infinitely expand, as opposed to a liquid or solid. For example, nitrogen, oxygen, and carbon dioxide are normally gases.

GAS-TIGHT: The ability to hold a gas under pressure within the suit.

GORE-TEXTM: A trademark of the W.L. Gore Company for a material that has water vapor transmission properties (allows some water vapor transmission for cooling) and is used in protective clothing.

4HTM: A trademark of the Safety 4 Company for a film laminate of polyethylene and ethylene vinyl alcohol copolymer used in protective clothing; also sometimes called PE/EVAL.

HAZARD ASSESSMENT: The process whereby the degree of risk to the wearer of the CPC is determined.

HAZARDOUS WASTE: Any discarded or spilled material that is listed as a hazardous waste under RCRA.

HAZWOPER: Acronym for the OSHA standard entitled "Hazardous Waste Operations and Emergency Response." Codified as 29 CFR 1910.120. Designed to protect the health and safety of individuals treating hazardous wastes or performing environmental cleanups or emergency response actions.

102

HEALTH HAZARD: A substance that can have a harmful effect on humans.

HEAT STRESS: The stress on the body from an inability to adequately dissipate heat from environmental conditions (such as protective clothing) and/or work.

HEMATOPOIETIC TOXINS: Substances that are toxic to the blood and blood-forming organs.

HEPATOTOXIN: Substance that is toxic to the liver.

HIGHLY FLAMMABLE: A material with a flash point of less than 25°F.

IARC: International Agency for Research on Cancer.

IDLH: Immediately Dangerous to Life and Health. An atmosphere or condition that poses an immediate threat to life or could produce irreversible, debilitating effects on health. Usually defined based on a 30-minute exposure.

IMPERMEABLE (OR IMPERVIOUS): Not permeable. This is not a term that is technically correct as applied to protective clothing, except in rare circumstances.

INGESTION: Swallowing or eating.

IRRITANTS: Not corrosive, but causing reversible inflammatory effects on living tissue by chemical action at the site of contact.

LAMINATED: A protective material made up of the same or differing barrier layers.

LEVEL A: An EPA designation for the highest level of PPE for emergency response. For protective clothing, this usually includes the use of a gas-tight totally encapsulating ensemble.

LEVEL B: An EPA designation for the next-to-highest level of PPE for emergency response. For protective clothing, this usually includes the use of a chemically resistant splash suit.

LEVEL C: An EPA designation for the next-to-lowest level of PPE for emergency response. For protective clothing, this usually includes the use of a chemically resistant splash suit.

LEVEL D: An EPA designation for the lowest level of protection for emergency response. Typically a work uniform and safety glasses and gloves. May not be worn where respiratory or skin hazards exist.

LOCAL: Effect occurring at the site of contact or entry into the body.

MELTING POINT: The temperature at which a solid turns into a liquid.

MSDS: Material Safety Data Sheet. A document that describes the health and safety hazards associated with a product. It should

also provide information on the selection of protective equipment, spill response, disposal, and other environmental information.

NARCOTICS AND ANESTHETICS: Agents that cause central nervous system depression with possible unconsciousness and death from respiratory arrest. Initial symptoms are often a euphoria rather than depression.

NATURAL RUBBER: Name for the rubber that is naturally derived from trees (gutta percha). A distilled version is called isoprene. Natural rubbers are used in protective clothing, but if untreated offer minimal chemical resistance.

NEAT: A solution or product that is undiluted.

NEOPRENE: A trade name of the DuPont Company for a rubberlike product used in protective clothing. Also called chloroprene.

NEPHROTOXINS: Substances that are toxic to the kidneys.

NEUROTOXINS: Substances that are toxic to the nervous system.

NEUTRALIZATION: The process of lessening the effects of a material by addition of another substance. For example, strong acids can be neutralized by weak bases.

NFPA: National Fire Protection Association.

NITRILE: A type of synthetic rubber used in protective clothing.

NOMEX: A trademark of the DuPont Company for an aramid fiber used as a base material in protective clothing, most notably because of the fire resistance of the fibers.

NORMALIZED: An adjustment to breakthrough time or permeation to standardize the results for thickness.

NUISANCE MATERIALS: Agents that produce transient irritation of eyes, skin, mucous membranes, or respiratory tract. No long-term or systemic effects.

OCCLUSION: The physical process of trapping a hazardous material against the skin, whereby the protective covering (inside the barrier) increases the potential for dermal effects.

ORGANIC: Any chemical derived from carbon or petroleum.

OSHA: Occupational Safety and Health Administration.

OXIDIZER: A material that yields oxygen or may initiate or promote combustion.

OXYGEN DEFICIENT ATMOSPHERE: Any atmosphere that contains less than 19.5% oxygen by volume.

PEL: Permissible Exposure Limit. Legally enforceable exposure limit established by OSHA.

104

PENETRATION: The flow of a chemical on a nonmolecular level, through zippers, stitched seams, and pinholes or other imperfections in chemical protective clothing.

PERMEABILITY: The ability to pass or move into or through a substance or material.

PERMEATION: The process by which a chemical moves through chemical protective clothing on a molecular (nonvisible) level.

PERMEATION RATE: The rate or mass flow of the chemical across the barrier, expressed as mass per unit area per time interval.

PERSONAL PROTECTIVE EQUIPMENT (PPE): The equipment provided to shield or protect an individual from the chemical, physical, or thermal hazards that may be encountered during a response action or work activity.

pH: A logarithmic scale from 0 to 14 that represents the acidity or alkalinity of an aqueous solution. Pure water has a neutral pH of 7.0. A low pH is acidic, while a high pH is alkaline or basic.

POLYETHYLENE: A common and relatively inexpensive plastic material (made of repeating units of ethylene) used in protective clothing or as a coating for protective clothing. Also referred to as PE.

POLYMER: A substance made up of repeating units of one or more chemicals.

POLYVINYL ALCOHOL: A type of plastic (made of repeating units of vinyl alcohol) that has some solubility in water, but very good organic solvent resistance, and is used in protective clothing. Also called PVA, which is a trade name of the Ansell Edmont Company.

POLYVINYL CHLORIDE: A common type of plastic (made of repeating units of vinyl chloride) used in protective clothing. This is the product that is commonly thought of when someone refers to a "plastic."

PPM: Parts per million parts. Usually describes the amount of a vapor or gas in contaminated air.

PROTECTIVE CLOTHING MATERIAL: Any material or combination of materials used in an item of clothing for the purpose of isolating parts of the body from a potential hazard.

PROTECTIVE GLOVE: Glove(s) used for the purpose of protecting the hands and wrist from contact with a potential hazard.

PSI: Pounds per square inch. A unit of pressure.

PTFE: An abbreviation for the polymer polytetrafluoroethylene. Teflon is a trademark for tetrafluoroethylene (TFE).

PYROPHORIC: A material that ignites spontaneously in air at or below 130°F.

RADIOACTIVE: Substances that emit ionizing radiation.

RCRA: Resource Conservation and Recovery Act of 1976. EPA regulation that governs hazardous wastes.

REACTIVE MATERIALS: Substances capable of or tending to react chemically with other substances. These reactions could produce heat or new substances that are dangerous.

REPRODUCTIVE TOXIN: Toxic material that effects male or female reproductive systems or the developing fetus.

RESPIRATORY PROTECTION: Equipment designed to protect the user from the inhalation of harmful or toxic materials.

RESPONDER: A trade name of the Life-Guard Company for material used in protective clothing.

RESPONSE ACTION: The control, containment, confinement, and cleanup of a release to the environment of a toxic or hazardous substance.

ROUTES OF ENTRY: The ways that a toxic material can enter the body. The four major routes of entry are inhalation, absorption (skin contact), ingestion, and injection. SARANEX: A trademark of the Dow Chemical Company for a film laminate (23-P) of polyethylene, polyvinylidene chloride, and ethene-vinyl acetate (EVA). Used as a coating for protective clothing.

SATURATED: The most concentrated solution that can persist in the presence of an excess of the undissolved substance. Abbreviated as SAT.

SBR: Styrene butadiene rubber. A synthetic rubber sometimes used in protective clothing.

SCBA: Self-Contained Breathing Apparatus. A respiratory protection device usually consisting of a tank of compressed air, a pressure regulator, hosing, and a facepiece.

SENSITIZER: A material that can cause an allergic skin or respiratory reaction.

SILVER SHIELD: A trademark of the North Company for a film laminate of a similar composition to the 4H product and also used in protective clothing.

SOLUBILITY: A term that normally expresses the amount of material (as a percentage by weight) that will dissolve in a liquid, such as water at normal temperatures (producing a solution).

106

SPECIFIC GRAVITY: The weight of a substance compared to the weight of an equal volume of water (water = 1).

SPLASH PROTECTIVE SUIT: A one-piece or multiple-piece garment constructed of protective clothing materials and designed to protect the wearer against chemical contact by splash.

STEADY STATE PERMEATION RATE: A constant rate of permeation that occurs after breakthrough when all forces affecting permeation have reached equilibrium.

STEL: Short-Term Exposure Limit. A level above the 8-hour TWA, TLV, or PEL that should not be exceeded for more than 15 minutes four times a shift.

SUBLIME: Change from a solid to a vapor without becoming a liquid (dry ice is an example).

SYSTEMIC: Effect occurring at a site that is remote from the site of contact with or entry into the body.

TEFLONTM: A trademark of the DuPont Company for a plastic-like material (tetrafluoroethylene) that has excellent chemical and thermal resistance properties, but poor physical properties, and is used in combination with other materials in protective clothing (see PTFE).

TLV: Threshold Limit Value. An airborne concentration of a substance and conditions under which it is believed that nearly all

workers may be repeatedly exposed day after day without adverse effects. Recommended exposure limits are revised annually by the American Conference of Governmental Hygienists based on the latest toxicological information.

TLV-SKIN: A substance that may also have a dermal route of entry and that can affect the overall exposure.

TOTALLY ENCAPSULATING CHEMICAL PROTECTIVE SUIT: A full-body garment that is constructed of protective clothing materials and covers all portions of the wearer's body as well as the respiratory protection equipment. "Gas tight" refers to the ability to be pressurized with minimal leakage.

TOXICITY: The inherent ability of a material to do harm to the body.

TOXICOLOGY: The science that deals with the poisonous or hazardous properties of materials.

TOXIC SUBSTANCE: A substance capable of producing adverse (harmful) effects upon contact with, or entry into, the body or the environment.

TRELLCHEM HPS and VPS: Trademark of the Trelleborg Company for materials used in protective clothing.

TYCHEMTM: A trademark of the DuPont Company for a plastic-like material used in protective clothing.

TYVEKTM: A trademark of the DuPont Company for nonwoven polyethylene used in protective clothing.

TWA: Time Weighted Average. The average exposure over a given time period. Normally an 8-hour shift.

VAPOR: The gaseous state of a liquid or solid. For example, water gives off water vapor through evaporation.

VAPOR DENSITY: The weight of a given volume of pure vapor compared to that of dry air (air = 1). A vapor density of less than

one means that a substance is lighter than air and will float upward, while a density greater than one means it will sink downward.

VAPOR PRESSURE: The pressure exerted by vapor above its own liquid in a closed container.

VITONTM: A trademark of the DuPont Company for a rubber-like copolymer of hexafluoropropylene and vinylidene fluoride, used in protective clothing.

WATER SOLUBILITY: The ability of a liquid or solid to mix with or dissolve in water.

108



SECTION VI

Standards for Chemical Protective Clothing

This section contains information on testing and performance standards for chemical protective clothing. It is divided into ASTM, NFPA, and ISO standards.

ASTM Standards

The American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, telephone 610-832-9500 publishes information on standard methods, practices, and guides (the last two digits refer to the year approved) related to the testing, selection, and use of chemical protective clothing. These publications include:

- F739-91. "Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continous Contact"
- F903-95. "Test Method for Resistance of Protective Materials Used in Protective Clothing to Penetration by Liquids"

- F1001-89. "Guide for the Selection of Chemicals to Evaluate Protective Clothing Materials"
- F1052-91. "Practice for Pressure Testing of Gas-Tight Totally-Encapsulating Chemical-Protective Suits"
- F1154-88. "Practice for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical-Protective Suit Ensembles"
- F1186-93. "Classification System for Chemicals According to Functional Groups"
- F1194-89. "Guide for Documenting the Results of Chemical Permeation Testing on Materials Used in Protective Clothing"
- F1296-91. "Guide for Evaluating Chemical Protective Clothing"
- F1301-90. "Practice for Labeling Chemical Protective Clothing"
- F1359-91 "Practice for Determining the Liquid-Tight Integrity of Chemical Protective Suits or Ensembles Under Static Conditions"
- F1383-92. "Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Intermittent Contact"
- F1407-95. "Test Method for Resistance of Chemical Protective Clothing Materials to Liquid Permeation—Permeation Cup Method"
- F1461-93. "Practice for a Chemical Protective Clothing Program"
- F1494-94. "Terminology Relating to Protective Clothing"

NFPA Standards

The National Fire Protection Association, located in Quincy, MA (telephone 800-344-3555), publishes standards in fire safety and protection-related areas. They have established performance standards for chemical protective clothing for use in support areas, for splash protection, and for "Level A" related spill cleanup work. These standards are:

110



- NFPA 1991. "Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies"
- NFPA 1992. "Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies"
- NFPA 1993. "Standard on Protective Suits for Non Emergency, Non Flammable Hazardous Chemical Operations"

ISO Standards

Europe has several country standards setting bodies (e.g., DIN in Germany); however, the overall standards-setting body for the European Economic Community (known as CEN) and ISO standards (International Organization for Standardization) will soon be essentially the same for protective clothing (many of the existing CEN standards are being adopted).

ISO standards for protective clothing are under the jurisdiction of Technical Committee 94, subcommittee 13 on Protective Clothing. The Secretariat for this committee is the Swiss national standards organization, SNV. Their address is SNV, Mühlebachstrasse 54, CH-8008, Zürich, Switzerland. The telephone number is +411 454 5454.

At present, there are only two official standards published that relate to chemical protective clothing. However, there are a large number of proposed standards for protective clothing that are in various stages of development or balloting. The TC94/SC 13 secretariat should be contacted for the most current listing of ISO standards. The two approved standards are:

- ISO 6529-1990. "Protective Clothing for Use Against Liquid Chemicals—Resistance of Materials to Permeation by Liquids"
- ISO 6530-1990. "Protective Clothing for Use Against Liquid Chemicals—Resistance of Materials to Penetration by Liquids"



SECTION VII

Barriers

Manufacturers of Chemical Protective Clothing

Company Name

This section contains a partial listing of manufacturers publishing test results of the resistence of their barrier materials by any standard test method. The manufacturers are listed as "Glove Manufacturers," "Boot Manufacturers," or "Suit Manufacturers." The list contains contact information by manufacturer and type of barrier material. This listing is limited to those barriers shown in section IV and will not include all CPC manufacturers, suppliers, or distributors. It is also important to remember that the listings do not include all product lines, laminates, or blends. Overseas manufacturing contacts are listed for some of the product lines but not all of them (e.g., MSA has sales offices throughout the world). The reader is encouraged to contact the manufacturers for further information. As a last note, inclusion on this list is not an

endorsement by the authors, nor should omission be considered a lack of recommendation.

Glove Manufacturers									
Ansell Edmont Industrial	Natural Rubber								
400 Northridge Rd., Suite 800	Neoprene								
Atlanta, GA 30350	Nitrile								
Tel: (888) 426-3663	PVAL								
Fax: (614) 622-6222	PVC								
Internet: www.industry.net/ansell.edmont	PE								

Ansell Canada, Inc. See Ansell Edmont P.O. Box 120 30 Boul. de l'Aeroport Industrial Reinholds, PA 17569 Bromont, Ouebec J0E 1L0 Tel: (800) 523-8025 Canada Fax: (717) 336-0502 Tel: (514) 538-1850 Comasec Safety, Inc. Butvl Fax: (514) 534-1848 P.O. Drawer 1219 Natural Rubber Ansell Edmont Europe N.V. See Ansell Edmont 8 Niblick Road Neoprene Wiingaardveld 34C Industrial Enfield, CT 06082 Nitrile B-9300 Aalst Tel: (800) 333-0219 **PVAL** Belgium Fax: (860) 741-2207 **PVC** Tel: +32 537 10505 Comasec S.A. see Comasec Fax: +32 537 10181 Route de Muisement Safety, Inc. Best Manufacturing Co. Butyl F-28103 Dreux P.O. Box 8 Natural Rubber France Edison Street Neoprene Tel: +33 374 66840 Menlo, GA 30731-0008 Nitrile Comasec Yate, Ltd. see Comasec Tel: (800) 241-0323 **PVC** Greatwestern Business Park Safety, Inc. Fax: (706) 862-6000 VitonTM Yate Avon, B517 5RF Internet: www.bestglove.com/chemguid.html England Guardian Protective Wear Butyl Tel: +44 454 323633

LRC - Surety Products, Inc. ["Marigold Gloves"] 1819 Main St., P.O. Box 4703

Sarasota, FL 34230 Tel: (800) 733-0987 Fax: (813) 366-9592

550 West Rte 897

London International Group PLC Unit 205, Cambridge Science Park

Cambridge, CB4 4GZ

England

Tel: +44 223 423232 Fax: +44 223 423310 MAPA Professional 512 E. Tiffin Street Willard, OH 44890 Tel: (800) 537-2897 Fax: (800) 537-3299

North Safety Products-Hand Protection

4090 Azalea Drive P.O. Box 70729 Charleston, SC 29405 Natural Rubber Nitrile

Neoprene

See LRC

Natural Rubber Neoprene Nitrile

Butyl Natural Rubber Neoprene Nitrile Tel: (803) 554-0606 Fax: (803) 745-5911

Fax: +44 454 324366

Internet: www.northsafe.com/other.html Pioneer Industrial Products Co.

Figure 1 From Street Figure 2 Figure 2 Figure 2 Figure 3 Figure 3

Playtex Products, Inc. Industrial Gloves Division 300 Nyala Farms Rd. Westport, CT 06880 Tel: (203) 341-4091

Fax: (203) 341-4105 Polyco Ltd Great Cambridge Industrial Estate

Lincoln Road Enfield, EN1 1SH England

Tel: +44 181 4433388 Fax: +44 181 8049945 PVC VitonTM

Natural Rubber Neoprene Nitrile PVC

Natural Rubber Neoprene

Natural Rubber Neoprene Nitrile PVC

Safety 4 "4H Glove" Safety 4 A/S

P. O. Box 238 DK-2800 Lyngby

Denmark

Tel: +45 459 30957 Fax: +45 459 31518

Safety 4 Inc.

9765 Widmer Bldg. 5 Lenexa, KS 66245 Tel: (913) 492-0860 Fax: (913) 492-0584

Boot Manufacturers

Bata Shoe Company, Inc. 4501 Pulaski Highway P.O. Box 479 Belcamp, MD 21017

Tel: (410) 272-20001

Fax: (301) 272-3346

Distributed by Ansell Edmont

PE/EVAL

See Safety 4 A/S

Nitrile **PVC**

E-mail: 620@belcamp.bata.com

Internet: www.bata.com

Suit and Suit Material Manufacturers

Chemical Fabrics Corp.

P.O. Box 1137

Merrimack, NH 03054 Tel: (603) 424-9000 Fax: (603) 424-9012

Draeger Aktiegesellschaft Moislinger Allee 53/55

2400 Lubeck 1 Germany

Tel: +49 451 8822658 Fax: +49 451 8822080

National Draeger Inc. 101 Technology Drive

Pittsburgh, PA 15230 Tel: (800) 922-5518 Fax: (412) 787-2207

Internet: www.national.draeger.com

Teflon

Butyl

VitonTM

See Drager

PE

Butyl

Neoprene

VitonTM

Aktiegesellschaft

116

E.I. du Pont de Nemours & Co., Inc. Fibers Dept., Laurel Run Building

P.O. Box 80 705 705 Centerville Road

Wilmington, DE 19880-0705

Tel: (800) 448-9835 Fax: (302) 999 4763

Internet: www.dupont.com/tyvek/protective-apparel

Fairprene Industrial Products Co., Inc.

85 Mill Plain Road Fairfield, CT 06430 Tel: (203) 259-3351 Fax: (203) 254-2481

Kappler Safety Group

P.O. Box 27

Guntersville, AL 35976 Tel: (800) 633-2410 Fax: (205) 582-2706

Internet: www.kappler.com:80/main.html

Europe Kappler, Ltd. Kapplerclose

Chlorobutyl Neoprene

BarricadeTM

CoatedTyvekTM

Tychem 10 000TM

PE/SaranexTM

Butyl CPF 3TM Neoprene

ResponderTM

See Kappler Safety Group

Tel: +44 737 642000 Fax: +44 737 642129

Nedenfield, Nottingham, NG4 2PT

England

Tel: +44 602 618182 Fax: +44 602 615676

Molnlycke Tissue AB S-405 03 Göteborg

Sweden

Tel: +46 316 79500 Fax: +46 318 77792

MSA

Mine Safety Appliances Co.

P.O. Box 426 Pittsburgh, PA 15230

Tel: (800) 672-2222 Fax: (412) 967-3460

Internet: www.msanet.com/safetyproducts

Respirex Ltd. Butyl

Neoprene P.O. Box 6 **PVC** Redhill, Surrey RH1 3LX VitonTM England

Standard Safety Equipment Co.

1407 Ridgeview Drive McHenry, IL 60050

Tel: (815) 363-8565

Fax: (815) 363-8633

Trelleborg AB

Protective Products Division

23181 Trelleborg

PVC

Butyl

VitonTM

HРS™

Sweden

Tel: +46 410 14289

Fax: +46 410 16059

Trelleborg Viking, Inc.

170 West Road, Suite 1

Portsmouth, NH 0381

Tel: (603) 436-1236

Fax: (603) 436-1392

See Trelleborg AB



