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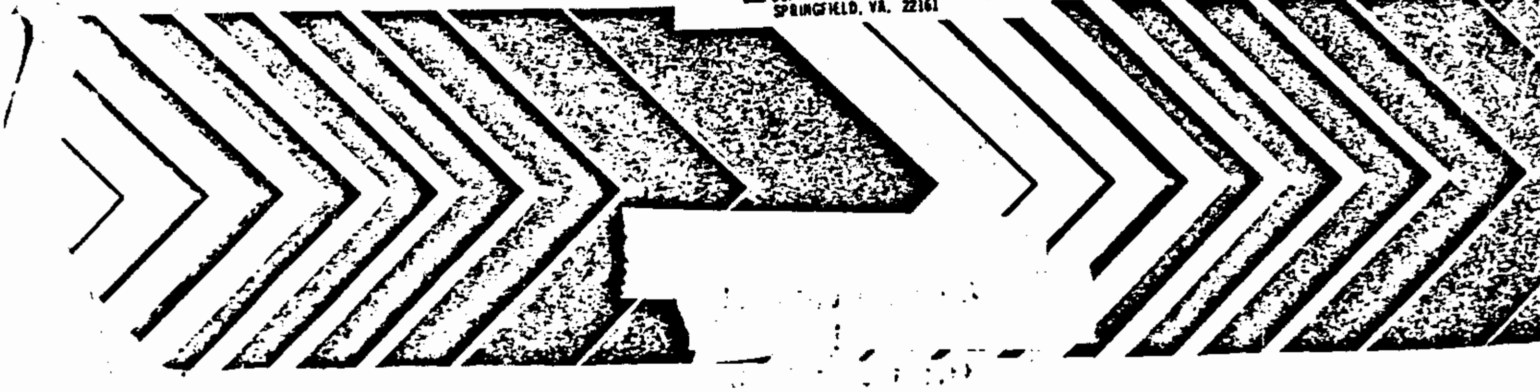
A Method for Determining the Compatibility of Hazardous Wastes



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16. ABSTRACT

This report describes a method for determining the compatibility of the binary combinations of hazardous wastes. The method consists of two main parts, namely: 1) the step-by-step compatibility analysis procedures, and 2) the hazardous wastes compatibility chart. The key element in the use of the method is the compatibility chart. Wastes to be combined are first subjected through the compatibility procedures for identification and classification, and the chart is used to predict the compatibility of the wastes on mixing.

The chart consists of 41 reactivity groups of hazardous wastes designated by Reactivity Group Numbers (RGN). The RGN are displayed in binary combinations on the chart, and the compatibility of the combinations are designated by Reaction Codes (RC).

The method is applicable to four categories of wastes based on available compositional information: 1) compositions known specifically, 2) compositions known nonspecifically by chemical classes or reactivities, 3) compositions known nonspecifically by common or generic names of wastes, 4) compositions unknown requiring chemical analysis.

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A METHOD FOR DETERMINING THE COMPATIBILITY OF HAZARDOUS WASTES

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DISCLAIMER

FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimonies to the deterioration of our natural environment. The complexity of that environment and the interplay of its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution; it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems to prevent, treat, and manage wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, to preserve and treat public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research and provides a most vital communication link between the researcher and the user community.

This study involved the development of a method for determining the compatibility of binary combinations of hazardous wastes. A literature study was conducted of case histories of accidents caused by the combinations of incompatible wastes, industrial wastestream constitutents, hazardous chemical data, and basic chemical reactions. Based on this study, the compatibility method was developed.

The method consists of a step-by-step compatibility analysis procedure and a compatiblity chart. The chart is the key element in the use of the method. Wastes to be mixed or combined are first subjected, through the compatibility analysis procedure, to identification and classification, and the chart is used to predict the compatibility of the wastes on mixing.

The method will be useful in the regulation and management of hazardous wastes. It finds its usefulness most in determining the types of wastes that may be mixed for economic gains and in predicting adverse reaction consequences that can inflict damage to life, property, and the environment.

Francis T. Mayo, Director
Municipal Environmental
Research Laboratory

PREFACE

The enactment of the Resource Conservation and Recovery Act of 1976 was in response to the increasing attack upon the nation's environment by the ever-expanding volume of hazardous wastes that are disposed of to the land. This legislation has charged the U.S. Environmental Protection Agency (EPA) with the responsibility of setting up a total management system for hazardous wastes with the goal of minimizing the impact of these wastes upon the public health and the environment and on the conservation of national material and energy resources.

The development of such a management system requires extensive information on waste producing processes, waste chemical compositions, and physical/chemical characteristics, as well as the best available recovery and disposal technologies. There are many ways in which hazardous wastes may inflict damage to public health and the environment. These are long-term contamination of ground and surface water, pollution of the air by volatile materials and dusts, and extensive contamination of usable land. However, one of the more immediate and disastrous impacts results when waste products undergo violent and toxin-producting chemical reactions which kill or maim humans and/or destroy property. These reactions most often occur because waste handlers have either an inadequate knowledge of chemical compositions or of how the chemical components of different waste types interact. The objectives of this report are to:

1) Present the chemical reactions that are likely to produce significant hazards to waste handlers and the environment.

2) Present a listing of chemical classes based on molecular structure and chemical reactivity that typically occur in wastes.

3) Provide guidelines for estimating which chemical classes occur in specific wastestreams.

4) Provide a method for estimating the potential consequences of mixing of different classes of wastes.

The best available knowledge of wastestream composition, chemical thermodynamics, and reaction consequences was used to prepare the report. However, during its preparation, the authors became aware of many areas where existing knowledge was inadequate to make reasonably valid determinations. These areas of poor data or background information are noted wherever possible in the report.

This document should be considered an interim report on the study of waste interaction. The authors, with the support of the EPA, have begun actual laboratory investigations of waste compositions and of interactions between real wastestreams, and subsequently a final report will be prepared.

It is the authors' sincere hope that those in the waste management industry as well as the waste regulatory agencies, will find this report useful in reducing the risk to the public health and the environment in the handling, processing, treatment, and disposal of hazardous wastes.

ABSTRACT

This report describes a method for determining the compatibility of binary combinations of hazardous wastes. The method consists of two main parts, namely: 1) the step-by-step compatibility analysis procedures, and 2) the hazardous wastes compatibility chart. The key element in the use of the method is the compatibility chart. Wastes to be combined are first subjected through the compatibility procedures for identification and classification, and the chart is used to predict the compatibility of the wastes on mixing.

The chart consists of 41 reactivity groupings of hazardous wastes designated by Reactivity Group Numbers (RGN). The RGN are displayed in binary combinations on the chart, and the compatibility of the combinations are designated by Reaction Codes (RC).

The method is applicable to four categories of wastes based on available compositional information: 1) compositions known specifically, 2) compositions known nonspecifically by chemical classes or reactivities, 3) compositions known nonspecifically by common or generic names of wastes, 4) compositions unknown requiring chemical analysis.

The report is intended for use in many aspects of the management of hazardous wastes. The compatibility information that it provides can be used to determine which wastes can or can not be mixed for economic purposes or to prevent or minimize adverse reaction consequences.

The report is the result of a literature study of case histories of accidents caused by the combinations of incompatible wastes, industrial wastestream constituents and hazardous chemical data, and basic chemical reactions.

This report is submitted in partial fulfillment of Research Grant No. R804692010 by the Hazardous Materials Management Section and the Hazardous Materials Laboratory of the California Department of Health Services under the sponsorship of the Municipal Environmental Research Laboratory of the U.S. Environmental Protection Agency. This report covers a period from September, 1976 to September, 1978, and work was completed as of September, 1978.

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ACKNOWLEDGMENT

Special acknowledgment is given to the project officer of this study, Richard A. Carnes of the U.S. Environmental Protection Agency, Municipal Environmental Research Laboratory, for his assistance and guidance. Acknowledgment is also given to Dr. Paul H. Williams of the Hazardous Material Management Section for his contributions in the refinement of the hazardous waste compatibility chart.

SECTION 1

INTRODUCTION

The Resource Recovery and Conservation Act of 1976 (PI 94-580) defines hazardous waste as solid waste or a combination of solid wastes which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause or contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. The law also defines solid waste to mean not only solids but also liquids, semisolids, and contained gaseous materials.

The "combination of solid wastes" part of the definition often presents problems in many aspects of the management of hazardous wastes. In some instances, the combination or mixture of two or more types of the wastes produces undesirable or uncontrolled reactions resulting in adverse consequences. These reactions may cause any one or more of the following: 1) heat generation, 2) fire, 3) explosion, 4) formation of toxic fumes, 5) formation of flammable gases, 6) volatilization of toxic or flammable substances, 7) formation of substances of greater toxicity, 8) formation of shock and friction sensitive compounds, 9) pressurization in closed vessels, 10) solubilization of toxic substances, 11) dispersal of toxic dusts, mists, and particles, and 12) violent polymerization. In this report, such reactions are called incompatible reactions and the reacting wastes are called incompatible wastes.

In the review of the literature and surveys of hazardous waste management practices, several adverse reaction consequences resulting from the mixing of incompatible hazardous wastes have been noted. These consequences have caused serious accidents involving extensive damage to property, equipment, vegetation, and environment and/or injury or death to man, and other living things. Analysis of the case histories of the accidents (Appendix 5) indicates that such accidents resulted from three primary causes.

The first primary cause is the insufficiency or inaccuracy of information about the wastes (Appendix 5, Case History (CH) Nos. 2,5,6,7,9,11,12,16,18,19,21,22). Hazardous wastes are often complex mixtures of chemicals. To define them usually requires laboratory analysis which is expensive and thus often not performed. Waste generators may not maintain adequate records of the components of their wastestreams. In some cases, information about certain wastestreams are deleted or altered to reduce the cost of disposal. Still, in some instances, the properties of some wastes change with time and temperature, potentially producing more hazardous and unknown components. Persons handling the wastes often are ignorant of or pay little attention to the inherent hazardous properties of the wastes.

The second primary cause of the accidents is indiscriminate handling of the wastes. Often supposedly empty containers actually contain hazardous residues that result in adverse consequences when reused (CH Nos. 2, 20, 21, 23). Haulers uninformed of hazardous chemical interactions often top off their loads on the way to the disposal sites, initiating violent reactions that often result in disastrous consequences (CH Nos. 1, 23). Clandestine transfers of wastes into disposal sites without attendant operators have resulted in accidents (CH No. 9). Rough handling of waste containers have resulted in the rupture or leakage of highly reactive materials (CH No. 16). Inadvertent mixing of two or more types of incompatible wastes in one vessel have resulted in hazardous consequences (CH No. 10). Uncontrolled reactions have been known to result from inadequately designed chemical treatment processes for purposes of detoxification or resource recovery (CH No. 22).

The third primary cause of the accidents is indiscriminate disposal practices. Incompatible bulk wastes have been indiscriminately mixed at disposal sites. Wastes that are incompatible with the composition of the disposal areas have been noted at disposal sites such as sanitary landfills, mine openings, injection wells, and burial cells (CH Nos. 3, 4, 7, 15). Often the inexpensive or unwanted containers used to contain wastes for disposal readily rupture or leak (CH Nos. 13, 24). Containerized wastes irrespective of contents often are co-disposed and hazardous reactions result when the containers rupture or leak because of corrosion and the wastes mix (CH Nos. 7, 8, 9, 14).

The method of determining waste compatibilities described in this report was developed on the principal assumption that wastes interactions are due to the reactions produced by the pure chemicals in the wastes. Included in this assumption is the condition that the chemicals react at ambient temperature and pressure and that their reactivities are uninfluenced by concentration, synergistic and antagonistic effects. In this assumption, the compatibility of a combination of wastes can be predicted by the reactivities of the chemical constituents in the respective wastes.

Available data indicate that hazardous wastes are ill-defined and consist of complex mixtures generated by a great variety of sources. No two types of wastes appear to be identical. Even a single process appears to produce different types of wastes. Laboratory analyses of wastes seem to be non-existent or very cursory because of high costs and the complexity of required analytical methods. Characterization of the wastes by the analysis of the processes and the materials used appear to give inaccurate descriptions of the resulting wastes. The data indicate that each waste is unique and individual reactivities may be best assessed by identifying respective chemical constituents. This information supports the pure chemical approach used in determining the reactivities of the wastes in the development of the compatibility method.

For convenience in referencing when using the compatibility method, the pure chemicals known or expected to be present in hazardous wastes are classified under 41 different Reactivity Group Numbers (RGN) based on molecular functional groups or chemical reactivities.

ORGANIZATION OF THE REPORT

The report is organized into three main sections (Section 4 to 6) and supplemented by five appendices (Appendices 1 to 5).

Section 4 is the method for determining the compatibility of binary combinations of most hazardous wastes. The section includes the application and limitation of the method, the compatibility reaction criteria and Reaction Codes (RC), the step-by-step procedures, compatibility analysis flow chart, and typical examples of how to determine compatibilities based on available information.

Section 5 contains the description and use of the hazardous wastes compatibility chart. The chart is used to predict the potential adverse reaction consequences when two types of wastes are mixed or allowed to come in contact with one another. In the same section are the explanations of the multiple RC used to designate the adverse reaction consequences and the limitations of the use of the chart.

The last part of the handbook consists of the five appendices. Appendix 1 lists the chemical substances known or expected to be present in hazardous wastestreams. The list was compiled from a literature search and surveys of hazardous wastes practices. The list is used to obtain RGN of waste constituents when the composition of wastes are known specifically.

Appendix 2 lists hazardous wastes by molecular functional groupings or classes and by chemical reactivities. The list was compiled from the same sources as used in Appendix 1. The appendix is used to obtain the RGN of wastes when the composition is known nonspecifically by chemical classes or reactivities only.

Appendix 3 compiles an industry index against Standard Industrial Classification (SIC) code number and lists wastestreams by common or generic names. The two lists are used to obtain the RGN of wastes when the compositions are known nonspecifically by common or generic names only.

Appendix 4 outlines the potential adverse reaction consequences predicted in the Hazardous Wastes Compatibility Chart (Figure 6). The appendix identifies the binary combinations of wastes by RGN and describes the corresponding potential incompatible reaction consequences. The reaction consequences were compiled from the same references as used in Appendix 1 and from basic chemical reactions.

Appendix 5 consists of some documented case histories of accidents caused by the mixing of incompatible hazardous wastes. The information from these cases was used as basic reference in the development of the Hazardous Wastes Compatibility Chart and the list of binary wastes reactions in Appendix 4.

SCOPE, APPLICATIONS AND LIMITATIONS OF THE REPORT

The report provides a systematic method for determining the compatibility of most binary combinations of hazardous wastes produced by industry and agriculture. Additionally, the report provides a list of compounds known or expected to be present in hazardous wastes. Lastly, the report classifies the compounds as well as the wastes into chemical reactivity groupings and lists the potential adverse reaction consequences of most incompatible binary combinations of the groupings.

This report will be a useful reference in the management of hazardous wastes. It will be useful to the waste generators in identifying and segregating their wastes for disposal; to the transporters for segregating, combining, and/or proper containerizing of the wastes; to the site operators for determining co-burial of containerized wastes in the same cell or co-ponding of bulk wastes; to the regulatory agencies for determining suitability of sites for disposal of certain wastes; and to those who perform chemical treatment of the wastes for purposes of detoxification or resource recovery to prevent possible uncontrolled reactions.

This report cannot be used to predict all the potential incompatible reactions of any two given wastes, and neither can it furnish information on all hazardous wastestreams because of the tremendous variety of waste types, constituents, and characteristics. Additionally, the report does not address ternary combinations of incompatible hazardous wastes.

SECTION 2

CONCLUSIONS

An extensive review of the literature and surveys of hazardous waste management practices has shown that adverse reactions can result from the mixing or combination of incompatible hazardous wastes. These reactions have been categorized into twelve classes on the basis of reaction products with the potential of causing public health and environmental damage. The twelve classes are: 1) heat generation, 2) fire, 3) gas formation, 4) formation of toxic fumes, 5) generation of flammable gases, 6) volatilization of toxic or flammable substances, 7) formation of substances of greater toxicity, 8) production of shock and friction-sensitive compounds, 9) pressurization in closed vessels, 10) solubilization of toxic substances, 11) dispersal of toxic dusts, mists, and particles, and 12) violent polymerization.

Three primary causes of the combination of incompatible wastes were identified, namely:

1) Insufficiency or inaccuracy of information about the wastes,

2) Indiscriminate handling of the wastes, and

3) Indiscriminate waste disposal practices.

In order to prevent and/or minimize the chances of combining incompatible hazardous wastes and to avoid the resulting adverse reactions, it was concluded that a method of determining waste compatibility is necessary. Such a method was developed for the binary combinations of waste types. A compatibility method addressing ternary or more combinations was considered but found to be unwieldy. In the binary method the potential for occurrence of any one of the twelve identified reactions was taken as an indication of incompatibility. The determination of the occurrence of incompatible reactions was based on the assumption that the waste reactions are results of pure chemical components of the wastes reacting at ambient temperature and pressure. These assumptions are made primarily for reasons of simplification; however, it is believed that they are justified in view of most disposal and transport situations.

The development of the step-by-step procedures for the compatibility method required the assignment of waste components into reactivity groups based on molecular functionality and reactivity characteristics. Using this procedure, it was found that the reactivity group(s) of the components of one waste paired with the reactivity groups of another waste could predict the potential occurrence of certain incompatible reactions. A two-dimensional graphic display was determined as the best method for presenting the reactivity groups and allowing intergroup pairing. This resulted in the development of the compatibility chart presented in Figure 6 of Section 5. Color coding of group pairings can be added to aid in rapid determination of potential incompatibilities.

A primary conclusion that was reached from this work was that there is a dearth of information about the reactivities of chemicals in the complex matricies of wastes. Many factors assuredly do greatly influence waste component reactions. Among these are temperature, catalytic effects of dissolved or particulate metals, soil reactions, and reactions with surfaces of transport vehicles or containers. The simplified compatibility methodology that has been developed in this study, however, should provide a useful aid to persons involved in generating, transporting, processing, and disposing of hazardous wastes if reasonable precaution is taken in its use.

SECTION 3

RECOMMENDATIONS

The incompatible reactions predicted for the different binary combinations of hazardous wastes in the hazardous wastes compatibility chart are based on a literature search and consideration of basic chemical reactions only. The reactions should be validated using actual wastestreams where possible. The reactions designated by the reaction code "U" on the chart, which means potential adverse reaction consequence may occur but little information is available in the literature, should be investigated. The multiple reaction codes on the chart should also be further investigated to determine the validity of the given order of occurrences of the incompatible reactions, and the possible occurrences of additional reaction consequences.

Additional investigation is recommended to determine the possibility of consolidating the present 41 reactivity groupings of the wastes to a smaller number based on general reactivity characteristics alone, instead of on both molecular functional groups and reactivities.

It is also recommended that a field test apparatus for determining waste reactivities be investigated. This apparatus can be extremely useful in the management of hazardous wastes.

SECTION 4

METHOD FOR DETERMINING COMPATIBILITY OF HAZARDOUS WASTES

APPLICATION

This method is used to determine the compatibility reactions of most binary combinations of most hazardous wastes. The method is applicable to four categories of wastes based on information available, namely: 1) compositions unknown, 2) compositions known specifically, 3) compositions known nonspecifically by chemical classes or reactivities, and 4) compositions known nonspecifically by common or generic names only.

The method starts with a compatibility analysis flow chart (Figure 1) indicating the analysis pathways for the four categories of wastes above, followed by the compatibility reaction criteria and the stepwise precedures for determining compatibility.

COMPATIBILITY REACTION CRITERIA

The reactions between binary combinations of wastes are NOT COMPATIBLE according to this method when the following undesirable and hazardous consequences are produced:

Reaction Codes (RC)	Reaction Consequences
H	Generates heat by chemical reaction
F	Produces fire from extremely exothermic reactions, ignition of reaction mixtures or of the reaction products.
G	Generates innocuous gases such at N_2, CO_2, etc. but can cause pressurization and rupture of closed containers
GT	Generates toxic gases such as HCN, H_2S, etc.
GF	Generates flammable gases such as H_2, C_2H_2, etc.
E	Produces explosion due to extremely vigorous reactions or reactions producing enough heat to detonate unstable reactants or reaction products.
P	Produces violent polymerization resulting in the generation of extreme heat and sometimes toxic and flammable gases.
S	Solubilizes toxic substances including metals

The RC are used in the compatibility chart (Figure 6) to denote the potential hazardous reaction consequences that can result from the binary combinations of the wastes.

PROCEDURES FOR DETERMINING COMPATIBILITY

Five main steps are required in the step-by-step procedures for determining the reaction compatibility of any Wastes A and B. The procedures are conducted with reference to Figure 1 (Flow Diagram for Determining Hazardous Wastes Compatibility), Figure 6 (Hazardous Wastes Compatibility Chart), Appendix 1 (List of Chemical Compounds), Appendix 2 (List of Wastes Constituents by Chemical Classes and Reactivities, and Appendix 3 (List of Wastestreams by Common or Generic Names).

Step 1: Obtain as much information as possible about the history and compositions of the wastes. Such information can usually be obtained from the records of the waste producers, the manifests that accompany the wastes and examination of the processes that produced the wastes. When no information is available, collect representative samples of the wastes and submit them for analysis. The analysis should provide information on the specific chemical constituents or classes of compounds in the wastes.

Step 2: Starting with Waste A, list down on the worksheet (Figure 2) on the column for Waste A, the chemical names or classes of compounds in the waste or the generic names of the waste. The composition of the waste is Known Specifically when the constituents are listed by chemical names such as ethylene glycol, sodium nitrate, etc.; Known Nonspecifically by classes when the constituents are identified only by chemical classes or reactivities such as alcohols, caustics, mercaptans, etc. The waste is Known Nonspecifically by generic names when classified as spent caustic, tanning sludge, copper plating waste, etc.

Step 3: When the composition of Waste A is Known Specifically by chemical names, consult Appendix 1. Find the chemicals in the list and note down their respective Reactivity Group Numbers (RGN) in the Worksheet. If a chemical component is not listed in Appendix 1, look for its synonym(s) (Ref. 7, 14, 21, 30, 32, 37, 41, 54, 59, 69, 70, 76) and note down its RGN (Section 4.4, Example 1, Note 2). When no synonym can be found, the RGN of the component may be alternatively determined based on its chemical class or reactivity (Section 4.4, Example 1, Note 3).

When the composition of the waste is Known Nonspecifically by chemical classes or reactivities only, consult Appendix 2 and note down the corresponding RGN on the Worksheet (Section 4.4, Example 2).

When the composition of the waste is Known Nonspecifically but classified by common or generic names, consult Appendix 3 and note down the RGN in the Worksheet (Section 4.4, Example 3).

Step 4: Repeat steps 2 and 3 for Waste B and list down the information on the column for Waste B on the Worksheet.

Step 5: Consult the Hazardous Wastes Compatibility Chart in Section 5 and determine the Reaction Codes (RC) between any binary combinations of RGN of Wastes A against

B. Note all RC on the Worksheet. If no RC are listed, Wastes A and B are compatible and vice versa.

SPECIFIC EXAMPLES

The following examples illustrate the stepwise procedures for determining the compatibility of hazardous wastes:

Example 1 - Composition Known Specifically

Step 1: The manifests identify the constituents of the wastes specifically as follows:

Waste A contains ethylene glycol, chhlorobenzene, and hydrochloric acid.

Waste B contains isooctane and sodium sulfide.

List the components of Waste A on the column for Waste A on the Worksheet (Figure 2). Consult Figure 1 and follow the compatibility flow diagram for Composition Known Specifically.

Step 2: Find the RGN of the components ethylene glycol, chlorobenzene and hydrochloric acid in Appendix 1. Thus, the RGN for the components are: ethylene glycol - 4, chlorobenzene - 17, and hydrochloric acid - 1.

Step 3: Record the RGN of the components on the Worksheet.

Step 4: List the components of Waste B on the column for Waste B on the Worksheet. Repeat steps 2 and 3 for Waste B. thus, the RGN of the components of Waste B are as follows: Isooctane-29, and sodium sulfide-33.

Step 5: Pair up each listed RGN of Waste A against that of Waste B. Hence the following pairs are possible: 4 & 29, 4 & 33, 17 & 29, 17 & 33, 1 & 29, 1 and 33. For each pair, find the Reaction Codes (RC) in the Hazardous Wastes Compatibility Chart (Figure 6). Record the corresponding RC for each pair in the Worksheet. Note that the RC for all binary combinations of RGN for wastes A and B are blank except for RGN 1 & 3 which are GT GF. The completed Worksheet is shown in Figure 3.

Conclusion: Waste A is incompatible with Waste B. Potential hazard of toxic (GT) and flammable (GF) gas formations are indicated if the wastes are mixed.

NOTE 1: If Waste A contains a water reactive constituent (RGN 107) and Waste B contains an aqueous component, then water (RGN 106) should be listed as one of the hazardous components for Waste B in Step 1.

NOTE 2: If a chemical constituent is not listed in Appendix 1, its synonym(s) can be obtained from chemical references (Ref. 7, 14, 21, 30, 32, 37, 41, 54, 59, 69, 70, 76) and used to determine its RGN. For example, Pyranton is a chemical not listed in Appendix 1. By consulting the Merck Index (Ref. 54), the synonym for this chemical is diacetone alcohol which is listed in Appendix 1 with RGN of 4 and 19. Thus, the compatibility of this compound with other waste constituents can be established in the same way as Example 1.

NOTE 3: When a synonym for an unlisted compound cannot be found, the RGN under which it is listed may be derived by molecular functional groups or chemical reactivity. For example, isobutyl carbinol is not listed in Appendix 1. The Merck Index (Ref. 54), however, lists the compound as an alcohol. Therefore, by consulting Appendix 2, isobutyl carbinol may be classified under RGN 4. When the compound contains more than one functional groups, all applicable RGN must be identified. A compound like peroxosulfuric acid is not listed in Appendix 1. This compound, however, is known to be a strong mineral acid as well as a very powerful oxidizing agent. Therefore, the compound may be classified under RGN 2.

Example 2 - Composition Known Nonspecifically by Chemical Classes or Reactivities.

Step 1: The manifests identify the wastes constituents as follows:

Waste A contains toxic metals, aldehydes and alcohols.

Waste B contains toxic metals and oxidizing agents.

List the components of Waste A on the column for Waste A on the Worksheet (Figure 2). Consult Figure 1 and follow the compatibility flow diagram for composition Known Nonspecifically by Chemical Classes or Reactivities.

Step 2: Find the RGN for toxic metals, aldehydes and alcohols in Appendix 2. Thus, the RGN for the components are: toxic metals - 24, aldehydes -5, and alcohols - 4.

Step 3: Record the RGN of the components on the Worksheet.

Step 4: List the components of Waste B in the column for Waste B on the Worksheet. Repeat steps 2 and 3 for Waste B. Thus, the RGN for the components of Waste B are: toxic metals - 24 and oxidizing agents - 104.

Step 5: Determine the compatibility of Waste A and B in the same manner as in Step 5 of Example 1. The completed Worksheet for this example is shown in Figure 4.

Conclusion: Waste A is incompatible with Waste B. Potential for heat and fire generations (H_F) are indicated if the wastes are mixed.

Example 3 - Composition Known Nonspecifically by Common or Generic Names of Wastes

Step 1: The manifests describe the wastes as follows:

Waste A is a metal plating waste.

Waste B is a pectin waste from the production of citrus products.

List the generic name of Waste A on the column for Waste A on the Worksheet (Figure 2). Consult Figure 1 and follow the compatibility flow diagram for composition Known Nonspecifically by Common or Generic Names of Waste.

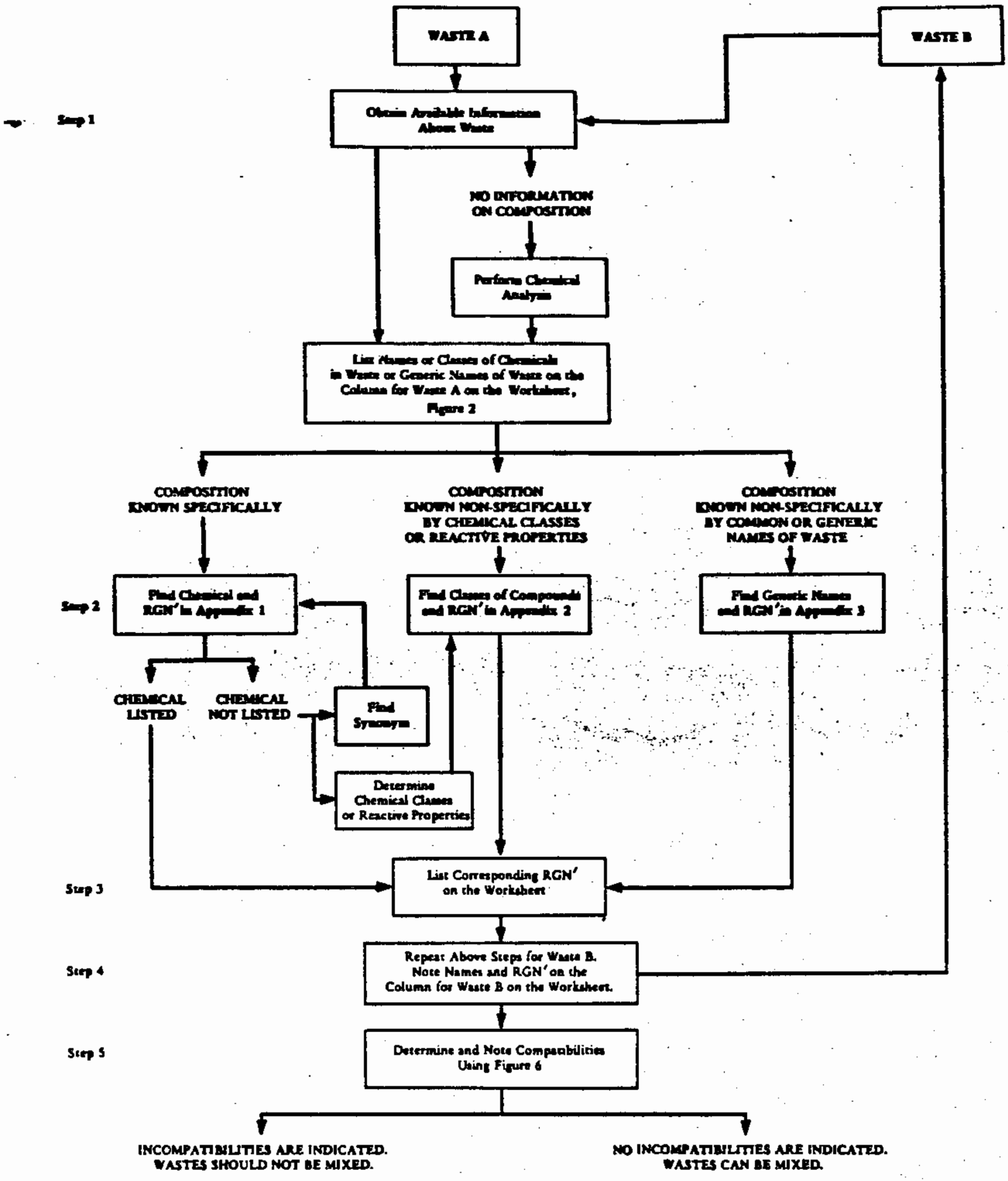
Step 2: Find the RGN of "metal plating waste" according to Appendix 3. The RGN for this generic waste are 11 and 24.

Step 3: Enter the RGN of Waste A on the Worksheet.

Step 4: Enter the waste generic name of "Citrus Pectin Waste" on the column for Waste B on the Worksheet. Repeat steps 2 and 3 above for Waste B. Thus, the most likely RGN for this generic waste are 1 and 4.

Step 5: Determine the compatibility of Waste A and B in the same manner as in Step 5 of Example 1. The completed Worksheet for this example is shown in Figure 5.

Conclusion: Waste A is incompatible with Waste B. Potential hazards of toxic and flammable gas formations (GT_{GF}) are indicated if the wastes are mixed. Also solubilization (S) of metals may occur.



Note: 1. Reactivity Group Numbers

Figure 1. Flow diagram for determining hazardous waste compatibility.

Waste A ____________________ Source ______________

Waste B ____________________ Source ______________

Name of Waste Evaluation ____________________ Date __________

	WASTE B Name								
	Reactivity Group No.								
WASTE A									
Name	Reactivity Group No.								

Note: Refer to Figure 6 for the definitions of the Reaction Code entered on the squares of this worksheet.

Figure 2. Worksheet for determining hazardous waste compatibility.

EXAMPLE 1

Waste A ______________________ Source ______________

Waste B ______________________ Source ______________

Name of Waste Evaluation ______________________ Date __________

WASTE A		WASTE B							
	Reactivity Group No.	29	33						
	Name	Isooctane	Sodium Sulfide						
Name	Reactivity Group No.								
Ethylene Glycol	4								
Chlorobenzene	17								
Hydrochloric Acid	1		GT GF						

Note: Refer to Figure 6 for the definitions of the Reaction Code entered on the squares of this worksheet.

Figure 3. Completed worksheet for determining hazardous waste compatibility when the wastestream compositions are known specifically.

EXAMPLE 2

Waste A ______________________ Source ______________

Waste B ______________________ Source ______________

Name of Waste Evaluation ______________________ Date __________

WASTE B

WASTE A

Name	Reactivity Group No.	24 Toxic Metals	104 Oxidizing Agent						
Toxic Metals	24								
Aldehydes	5		H_F						
Alcohols	4		H_F						

Note: Refer to Figure 6 for the definitions of the Reaction Code entered on the squares of this worksheet.

Figure 4. Completed worksheet for determining hazardous waste compatibility when the wastestream compositions are known non-specifically by chemical classes.

EXAMPLE 3

Waste A ______________________ Source ______________

Waste B ______________________ Source ______________

Name of Waste
Evaluation ______________________ Date __________

WASTE A	WASTE B								
	Name	Pectin Waste							
	Reactivity Group No.	4	1						
Name	Reactivity Group No.								
Metal Plating Waste	11		GT GF						
	24		S						

Note: Refer to Figure 6 for the definitions of the Reaction Code entered on the squares of this worksheet.

Figure 5. Completed worksheet for determining hazardous waste compatibility when wastestream compositions are known non-specifically by generic names.

SECTION 5

HAZARDOUS WASTES COMPATIBILITY CHART

INTRODUCTION

The chart (Figure 6) is the single most important part of this report. It is a quick and ready reference for determining the compatibility reactions of most binary combinations of hazardous wastes. It is used in conjunction with the detailed compatibility analysis procedures in Section 4.

DESCRIPTION OF THE CHART

The 41 reactivity group classifications of hazardous wastes listed in Appendix 2 are presented in this chart.

The first colulmn of the chart lists the reactivity groups by Reactivity Group Numbers (RGN). The first 34 RGN which are based on chemical classes or molecular functional groups are listed consecutively from 1 to 34. The last 7 RGN which are based on general chemical reactivities are listed consecutively from 101 to 107. The second column lists the corresponding reactivity group names. The first 34 group names are each followed by a number of reaction squares equal to their respective RGN. In other words, RGN 1 is followed by 1 square, RGN 2 by 2 squares, etc. The group names designated by RGN 101 to 107 are followed by 34, 36, 37, 38, 39, 40 and 41 squares, respectively. The squares form rows as well as columns of squares on the chart. A terminal square of a row represents a binary combination of one reactive group with itself and is labelled with its RGN. The terminal squares serve as headings for the columns of squares and as a whole appear as a diagonal row of squares on the chart. An additional bottom row of squares is correspondingly labelled as the diagonal row of squares. The RGN on the first column of the chart and those on the diagonal and bottom rows of squares provide the reference coordinates for locating the potential hazardous reaction consequences of any binary combinations of the wastes reactivity groups.

The rest of the squares on the chart are either blank or filled in with Reaction Codes (RC). When a square is blank, the wastes in the binary combination represented by that square are compatible. Conversely, any RC on the squares indicate potential incompatible reactions that can result from the combination of the wastes reactivity groups represented by the individual squares. The predicted reactions are based on the combinations of the most reactive chemicals in the respective reactivity groups. All the binary wastes combinations designated with RC are described in greater detail in Appendix 4. Where waste combinations are believed to be incompatible but no sufficient supporting data have been found in the literature, incompatible reactions are also noted and marked on the chart with RC or "U". The RC are identified in the legend on the upper right hand corner of the chart and described in detail in Section 4.2. The multiple RC are explained in Section 5.4.

PROCEDURES FOR USING THE CHART

Step 1: For the binary combination of any reactivity groups, first find the Reactivity Group Number (RGN) of the first group on the first column of the chart.

Step 2: Find the RGN of the second group from the bottom squares of RGN.

Step 3: Find the intersecting reaction square for the two RGN.

Step 4: Note the Reaction Code(s) (RC) in the square.

Step 5: Refer to the legend on the chart or Section 5.4 for the explanation of the RC.

Step 6: When no RC is found on the reaction square, the two groups of wastes are compatible. When any RC are noted on the square, the wastes are incompatible when mixed or allowed to come in contact with one another.

EXPLANATION OF THE MULTIPLE REACTION CODES

For many binary combinations, multiple Reation Codes (RC) are used to denote the reaction consequences. The order in which these letter codes appear in the squares corresponds to the order in which the consequences can occur. For example, in RC $(^{H}F_{E})$, the first letter denotes the initial or primary hazardous consequence of a binary reaction which in this case is HEAT generation. The second and third letters denote the resulting secondary consequences of the production of FIRE and EXPLOSION from the heat generated by the primary reaction. In some cases the third letter code refers to a resulting tertiary consequence such as the evolution of a toxic gas from a fire caused by excessive HEAT generation $(^{H}F_{G_T})$. Where the codes GT_{GF} appear, the GASES evolved are TOXIC and FLAMMABLE such as hydrogen sulfide, hydrogen cyanide, or carbon disulfide. The relative positions of the letter codes to one another in this case bear no significance. The codes can also be written as GF_{GT}.

LIMITATIONS OF THE CHART

The potential reaction consequences predicted by the chart are based on pure chemical reactions only at ambient temperature and pressure. Concentration, synergistic, and antagonistic effects have been assumed not to influence the reactions. The reactions have not as yet been validated on actual wastes containing the chemicals.

REACTIVITY GROUP NO.	REACTIVITY GROUP NAME													
1	Acids, Mineral, Non-oxidizing	1												
2	Acids, Mineral, Oxidizing		2											
3	Acids, Organic		G H	3										
4	Alcohols and Glycols	H	H F	H P	4									
5	Aldehydes	H P	H F	H P		5								
6	Amides	H	H GT				6							
7	Amines, Aliphatic and Aromatic	H	H GT	H		H		7						
8	Azo Compounds, Diazo Compounds and Hydrazines	H G	H GT	H G	H G	H			8					
9	Carbamates	H G	H GT						G H	9				
10	Caustics	H	H	H		H				H G	10			
11	Cyanides	GT GF	GT GF	GT GF					G			11		
12	Dithiocarbamates	H GF F	H GF F	H GF GT		GF GT		L	H G				12	
13	Esters	H	H F						H G		H			13
14	Ethers	H	H F											
15	Fluorides, Inorganic	GT	GT	GT										
16	Hydrocarbons, Aromatic		H F											
17	Halogenated Organics	H GT	H F GT					H GT	H G		H GF	H		
18	Isocyanates	H G	H F GT	H G	H P			H P	H G		H P G	H G	L	
19	Ketones	H	H F						H G		H	H		
20	Mercaptans and Other Organic Sulfides	GT GF	H F GT						H G					
21	Metals, Alkali and Alkaline Earth, Elemental	GF H F	GF H F	GF H F	GF H F	GF H F	GF H	GF H	GF H	GF H	GF H	GF H	GF GT H	GF H
22	Metals, Other Elemental & Alloys as Powders, Vapors, or Sponges	GF H F	GF H F	GF					H F GT	L	GF H			
23	Metals, Other Elemental & Alloys as Sheets, Rods, Drops, Moldings, etc.	GF H F	GF H F						H F G					
24	Metals and Metal Compounds, Toxic	S	S	S			S	S			S			
25	Nitrides	GF H F	H F E	H GF	GF H E	GF H			U	H G	U	GF H	GF H	GF H
26	Nitriles	H GT GF	H F GT	H							U			
27	Nitro Compounds, Organic		H F GT			H					H E			
28	Hydrocarbons, Aliphatic, Unsaturated	H	H F			H								
29	Hydrocarbons, Aliphatic, Saturated		H F											
30	Peroxides and Hydroperoxides, Organic	H G	H E		H F	H G		H GT	H F E	H F GT		H E GT	H F GT	
31	Phenols and Cresols	H	H F						H G					
32	Organophosphates, Phosphothioates, Phosphodithioates	H GT	H GT						U		H E			
33	Sulfides, Inorganic	GT GF	H F GT	GT		H			E					
34	Epoxides	H P	H P	H P	H P	U		H P	H P		H P	H P	U	
101	Combustible and Flammable Materials, Miscellaneous	H G	H F GT											
102	Explosives	H E	H E	H E					H E		H E			H E
103	Polymerizable Compounds	P H	P H	P H					P H		P H	P H	U	
104	Oxidizing Agents, Strong	H GT		H GT	H F	H F	H F GT	H F GT	H E	H F GT		H E GT	H F GT	H F
105	Reducing Agents, Strong	H GF	H F GT	H GF	H GF F	GF H F	GF H	H GF	H G				H GT	H F
106	Water and Mixtures Containing Water	H	H						G					
107	Water Reactive Substances	← EXTREMELY REACTIVE!												
		1	2	3	4	5	6	7	8	9	10	11	12	13

Figure 6. Hazardous waste compatibility chart.

Reactivity Code	Consequences
H	Heat generation
F	Fire
G	Innocuous and non-flammable gas generation
GT	Toxic gas generation
GF	Flammable gas generation
E	Explosion
P	Violent polymerization
S	Solubilization of toxic substances
U	May be hazardous but unknown

Example

H F GT	Heat generation, fire, and toxic gas generation

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	101	102	103	104	105	106	107
14																											
	15																										
		16																									
			17																								
				18																							
					19																						
			H	H	H	20																					
			H E	GF H	GF H	GF H	21																				
			H E	GF H		H GF F		22																			
			H F						23																		
										24																	
			GF H	U	GF H	GF H	U				25																
							H P			S	GF H	26															
							H GF E				H GF E		27														
								H E						28													
															29												
			H E	H	E	H F GT	H E	P U		H G	H GF E	H P GT		H P		30											
				H P			GF H				GF H					H	31										
							H									U		32									
				H												H GT			33								
						H P	H P	H P		H P	H P					H P	H P	U	H P	34							
							H G F				H GF F					H F GT					101						
							H E	H E	H E	E	E					H E	H E		H E	H E	H E	102					
							P H	P H	P H	P H	P H					P H	P H		P H			H E	103				
H F		H F	H GT	H F GT	H F	H F GT	H F E	H F E	H F		H F E	H F GT	H E	H F	H F	H G	H F	H F GT	H F GT	H F G	H F G	H E	H F GT	104			
			H E	GF H	GF H	GF H						H GF	H E			H E	GF H	GT GF H		H	GF H	H E	H P GF	H F E	105		
				H G			GF H	GF H		S	GF H								GT GF						GF GT	106	
DO NOT MIX WITH ANY CHEMICAL OR WASTE MATERIAL! EXTREMELY REACTIVE! →																											107

Figure 6. Hazardous waste compatibility chart (continued).

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APPENDICES

APPENDIX I. LIST OF CHEMICAL SUBSTANCES

This appendix lists the chemical substances that may be found in hazardous wastestreams. The list is not inclusive but represents the data compiled through a literature survey and examination of hazardous waste management practices.

The list consists of three columns. The first column lists the chemical or trade names in alphabetical order. The trade names are denoted by asterisks (*). The second column list the synonyms or common names of the chemical substances when available. The third column lists the reactivity group numbers (RGN) assigned to the substances as derived in Appendix 2. A compound may be assigned more than one RGN.

This appendix is used to obtain the RGN of waste constituents when known specifically. The RGN is used to determine the compatibility of the combinations of wastes according to the compatibility method in Section 4.

The chemical substances listed were compiled from several sources. The list of Hazardous Wastes and Hazardous Materials and List of Extremely Hazardous Wastes and Extremely Hazardous Materials in California's Industrial Waste Law of 1972 (Ref. 44) served as the starting reference. The primary sources of information consisted of published reports (Ref. 1, 7, 12, 13, 14, 32, and 52) identifying the hazardous chemical substances in industrial wastestreams. Additional chemical entries were abstracted from the California Waste Haulers Record files (Ref. 10), California Extremely Hazardous Waste Disposal Permit files (Ref. 8), and the TRW Systems' report on recommended methods of reduction, neutralization, recovery, and disposal of hazardous wastes (Ref. 77).

Names	Synonyms	RGN
Abate*		32
Acenaphthene		16
Acetamide		6
Acetaldehyde		5
Acetic acid		3
Acetic anhydride		107
Acetone	Dimethyl ketone	19
Acetone cyanohydrin	Hydroxyisobutyronitrile	4, 26
Acetonitrile	Methyl cyanide	26
Acetophenone		19
Acetoxybutane	Butyl acetate	13
Acetoxypentane	Amyl acetate	13
Acetyl acetone		19

Names	Synonyms	RGN
Acetyl azide		102
Acetyl benzoyl peroxide		30
Acetyl bromide		17, 107
Acetyl chloride		17, 107
Acetylene		28
Acetyl nitrate		27, 102
Acetyl peroxide		30
Acrolein	Aqualin	5, 103
Acrylic acid		3, 103
Acrylonitrile		26, 103
Adipic acid		3
Adiponitrile		26
Agallol	Methoxyethylmercuric chloride	24
Agaloaretan	Methoxymethylmercuric chloride	24
Aldicarb	Temik*	9, 20
Aldrin		17
Alkyl aluminum chloride		107
Alkyl resins		101
Allene		28
Allyl alcohol	2-Propen-1-ol	4
Allyl bromide	Bromopropene	17
Allyl chloride	Chloropropene	17
Allyl chlorocarbonate	Allyl chloroformate	13, 17
Allyl chloroformate	Allyl chlorocarbonate	13, 17
Allyl trichlorosilane		107
Aluminum		22, 23
Aluminum aminoborohydride		107
Aluminum borohydride		105, 107
Aluminum bromide		107
Aluminum carbide		105
Aluminum chloride		107
Aluminum diethyl monochloride	Diethylaluminum chloride	105, 107
Aluminum fluoride		15, 107
Aluminum hydride		105
Aluminum hypophosphide		107
Aluminum phosphide		107
Aluminum tetraazidoborate		8
Aminobenzene	Aniline	7
Aminobutane	Butylamine	7
Aminochlorotoluene	Chlorotoluidine	7, 17
Aminodiphenyl		7
Aminoethane	Ethylamine	7
Aminoethanol		4, 7
Aminoethanolamine		7
Aminohexane	Hexylamine	7
Aminomethane	Methylamine	7
Aminopentane	Amylamine	7
Aminophenol		7, 31

Names	Synonyms	RGN
Aminopropane	Isopropyl amine	7
Amino propionitrile		7, 26
Aminothiazole		7, 8
Aminotoluene	Toluidine	7
Ammonia		10
Ammonium arsenate		24
Ammonium azide		102
Ammonium bifluoride		15
Ammonium chlorate		102, 104
Ammonium dichromate		24, 102
Ammonium fluoride		15
Ammonium hexanitrocobaltate		24, 102
Ammonium hydroxide		10
Ammonium hypophosphide		105
Ammonium molybdate		24
Ammonium nitrate		102
Ammonium nitridoosmate		24, 104
Ammonium nitrite		102
Ammonium perchlorate		104
Ammonium periodate		102, 104
Ammonium permanganate		24, 102, 104
Ammonium persulfate		104
Ammonium picrate		102
Ammonium sulfide		33, 105
Ammonium tetrachromate		24, 104
Ammonium tetraperoxychromate		24, 102, 104
Ammonium trichromate		24, 104
Amyl acetate	Acetoxy pentane	13
Amyl alcohol		4
Amyl chloride	Chloropentane	17
Amyl cyanide		26
Amylamine	Aminopentane	7
Amylene	Pentene	28
Amyl mercaptan	Pentanethiol	20
Aniline		7
Animert* V-101	Tetrasul	20
Anisole		14
Anisole chloride		107
Anthracene		16
Antimony		23, 24
Antimony chloride	Antimony trichloride	24, 107
Antimony fluoride	Antimony trifluoride	24, 107
Antimony nitride		24, 25
Antimony oxychloride		24
Antimony oxide	Antimony trioxide	24
Antimony pentachloride		24
Antimony pentafluoride		24
Antimony pentasulfide		24, 33, 105
Antimony perchlorate		24, 104
Antimony potassium tartrate		24

Names	Synonyms	RGN
Antimony sulfate	Antimony trisulfate	24
Antimony sulfide	Antimony trisulfide	24, 33, 105
Antimony tribromide		24, 107
Antimony trichloride	Antimony chloride	24, 107
Antimony trifluoride	Antimony fluoride	24, 107
Antimony triiodide		24, 107
Antimony trioxide	Antimony oxide	24
Antimony trisulfate	Antimony sulfate	24
Antimony trisulfide	Antimony sulfide	24, 33
Antimony trivinyl		24, 107
Aqualin	Acrolein	5, 103
Aqueous solutions & mixtures		106
Aretan*	Methoxyethylmercuric chloride	24
Aroclor*	Polychlorinated biphenyl	17
Arsenic		24
Arsenic bromide	Arsenic tribromide	24, 107
Arsenic chloride	Arsenic trichloride	24, 107
Arsenic dislufide	Arsenic sulfide	24, 33, 105
Arsenic iodide	Arsenic triiodide	24, 107
Arsenic oxide	Arsenic pentoxide	24
Arsenic pentaselenide		24
Arsenic pentasulfide		24, 33
Arsenic pentoxide	Arsenic oxide	24
Arsenic sulfide	Arsenic disulfide	24, 33, 105
Arsenic tribromide	Arsenic bromide	24, 107
Arsenic trichloride	Arsenic chloride	24, 107
Arsenic trifluoride		24
Arsenic triiodide	Arsenic iodide	24, 107
Arsenic trisulfide		24, 33, 105
Arsine		24, 105
Askarel	Polychlorinated biphenyl	17
Asphalt		101
Azidocarbonyl guanidine		8, 102
Azido-s-triazole		8
Azinphos ethyl		32
Aziridine	Ethyleneimine	7, 103
a,a'-Azodiisobutyronitrile		8, 26
Azodrin*	Monocrotophos	32
Bakelite*		101
Banol	Carbanolate	9
Barium		21, 24, 107
Barium azide		24, 102
Barium bromate		24, 104
Barium carbide		24, 105, 107
Barium chlorate		24, 104
Barium chloride		24
Barium chromate		24, 104
Barium fluoride		15, 24
Barium fluosilicate		24

Names	Synonyms	RGN
Barium hydride		24, 105
Barium hydroxide		10, 24
Barium hypophosphide		24, 105
Barium iodate		24, 104
Barium iodide		24
Barium monoxide	Barium oxide	10, 24, 107
Barium nitrate		24, 104
Barium oxide	Barium monoxide	10, 24, 107
Barium perchlorate		24, 104
Barium permanganate		24, 104
Barium peroxide		24, 104
Barium phosphate		24
Barium stearate		24
Barium sulfide		24, 33, 105, 107
Barium sulfite		24
Bassa*	BPMC	9
Bayer 25141	Fensulfothion	32
Baygon*		9
Benzadox	Topcide*	6
Benzal bromide		17
Benzal chloride		17
Benzaldehyde		5
Benz-a-pyrene		16
Benzene		16
Benzene diazonium chloride		8, 102
Benzene phosphorus dichloride		107
Benzidine		7
Benzoic acid		3
Benzonitrile		26
Benzophenone		19
Benzoquinone	Quinone	19
Benzotriazole		8, 102
Benzotribromide		17
Benzotrichloride		17
Benzotrifluoride	Trifluoromethylbenzene	17
Benzoyl chloride		107
Benzoyl peroxide	Dibenzoyl peroxide	30, 102
Benzyl alcohol		4
Benzylamine		7
Benzyl benzene	Diphenylmethane	16
Benzyl bromide	Bromotoluene	17
Benzyl chloride	Chlorotoluene	17
Benzyl chlorocarbonate	Benzyl chloroformate	17
Benzyl chloroformate	Benzyl chlorocarbonate	17
Benzyl silane		105, 107
Benzyl sodium		105
Beryllium		24
Beryllium copper alloy		24
Beryllium fluoride		15, 24
Beryllium hydride		24, 105, 107

Names	Synonyms	RGN
Beryllium hydroxide		10, 24
Beryllium oxide		24
Beryllium sulfide		33, 105
Beryllium tetrahydroborate		24, 105, 107
Bidrin*		32
Bismuth		22, 23, 24
Bismuth chromate		24
Bismuthic acid		24
Bismuth nitride		24, 25, 102
Bismuth pentafluoride		24, 107
Bismuth pentaoxide		24
Bismuth sulfide		24, 33, 105
Bismuth tribromide		24
Bismuth trichloride		24
Bismuth triiodide		24
Bismuth trioxide		24
Bismuth trisulfide		24, 33, 105
Blada-fum*	Sulfotepp	32
Blue vitriol	Copper sulfate	24
Bomyl		32
Borane		24, 107
Bordeaux arsenites		24
Boric acid		1
Boron arsenotribromide		24, 105
Boron bromodiiodide		24, 107
Boron dibromoiodide		24, 107
Boron nitride		24, 25
Boron phosphide		24, 107
Boron triazide		24, 102
Boron tribromide		24, 107
Boron trichloride		24, 107
Boron trifluoride		24, 107
Boron triiodide		24, 107
Boron trisulfide		24, 33, 105
BPMC	Bassa*	9
Brass		23
Bromic acid		2
Bromine		104
Bromine azide		102
Bromine cyanide	Cyanogen bromide	11
Bromine monofluoride		104, 107
Bromine pentafluoride		104, 107
Bromine trifluoride		104, 107
Bromoacetylene		17
Bromobenzoyl acetanilide		6, 19
Bromobenzyl trifluoride		17
Bromodiborane		105
Bromodiethylaluminum		107
Bromodimethoxyaniline		14
Bromoform	Tribromomethane	17

Names	Synonyms	RGN
Bromomethane	Methyl bromide	17
Bromophenol		17, 31
Bromopropene	Allyl bromide	17
Bromopropyne		17
Bromosilane		105
Bromotoluene	Benzyl bromide	17
Bromotrichloromethane		17
Bromotrifluomethane		17
Bromoxynil	3,5-Dibromo-4-hydroxy benzonitrile	17, 26, 31
Bronze		23
Buna-N*		101
Bunker fuel oil		101
Butacarb		9
Butadiene		28, 103
Butadiyne	Diacetylene	28
Butanal	Butyraldehyde	5
Butane		29
Butanediol		4
Butanethiol	Butyl mercaptan	20
Butanetriol trinitrate		102
Butanol	Butyl alcohol	4
Butanone	Methyl ethyl ketone	19
Butenal	Crotonaldehyde	5
Butene		28
Butene-2-one	Methyl vinyl ketone	19
Butyl acetate	Acetoxybutane	13
n-Butyl acrylate		13, 103
Butylamine	Aminobutane	7
Butyl alcohol	Butanol	4
t-Butyl azidoformate		8
Butyl benzene	Phenylbutane	16
Butyl benzyl phthalate		13
Butyl cellusolve*		4
Butyl dichloroborane		105
Butyl ether	Dibutyl ether	14
Butly formate		13
Butyl fluoride		17
Butyl glycidyl ether		34
Butyl hydroperoxide		30
t-Butyl hypochlorite		102, 104
n-Butyl lithium		105, 107
Butyl mercaptan	Butanethiol	20
Butyl peroxide		30
Butyl peroxyacetate	t-Butyl perbenzoate	30
Butyl peroxybenzoate		30
Butyl peroxypivalate		30
t-Butyl perbenzoate	Butyl peroxyacetate	30
t-Butyl-3-phenyl oxazirane		34
Butyl trichlorosilane		107

Names	Synonyms	RGN
Butyramide		6
Butyraldehyde	Butanol	5
Butyric acid		3
Butyronitrile		26
Bux*		9
Cacodylic acid	Dimethylarsenic acid	24
Cadmium		23, 24
Cadmium acetylide		24, 105, 107
Cadmium amide		24, 10, 107
Cadmium azide		24, 102
Cadmium bromide		24
Cadmium chlorate		24, 104
Cadmium chloride		24
Cadmium cyanide		11, 24
Cadmium fluoride		15, 24
Cadmium hexamine chlorate		24, 102
Cadmium hexamine perchlorate		24, 102
Cadmium iodide		24
Cadmium nitrate		24, 102, 104
Cadmium nitride		24, 25, 102
Cadmium oxide		24
Cadmium phosphate		24
Cadmium sulfide		24, 33, 105
Cadmium trihydrazine chlorate		24, 102
Cadmium trihydrazine perchlorate		24, 102
Calcium		24, 102
Calcium arsenate		24
Calcium arsenite		24
Calcium bromate		104
Calcium carbide		105, 107
Calcium chlorate		104
Calcium chlorite		104
Calcium fluoride		15
Calcium hexammoniate		105
Calcium hydride		105, 107
Calcium hydroxide	Hydrated lime	10
Calcium hypochlorite	Calcium oxychloride	104
Calcium hypophosphide		105
Calcium iodate		104
Calcium-manganese-silicon alloy		23
Calcium nitrate	Lime nitrate, nitrocalcite	104
Calcium oxide	Slaked lime	10, 107
Calcium oxychloride	Calcium hypochlorite	104
Calcium perchromate		104
Calcium permanganate		104
Calcium peroxide		104
Calcium phosphide		107
Calcium sulfide		33, 105
Camphor oil		101
Capric acid		3

Names	Synonyms	RGN
Caproic acid	Hexanoic acid	3
Caprylic acid		3
Caprylyl peroxide	Octyl peroxide	30
Carbacrol		31
Carbaryl		9
Carbetamide		6
Carbanolate	Banol	9
Carbofuran	Furadan*	9
Carbolic acid	Phenol	31
Carbolic oil		31
Carbon, activated, spent		101
Carbon bisulfide	Carbon disulfide	20
Carbon disulfide	Carbon bisulfide	20
Carbon tetrachloride	Tetrachloromethane	17
Carbon tetrafluoride		17
Carbon tetraiodide		17
Castrix	Crimidine	7
Catechol		31
Caustic potash	Potassium hydroxide	10
Caustic soda	Sodium hydroxide	10
CDEC		12
Cellulose		101
Cellulose nitrate	Nitro cellulose	27, 102
Cerium		22
Cerium hydride		105
Cerium trisulfide		33, 105
Cerous phosphide		105
Cesium		21
Cesium amide		107
Cesium azide		102
Cesium carbide		105
Cesium fluoride		15
Cesium hexahydroaluminate		105
Cesium hydride		105, 107
Cesium phosphide		107
Cesium sulfide		33, 105
Chloral hydrate	Trichloroacetaldehyde	5
Chlordane		17
Chlorestol	Polychlorinated biphenyl	17
Chlorfenvinphos		32
Chloric acid		2, 104
Chlorine		104
Chlorine azide		102
Chlorine dioxide		102, 104, 107
Chlorine fluoroxide		102, 104
Chlorine monofluoride		104, 107
Chlorine monoxide		104
Chlorine pentafluoride		104, 107
Chlorine trifluoride		104, 107
Chlorine trioxide		102, 104

Names	Synonyms	RGN
Chloroacetaldehyde		5, 17
Chloroacetic acid	Monochloroacetic acid	3, 17
Chloroacetone	Monochloroacetone	17, 19
Chloroacetophenone	Phenyl chloromethyl ketone	17, 19
Chloroacetyl chloride		107
Chloroacetylene		102
Chloroacrylonitrile		17, 26
Chloroazodin		8, 17
Chlorobenzene		17
Chlorobenzotriazole		8, 17
Chlorobenzoyl peroxide		17, 30
Chlorobenzylidene malononitrile		17, 26
Chlorobutyronitrile		17, 26
Chloro chromic anhydride	Chromyl chloride	24, 104, 107
Chlorocreosol		17, 31
Chlorodiborane		105
Chlorodiisobutyl aluminum		105, 107
Chlorodimethylamine diborane		105
Chlorodinitrobenzene	Dinitrochlorobenzene	17, 27
Chloro dinitrotoluene		17, 27
Chlorodipropyl borane		105
Chloroethane	Ethyl chloride	17
Chloroethanol		4, 7
Chloroethylenimine		17
Chloroform	Trichloromethane	17
Chlorohydrin		17
Chloromethane	Methyl chloride	17
Chloromethyl methyl ether		17
Chloromethyl phenoxyacetic acid		3, 17
Chloronitroaniline		17, 27
Chloronitrobenzene	Nitrochlorobenzene	17, 27
Chloropentane	Amyl chloride	17
Chlorophenol		31
Chlorophenyl isocyanate		17, 18, 107
Chloropicrin	Chlorpicrin, Trichloronitromethane	17, 27, 102
Chloropropane	Isopropyl chloride	17
Chloropropene	Allyl chloride	17
Chloropropylene oxide	Epichlorohydrin	17, 34
Chlorosilane		105
Chlorosulfonic acid		1
Chlorothion*		17, 32
Chlorotoluene	Benzyl chloride	17
Chlorotoluidine		7, 17
Chlorotrinitrobenzene	Picryl chloride	17, 27, 102
β-Chlorovinyldichloroarsine	Lewisite	24
Chlorpicrin	Trichloronitromethane	17, 27, 102
Chromic acid	Chromic anhydride, Chromium trioxide	2, 24, 104

Names	Synonyms	RGN
Chromic anyhdride	Chromium trioxide, Chromic acid	2, 24, 104
Chromic chloride	Chromium trichloride	24
Chromic fluoride	Chromium trifluoride	15, 24
Chromic oxide		24
Chromic sulfate	Chromium sulfate	24
Chromium		23, 24
Chromium sulfate	Chromic sulfate	24
Chromic sulfide		24, 33, 105
Chromium trichloride	Chromic chloride	24
Chromium trifluoride	Chromic fluoride	15, 24
Chromium trioxide	Chromic acid, Chromic anhydride	2, 24, 104
Chromyl chloride	Chloro chromic anhydride	24, 104, 107
Chrysene		16
CMME	Methyl chloromethyl ether	14, 17
Coal oil		101
Coal tar		31
Cobalt		22, 23, 24
Cobalt bromide	Cobaltous bromide	24
Cobalt chloride	Cobaltous chloride	24
Cobalt nitrate	Cobaltous nitrate	24, 104
Cobaltous bromide	Cobalt bromide	24
Cobaltous chloride	Cobalt chloride	24
Cobaltous nitrate	Cobalt nitrate	24, 104
Cobaltous resinate	Cobalt resinate	24
Cobaltous sulfate	Cobalt sulfate	24
Cobalt resinate	Cobaltous resinate	24
Cobalt sulfate	Cobaltous sulfate	24
Collodion	Pyroxylin	27
Copper		23, 24
Copper acetoarsenite	Paris Green	24
Copper acetylide		24, 102, 105, 107
Copper arsenate	Cupric arsenate	24
Copper arsenite	Cupric arsenite	24
Copper chloride	Cupric chloride	24
Copper chlorotetrazole		24
Copper cyanide	Cupric cyanide	11, 24
Copper nitrate	Cupric nitrate	24, 104
Copper nitride		24, 25
Copper sulfate	Cupric sulfate, Blue vitriol	24
Copper sulfide		24, 33, 105
Compound 1836	Diethyl chlorvinyl phosphate	17, 32
Coroxon*		32
Coumafuryl	Fumarin	19
Coumatetralyl		19
Cresol		31
Cresol glydicyl ether		34
Cresote		31
Crimidine	Castrix	7

Names	Synonyms	RGN
Crotonaldehyde	Butenal	5
Crotyl alcohol		4
Crotyl bromide		17
Crotyl chloride		17
Cumene	Isopropyl benzene	16
Cumene hydroperoxide	Dimethylbenzyl hydroperoxide	30
Cupric arsenate	Copper arsenate	24
Cupric arsenite	Copper arsenite	24
Cupric chloride	Copper chloride	24
Cupric cyanide	Copper cyanide	11, 24
Cupric nitrate	Copper nitrate	24, 104
Cupric sulfate	Copper sulfate	24
Cupriethylenediamine		7, 24
Cyanoacetic acid	Malonic nitrile	3, 26
Cyanochloropentane		17, 26
Cyanogen		26
Cyanogen bromide	Bromine cyanide	11
Cyanophenphos	Surecide*	26, 32
Cyanuric triazide		102
Cycloheptane		29
Cyclohexane		29
Cyclohexanol		4
Cyclohexanone		19
Cyclohexanone peroxide		30
Cyclohexylamine		7
Cyclohexenyl trichlorosilane		107
Cyclohexyl phenol		31
Cyclohexyl trichlorosilane		107
Cyclopentane		29
Cyclopentanol		4
Cyclopentene		28
Cyclopropane		29
Cyclotrimethylene trinitraamine	RDX	27, 102
Cymene		16
Cyolan*	Phospholan	20, 32
2,4-D	Dichlorophenoxyacetic acid	3, 17
Dasanit*	Fensulfothion	32
DBCP	Dibromochloropropane	17
DCB	Dichlorobenzene	17
DDD		17
DDNP	Diazodinitrophenol	8, 27, 102
DDT		17
DDVP	Dichlorovos, Vapona*	17, 32
DEAC	Diethylaluminum chloride	105, 107
Decaborane		107
Decahydronaphthalene	Decalin	29
Decalin	Decahydronaphthalene	29
Decane		29
Decanol		4
Decene		28

Names	Synonyms	RGN
Decyl benzene		16
Delnav*	Dioxathion	32
Demeton-s-methyl sulfoxid	Metasystox R*	32
Diacetone alcohol		4, 19
Diacetyl		19
Diacetylene	Butadiyne	28
Diamine	Hydrazine	8, 105
Diaminobenzene	Phenylene diamine	7
Diaminohexane	Hexamethylenediamine	7
Diazidoethane		8, 102
Diazinon*		32
Diazodinitrophenol	DDNP	27, 102
Dibenzoyl peroxide	Benzoyl peroxide	30, 102
Diborane	Diboron hexahydride	105, 107
Diboron hexahydride	Diborane	105, 107
Dibutyl ether	Butyl ether	14
Dibutyl phthalate		13
3,5-Dibromo-4-hydroxybenzonitrile	Bromoxynil	17, 26, 31
Dibromochloropropane	DBCP, Fumazone*, Nemagon*	17
Dibromoethane	Ethylene dibromide	17
Dichloroacetone		17, 19
Dichloroamine		104
Dichlororobenzene	DCB	17
Dichlorobenzidine		7, 17
Dichlorodimethylsilane	Dimethyl dichlorosilane	107
Dichloroethane	Ethylene dichloride	17
Dichloroethene	Dichloroethylene	17
Dichloroether	Dichloroethyl ether	14, 17
Dichloroethylarsine		24, 107
Ethyl dichlorosilane		107
Ethyl ether	Dichloroether	14, 17
Dichloroisocyanuric acid	Dichloro-s-triazine-2,4,5-trione	104
Dichloromethane	Methylene chloride	17
Dichlorophene		17
Dichlorophenol		17, 31
Dichlorophenoxyacetic acid	2,4-D	3, 17
Dichloropropane	Propylene dichloride	17
Dichloropropanol		4, 17
Dichloropropene	Dichloropropylene	17
Dichloropropylene	Dichloropropene	17
Dichloro-s-triazine-2,4,5-trione	Dichloroisocyanuric acid	104
Dichlorovos	DDVP	17, 32
Dicumyl peroxide		30
Dicyclopentadiene		28
Dieldrin		17
Diethanolamine		4, 7
Diethyl aluminum chloride	Aluminum diethylmonochloride, DEAL	105, 107
Diethylamine		7
Diethyl benzene		16

Names	Synonyms	RGN
Diethyl chlorovinyl phosphate	Compound 1836	17, 32
Diethyl dichlorosilane		107
Diethylene dioxide	Dioxane	14
Diethylene glycol dinitrate		27, 102
Diethylene glycol monobutyl ether acetate		13
Diethylene triamine		7
Diethyl ether		14
Diethyl ketone		19
Diethyltoluamide		6
Diethyl zinc	Zinc ethyl	24, 105, 107
Diesel oil		101
Difluorophosphoric acid		1
Diglycidyl ether	Bis(2,3-epoxypropyl) ether	34
Diisobutylene		28
Diisobutyl ketone		19
Diisopropanolamine		4, 17
Diisopropylbenzene hydroperoxide		30
Diisopropyl beryllium		24, 104, 107
Diisopropyl ether	Isopropyl ether	14
Diisopropyl peroxydicarbonate	Isopropyl percarbonate	30
Dimecron*	Phosphamidon	32
Dimefox	Hanane*	6, 32
Dimethyl acetylene		28
Dimethyl amine		7
Dimethylamino azobenzene	Methyl yellow	7, 8
Dimethyl arsenic acid	Cacodylic acid	24
Dimethylbenzyl hydroperoxide	Cumene hydroperoxide	30
Dimethyl butane	Neohexane	29
Dimethyl butyne		28
Dimethyl dichlorosilane	Dichlorodimethylsilane	107
Dimethyldithiophosphoric acid		32
Dimethyl ether		14
Dimethyl formal		19
Dimethyl formamide		6
Dimethylhexane dihydroperoxide		30
Dimethyl hydrazine	UDMH	8
Dimethyl ketone	Acetone	19
Dimethyl magnesium		105, 107
Dimethylnitrobenzene	Nitroxylene	27
Dimethylnitrosoamine	N-Nitrosodimethyl amine	7, 27
Dimethyl sulfide	Methyl sulfide	20
Dimeton		32
Dinitrobenzene		27
Dinitrochlorobenzene	Chlorodinitrobenzene	17, 27
2,4-Dinitro-6-sec-butyl phenol	Dinoseb	27, 31
Dinitrocresol	DNOC, Elgetol 30	27, 31
Dinitrophenol		27, 31
Dinitrophenyl hydrazine		8, 27
Dinitrotoluene		27

Names	Synonyms	RGN
Dinoseb	2,4-Dinitro-6-sec-butylphenol	27, 31
Dioxacarb		9
Dioxane	Diethylene dioxide	14
Dioxathion	Delnav*	32
Dipentaerythritol hexanitrate		27, 102
Dipentene		28
Diphenamide		6
Diphenyl	Phenylbenzene	16
Diphenyl acetylene		16
Diphenylamine		7
Diphenylamine chloroarsine	Phenarsazine chloride	7, 24
Diphenyl ethane		16
Diphenyl ethylene	Stilbene	16
Diphenyl methane	Benzylbenzene	16
Diphenylmethane diisocyanate		18, 107
Diphenyl oxide		14
Dipicryl amine	Hexanitrodiphenylamine	7, 27, 102
Dipropyl amine		7
Disulfoton	Disyston*	32
Disulfuric acid		1
Disulfur dinitride		25, 102
Disulfuryl chloride		107
Disyston*	Disulfoton	32
Dithane* M-45		12
Dithione*	Sulfotepp	32
DNOC	Dinitrocresol	27, 31
Dodecene		28
Dodecyl benzene		16
Dodecyl trichlorosilane		107
Dowco-139*	Mexacarbate	9
Dowicide 1	o-Phenyl phenol	31
Dowtherm		16
Durene		16
Dyfonate*	Fonofos	32
Dynes Thinner		101
Elgetol 30	Dinitrocresol	27, 31
Endolsulfan	Thiodan*	17, 20
Endothall		3
Endothion	Exothion	32
Endrin		17
EPN		32
Epichlorohydrin	Chloropropylene oxide	17, 34
Epoxybutane		34
Epoxybutene		34
Epoxyethane	Ethylene oxide	34, 103
Epoxyethylbenzene		34
Bis(2-3-Epoxypropyl) ether	Diglycidyl ether	34
Ethane		29
Ethanethiol	Ethyl mercaptan	20
Ethanol	Ethyl alcohol	4

Names	Synonyms	RGN
Ethion*	Nialate	32
Ethoxyethanol		4, 14
Ethyl acetate		13
Ethyl acetylene		28
Ethylacrylate		13, 103
Ethyl alcohol	Ethanol	4
Ethylamine	Aminoethane	7
Ethyl benzene	Phenylethane	16
Ethyl butanoate	Ethyl butyrate	13
Ethyl butyrate	Ethyl butanoate	13
Ethyl chloride	Chloroethane	17
Ethyl chloroformate		13, 17
Ethyl dichloroarsine	Dichloroethylarsine	24, 107
Ethyl dichlorosilane		107
Ethyl ether	Diethyl ether	14
Ethylene		28
Ethylene chromic oxide		24, 104
Ethylene chlorohydrin		4, 17
Ethylene cyanohydrin	Hydroxyproplonitrile	4, 26
Ethylene diamine		7
Ethylene dibromide	Dibromoethane	17
Ethylene dichloride	Dichloroethane	17
Ethylene glycol		4
Ethylene glycol dinitrate	Glycol dinitrate	27, 102
Ethylene glycol monomethyl ether		4, 14, 17
Ethyleneimine	Aziridine	7, 103
Ethylene oxide	Epoxyethane	34, 103
Ethyl formate		13
2-Ethylhexyl acrylate		13, 103
Ethyl mercaptan	Ethanethiol	20
Ethyl nitrate		27, 102
Ethyl nitrite		27, 102
Ethyl propionate		13
Ethyl trichlorosilane		107
Exothion	Endothion	32
Eugenol		31
Fensulfothion	Bayer 25141, Dasanit*	32
Ferbam		12
Ferric arsenate		24
Ferric sulfide		33
Ferrous arsenate	Iron arsenate	24
Ferrous sulfide		33, 105
Fluoranthrene		16
Fluorene		16
Fluorine		104, 107
Fluorine azide		102
Fluorine monoxide	Oxygen difluoride	104, 107
Fluoroacetanilide		6, 17
Fluoroacetic acid		3
Fluoroboric acid		1, 15

Names	Synonyms	RGN
Fluorosulfonic acid	Fluosulfonic acid	1, 107
Fluosulfonic acid	Fluorosulfonic acid	1, 107
Fluosilicic acid		1, 15
Fonofos*	Dyfonate*	32
Formaldehyde	Methanal	5
Formamide		6
Formetanate hydrochloride		6
Formic acid	Methanoic acid	3
Fostion*	Prothoate	32
Freon*		17
Fumaric acid		3
Fumarin	Coumafuryl	19
Fumazone*	Dibromochloropropane	17
Furadan*	Carbofuran	9
Furan	Furfuran	14
Furfural		5
Furfuran		14
Gas oil, cracked		101
Gasoline		101
Germanium sulfide		33, 105
Glutaraldehyde		5
Glycerin		4
Glycidol		34
Glycol diacetate		13
Glycol dinitrate	Ethylene glycol dinitrate	27, 102
Glycol ether		14
Glycolic acid		3
Glycol monolactate trinitrate		27, 102
Glycolonitrile		26
Gold acetylide		105, 107
Gold cyanate	Gold fulminate	102
Gold fulminate	Gold cyanate	102
Gold sulfide		33, 105
Grease		101
Guaiacol		31
Guanyl nitrosaminoguanylidene hydrazine		8, 102
Guanidine nitrate		27, 104
Gun cotton	Nitrocellulose	27, 102
Guthion*		32
Hafnium		22
Hanane*	Dimefox	6, 32
Hemimellitene		16
Heptachlor		17
Heptane		29
Heptanal		5
Heptanol		4
Heptanone		19
Heptene		28
Hexaborane		105
Hexachlorobenzene		17

Names	Synonyms	RGN
Hexadecyl trichorosilane		107
Hexaethyl tetraphosphate		32
Hexafluorophosphoric acid		1, 15
Hexahydride diborane	Diborane	105, 107
Hexamethyl benzene		16
Hexamethylenediamine	Diaminohexane	7
Hexamethylenetetraamine		7
Hexanal		5
Hexanitrodiphenylamine	Dipicrylamine	7, 27, 102
Hexanol		4
Hexanoic acid	Caproic acid	3
Hexene		28
Hexylamine	Aminohexane	7
Hexyl trichlorosilane		107
Hexyne		28
HMX		102
Hopcide*		9
Hydrated lime	Calcium hydroxide	10
Hydrazine	Diamine	8, 105
Hydrazine azide		8, 102
Hydrazoic acid	Hydrogen azide	102
Hydriodic acid	Hydrogen iodide	1
Hydrobromic acid	Hydrogen bromide	1, 107
Hydrochloric acid	Muriatic acid	1
Hydrocyanic acid	Hydrogen cyanide	1, 11
Hydrofluoric acid	Hydrogen fluoride	1, 15
Hydrogen azide	Hydrazoic acid	102
Hydrogen bromide	Hydrobromic acid	1, 107
Hydrogen cyanide	Hydrocyanic acid	1, 11
Hydrogen fluoride	Hydrofluoric acid	1, 15
Hydrogen iodide	Hydroiodic acid	1
Hydrogen peroxide		104
Hydrogen phosphide	Phosphine	105
Hydrogen selenide		24, 105
Hydrogen sulfide		33, 105
Hydroquinone		31
Hydroxyacetophenone		19, 31
Hydroxydibromobenzoic acid		3, 17
Hydroxydiphenol		31
Hydroxyhydroquinone		31
Hydroxyacetophenone		19, 31
Hydroxyisobutyronitrile	Acetone cyanohydrin	4, 26
Hydroxyl amine		105
Hydroxypropionitrile	Ethylene cyanohydrin	4, 26
Hypochlorous acid		2
Indene		16
Indium		22, 23, 24
Inerteen	Polychlorinated biphenyl	17
Iodine monochloride		107
Iodine pentoxide		104

Names	Synonyms	RGN
Iron		23
Iron arsenate	Ferrous arsenate	24
Isobutane		29
Isobutanol		4
Isobutyl acetate		13
Isobutyl acrylate		13, 103
Isobutylene		28
Isodecyl acrylate		13
Isodurene		16
Isoeugenol		31
Isohexane		29
Isooctane	Trimethylpentane	29
Isooctene		28
Isopentane	Methylbutane	29
Isophorone		19
Isoprene	Methyl butadiene	28, 103
Isopropanol		4
Isopropyl acetate		13
Isopropyl acetylene		28
Isopropylamine	Aminopropane	7
Isopropyl benzene	Cumene	16
Isopropyl chloride	Chloropropane	17
Isopropyl ether	Diisopropyl ether	14
Isopropyl mercaptan		20
N-Isopropylmethylcarbamate		9
α-Isopropyl methylphosphoryl fluoride		17, 32
Isopropyl percarbonate	Diisopropyl peroxydicarbonate	30
Isotactic propylene		101
J-100		101
Jet oil		101
Kerosene		101
Lacquer thinner		101
Landrin*		9
Lannate*	Methomyl	9, 20
Lauroyl peroxide		30
Lead		23, 24
Lead acetate		24
Lead arsenate	Lead orthoarsenate	24
Lead arsenite		24
Lead azide		24, 102
Lead carbonate		24
Lead chlorite		24, 104
Lead cyanide		11, 24
Lead dinitroresorcinate		24, 27, 102
Lead mononitroresorcinate		24, 27, 102
Lead nitrate		24, 104
Lead orthoarsenate	Lead arsenate	24
Lead oxide		24
Lead styphnate	Lead trinitroresorcinate	24, 27, 102
Lead sulfide		24, 33, 104

Names	Synonyms	RGN
Lead trinitroresorcinate	Lead styphnate	24, 27, 102
Lewisite	β-Chlorovinyldichloroarsine	24
Lime nitrate	Calcium nitrate	104
Lindane		17
Lithium		21, 107
Lithium aluminum hydride		105, 107
Lithium amide		10, 107
Lithium ferrosilicon		107
Lithium hydride		105, 107
Lithium hydroxide		10
Lithium hypochlorite		104
Lithium nitride		25
Lithium peroxide		104, 107
Lithium silicon		107
Lithium sulfide		33, 105
London purple		24
Lye	Sodium hydroxide	10
Magnesium		21, 22
Magnesium arsenate		24
Magnesium arsenite		24
Magnesium chlorate		104
Magnesium fluoride		15
Magnesium nitrate		104
Magnesium perchlorate		104
Magnesium peroxide		104
Magnesium sulfide		33, 105
Malathion		32
Maleic acid		3
Malonic nitrile	Cyanoacetic acid	3, 26
Maneb		12
Manganese		22, 23, 24
Manganese acetate		24
Manganese arsenate	Manganous arsenate	24
Manganese bromide	Manganous bromide	24
Manganese chloride	Manganous chloride	24
Manganese methylcyclopentadienyltricarbonyl		24
Manganese nitrate	Manganous nitrate	24, 104
Manganese sulfide		24, 33, 105
Manganous arsenate	Manganese arsenate	24
Manganous bromide	Manganese bromide	24
Manganous chloride	Manganese chloride	24
Manganous nitrate	Manganese nitrate	104
Mannitol hexanitrate	Nitromannite	27, 102
Matacil*		9
Mayer's reagent	Mercuric potassium iodide	24
Medinoterb acetate		13, 27
Meobal		9
Mercaptobenzothiazole		8, 20
Mercatoethanol		4, 20

Names	Synonyms	RGN
Mercarbam		32
Mercuric acetate		24
Mercuric ammonium chloride	Mercury ammonium chloride	24
Mercuric benzoate	Mercury benzoate	24
Mercuric bromide		24
Mercuric chloride	Mercury chloride	24
Mercuric cyanide	Mercury cyanide	11, 24
Mercuric dioxysulfate	Mercuric subsulfate	24
Mercuric iodide	Mercury iodide	24
Mercuric nitrate	Mercury nitrate	24, 104
Mercuric oleate	Mercury oleate	24
Mercuric oxide		24
Mercuric oxycyanide		11, 24, 102
Mercuric potassium iodide	Mayer's reagent	24
Mercuric salicylate	Salicylated mercury	24
Mercuric subsulfate	Mercuric dioxysulfate	24
Mercuric sulfate	Mercury sulfate	24
Mercuric sulfide		24, 33, 105
Mercuric thiocyanate	Mercury thiocyanide	24
Mercuric thiocyanide	Mercury thiocyanate	24
Mercurol	Mercury nucleate	24
Mercurous bromide		24
Mercurous gluconate		24
Mercurous iodide		24
Mercurous nitrate		24, 104
Mercurous oxide		24
Mercurous sulfate	Mercury bisulfate	24
Mercury		24
Mercury (vapor)		22, 24
Mercury acetate	Mercuric acetate	24
Mercury ammonium chloride	Mercuric ammonium chloride	24
Mercury benzoate	Mercuric benzoate	24
Mercury bisulfate	Mercurous sulfate	24
Mercury chloride	Mercuric chloride	24
Mercury cyanide	Mercuric cyanide	11, 24
Mercury fulminate		24, 102
Mercury iodide	Mercuric iodide	24
Mercury nitrate	Mercuric nitrate	24, 104
Mercury nucleate	Mercurol	24
Mercury oleate	Mercuric oleate	24
Mercury sulfate	Mercuric sulfate	24
Mesitylene	1,3,5-trimethylbenzene	16
Mesityl oxide		19
Mesurol*		9
Metasystox-R	Demeton-S-methyl sulfoxid	32
Metham		12
Methanal	Formaldehyde	5
Methane		29
Methanethiol	Methyl mercaptan	20
Methanoic acid	Formic acid	3

Names	Synonyms	RGN
Methanol	Methyl alcohol	4
Methomyl	Lannate*	9, 20
Methoxyethylmercuric chloride	Agallolaretan*	24
Methyl acetate		13
Methyl acetone		101
Methyl acetylene	Methyl butyne	28
Methyl acrylate		13, 103
Methyl alcohol	Methanol	4
Methyl aluminum sesquibromide		105, 107
Methyl aluminum sesquichloride		105, 107
Methylamine	Aminomethane	7
Methyl amyl acetate		13
N-Methyl aniline		7
Methyl aziridine	Propyleneimine	7
Methyl benzene	Toluene	16
Methyl bromide	Bromomethane	17
Methyl butadiene	Isoprene	28, 103
Methyl butane	Isopentane	29
Methyl butene		28
Methyl butyl ether		14
Methyl t-butyl ketone		19
Methyl butyne	Isopropyl acetylene	28
Methyl butyrate		13
Methyl chloride	Chloromethane	17
Methyl chlorocarbonate	Methyl chloroformate	13, 17
Methyl chloroform		17
Methyl chloroformate	Methyl chlorocarbonate	13, 17
Methyl chloromethyl ether	CMME	14, 17
Methyl cyanide	Acetonitrile	26
Methyl cyclohexane		29
Methyl dichloroarsine		24
Methyl dichlorosilane		107
Methylene chloride	Dichloromethane	17
Methylene diisocyanate		18, 107
4,4-Methylene bis(2-chloroaniline)		7, 17
Methyl ethyl chloride		17
Methyl ethyl ether		14
Methyl ethyl ketone	Butanone	19
Methyl ethyl ketone peroxide		30
Methyl ethyl pyridine		7
Methyl formate		13
Methyl hydrazine	Monomethyl hydrazine	8
Methyl iodide		17
Methyl isobutyl ketone		19
Methyl isocyanate		18, 107
Methyl isopropenyl ketone		19
Methyl magnesium bromide		105, 107
Methyl magnesium chloride		105, 107
Methyl magnesium iodide		105, 107
Methyl mercaptan	Methanethiol	20

Names	Synonyms	RGN
Methyl methacrylate		13, 103
Methyl naphthalene		16
Methyl parathion		32
Methyl pentanoate	Methyl valerate	13
Methyl propionate		13
Methyl n-propyl ketone		19
Methyl styrene		28, 103
Methyl sulfide	Dimethyl sulfide	20
Methyl trichlorosilane		107
Methyl valerate	Methyl pentanoate	13
Methyl vinyl ketone	Butene-2-one	19
Methyl yellow	Dimethylamino azobenzene	7, 8
Mevinphos	Phosdrin*	32
Mexacarbate	Dowco-139*	9
Mineral spirits		101
Mintacol*	Paraoxon	32
Mipcin*		9
Mobam*		9
Mocap*		32
Molybdenum		22, 23, 24
Molybdenum anhydride	Molybdenum trioxide	24
Molybdenum sulfide		24, 33, 105
Molybdenum trioxide	Molybdenum anhydride	24
Molybdic acid		24
Monochloroacetone	Chloroacetone	17, 19
Monochloroacetic acid	Chloroacetic acid	3, 17
Monocrotophos	Azodrin*	32
Monoethanol amine		4, 7
Monofluorophosphoric acid		1
Monoisopropanolamine		4, 7
Monomethyl hydrazine	Methyl hydrazine	8
Morpholine		7
Municipal solid waste	Refuse	101
Muriatic acid	Hydrochloric acid	1
Nabam		12
Nack	Sodium-potassium alloy	21, 107
Nak	Sodium-potassium alloy	21, 107
Naptha		101
Naphthalene		16
Naphthol		31
Naphthylamine		7
Naphthyl mercaptan		20
Naphtite	Trinitronaphthalene	27, 102
Nemagon*	Dibromochloropropane	17
Neohexane	Dimethyl butane	29
4-NBP	Nitrobiphenyl	27
Niacide*		12
Nialate	Ethion	32
Nickel		22, 24
Nickel acetate		24

Names	Synonyms	RGN
Nickel antimonide		24, 107
Nickel arsenate	Nickelous arsenate	24
Nickel arsenite	Nickelous arsenite	24
Nickel carbonyl	Nickel tetracarbonyl	24
Nickel chloride	Nickelous chloride	24
Nickel cyanide		11, 24
Nickel nitrate	Nickelous nitrate	24, 104
Nickelous arsenate	Nickel arsenate	24
Nickelous arsenite	Nickel arsenite	24
Nickelous chloride	Nickel chloride	24
Nickelous nitrate	Nickel nitrate	24, 104
Nickel selenide		24
Nickel subsulfide		24, 33, 105
Nickel sulfate		24
Nickel tetracarbonyl	Nickel carbonyl	24
Nitraniline	Nitroaniline	7, 27
Nitric acid		2
Nitroaniline	Nitraniline	7, 27
Nitrobenzene	Nitrobenzol	27
Nitrobenzol	Nitrobenzene	27
Nitrobiphenyl	4-NBP	27
Nitrocalcity	Calcium nitrate	104
Nitrocellulose	Cellulose nitrate, gun cotton	27, 102
Nitrochlorobenzene	Chloronitrobenzene	17, 27
Nitrogen dioxide		104
Nitromannite	Mannitol hexanitrate	27, 102
Nitrogen mustard		7, 17
Nitrogen tetroxide		104
Nitroglycerin	Trinitroglycerin	27, 102
Nitrohydrochloric acid		2
Nitrophenol		27, 31
Nitropropane		27
Nitrosodimethylamine	Dimethylnitrosiamine	7, 27
Nitrosoguanidine		27, 102
Nitrostarch	Starch nitrate	27, 102
Nitroxylene	Nitroxylol, Dimethylnitrobenzene	27
Nitroxylos	Nitroxylene, Dimethylnitrobenzene	27
N-Nitrosodimethylamine	Dimethylnitrosoamine	7, 27
Nonyl phenol		31
Nonyl trichlorosilane		107
Nonane		29
Nonene		28
Nonanone		19
Nonanal		5
Nonanol		4
Octadecyl trichlorosilane		107
Octadecyne		28
Octamethylpyrophosphoramide	Schradan	6, 32
Octanal		5
Octane		29

Names	Synonyms	RGN
Octanone		19
Octanol		4
Octene		28
Octyl peroxide	Caprylyl peroxide	30
Octyl trichlorosilane		107
Oil of bergamot		101
Oil of vitriol	Sulfuric acid	1
Oleum	Sulfuric acid	2, 24
Orris root		101
Orthozenol	o-Phenyl phenol	31
Osmium		23, 24
Osmium amine nitrate		24, 104
Osmium amine perchlorate		24, 104
Oxamyl		9
Oxalic acid		3
Oxygen difluoride		104, 107
PCB	Polychlorinated biphenyl	17
Paper		101
Paraoxon	Mintacol*	32
Parathion		32
Paris green	Copper acetoarsenite	24
PETD	Polyram combi*	12
PETN	Pentaerythrityl tetranitrate, Pentaerythritol tetranitrate	27, 102
Pentaborane		105
Pentachlorophenol		17, 31
Pentaerythritol tetranitrate	Pentaerythrityl tetranitrate, PETN	27, 102
Pentamethyl benzene		16
Pentane		29
Pentanethiol	Amyl mercaptan	20
Pentanal	Valeraldehyde	5
Pentanone		19
Pentene	Amylene	28
Pentylamine		7
Pentyne		28
Peracetic acid	Peroxyacetic acid	3, 30
Perbromic acid		2
Perchloric acid		2
Perchloroethylene	Tetrachloroethylene	17
Perchloromethyl mercaptan	Trichloromethylsulfenylchloride	17, 20
Perchlorous acid		2
Perchloryl fluoride		104
Periodic acid		2
Permonosulfuric acid		1
Peroxyacetic acid	Peracetic acid	3, 30
PETD	Polyram combi*	12
Petroleum naptha		101
Petroleum oil		101
Phenanthrene		16
Phenarsazine chloride	Diphenylamine chloroarsine	7, 24

Names	Synonyms	RGN
Phenol	Carbolic acid	31
Phenyl acetic acid		3
Phenyl acetonitrile		26
Phenyl acetylene		16
Phenylaniline	Diphenylamine	7
Phenylbenzene	Diphenyl	16
Phenylbutane	Butylbenzene	16
Phenylchloromethyl ketone	Chloroacetophenone	17, 19
Phenyl dichloroarsine		24
Phenylene diamine	Diaminobenzene	7
Phenylethane	Ethylbenzene	16
Phenyl hydrazine hydrochloride		8
o-Phenyl phenol	Orthozenol, Dowicide 1	31
Phenyl trichlorosilane		107
Phenyl valerylnitrile		26
Phenylpropane	Propylbenzene	16
Phloroglucinol		31
Phorate	Thimet*	32
Phosdrin*	Mevinphos	32
Phosphamidon	Dimecron*	32
Phosphine	Hydrogen phosphide	105
Phospholan	Cyolan*	20, 32
Phosphonium iodide		105, 107
Phosphoric acid		1
Phosphoric anhydride	Phosphorus pentoxide	107
Phosphoric sulfide	Phosphorus pentasulfide	33, 105, 107
Phosphorus (Amorphous red)		105, 107
Phosphorus (White-Yellow)		105
Phosphorus heptasulfide		33, 105
Phosphorus oxybromide	Phosphoryl bromide	104, 107
Phosphorus oxychloride	Phosphoryl chloride	104, 107
Phosphorus pentachloride	Phosphoric chloride	107
Phosphorus pentasulfide	Phosphoric sulfide	33, 105, 107
Phosphorus pentoxide	Phosphoric anhydride	107
Phosphorus sesquisulfide	Tetraphosphorus trisulfide	33, 105, 107
Phosphorus tribromide		107
Phosphorus trichloride		107
Phosphorus trisulfide		33, 105, 107
Phosphoryl bromide	Phosphorus oxybromide	104, 107
Phosphoryl chloride	Phosphorus oxychloride	104, 107
Phthalic acid		3
Picramide	Trinitroaniline	7, 27, 102
Picric acid	Trinitrophenol	27, 31, 102
Picridine		7
Picryl chloride	Chlorotrinitrobenzene	17, 27, 102
Piperidine		7
Pirimicarb		9
Polyglycol ether		14
Polyamide resin		101
Polybrominated biphenyl		17

Names	Synonyms	RGN
Polybutene		28
Polychlorinated biphenyls	PCB, Askarel, Arochlor*, Chlorextol, Inerteen	17
Polychlorinated triphenyls		17
Polethylene		101
Polyester resin		101
Polymeric oil		101
Polyphenyl polymethylisocyanate		18, 107
Polypropylene		28, 101
Polyram combi*	PETD	12
Polysulfide polymer		20, 101
Polystyrene		101
Polyurethane		101
Polyvinyl acetate		101
Polyvinyl chloride		101
Polyvinyl nitrate		27, 102
Potasan		32
Potassium		21, 107
Potassium acid fluoride	Potassium fluoride	15
Potassium aluminate		10
Potassium arsenate		24
Potassium arsenite		24
Potassium bifluoride	Potassium fluoride	15
Potassium bichromate	Potassium dichromate	24, 104
Potassium bromate		104
Potassium butoxide		10
Potassium cyanide		11
Potassium dichloroisocyanurate		104
Potassium dichromate	Potassium bichromate	24, 104
Potassium dinitrobenzfuroxan		27, 102
Potassium fluoride	Potassium acid fluoride	15
Potassium hydride		105, 107
Potassium hydroxide	Caustic potash	10
Potassium nitrate	Saltpeter	102, 104
Potassium nitride		25
Potassium nitrite		104
Potassium oxide		107
Potassium perchlorate		104
Potassium permanganate		24, 104
Potassium peroxide		104, 107
Potassium sulfide		33, 105
Promecarb		9
Propanal	Propionaldehyde	5
Propane		29
Propanethiol	Propyl mercaptan	20
Propanoic acid	Propionic acid	3
Propanol	Propyl alcohol	4
Propargyl bromide		17
Propargyl chloride		17
2-Propen-1-ol	Allyl alcohol	4

Names	Synonyms	RGN
Propiolactone		13
Propionaldehyde	Propanal	5
Propionamide		6
Propionic acid	Propanoic acid	3
Propionitrile		26
Propyl acetate		13
Propyl alcohol	Propanol	4
Propylamine		7
Propyl benzene	Phenyl propane	16
Propylene dichloride	Dichloropropane	17
Propylene glycol		4
Propylene glycol monomethyl ether		4, 14
Propylene oxide		34, 103
Propyleneimine	Methyl aziridine	7
Propyl ether		14
Propyl formate		13
Propyl mercaptan	Propanethiol	20
Propyl Trichlorosilane		107
Prothoate	Fostion*	32
Pseudocumene	1,2,4 trimethylbenzene	16
Pyridine		7
Pyrogallol		31
Pyrosulfuryl chloride	Disulfuryl chloride	107
Pyroxylin	Collodion	27
Quinone	Benzoquinone	19
Raney nickel		22
RDX	Cyclotrimethylene trinitramine	27, 102
Refuse	Municipal solid waste	101
Resins		101
Resorcinol		31
Rubidium		21
Salicylated mercury	Mercuric salicylate	24
Saligenin		31
Saltpeter	Potassium nitrate	102, 104
Schradan	Octamethyl pyrophosphoramide, OMPA	6, 32
Selenious acid	Selenous acid	1, 24
Selenium		22, 23, 24
Selenium diethyldithiocarbamate		12, 24
Selenium fluoride		15, 24
Selenous acid	Selenious acid	1, 24
Silicochloroform	Trichlorosilane	107
Silicon tetrachoride		107
Silicon tetrafluoride		15, 107
Silver acetylide		24, 102, 105, 107
Silver azide		24, 102
Silver cyanide		11, 24
Silver nitrate		24, 104
Silver nitride		24, 25, 102
Silver styphnate	Silver trinitroresorcinate	24, 27, 102

Names	Synonyms	RGN
Silver sulfide		24, 33, 105
Silver tetrazene		24, 102
Silver trinitroresorcinate	Silver styphnate	24, 27, 102
Slaked lime	Calcium oxide	10, 107
Smokeless powder		102
Sodamide	Sodium amide	10, 107
Soda niter	Sodium nitrate	104
Sodium		21, 105, 107
Sodium acid fluoride	Sodium fluoride	15
Sodium aluminate		10, 105
Sodium aluminum hydride		105, 107
Sodium amide	Sodamide	10, 107
Sodium arsenate		24
Sodium arsenite		24
Sodium azide		102
Sodium bichromate	Sodium dichromate	24, 104
Sodium bifluoride	Sodium fluoride	15
Sodium bromate		104
Sodium cacodylate	Sodium dimethylarsenate	24
Sodium carbonate		10
Sodium carbonate peroxide		104
Sodium chlorate		104
Sodium chlorite		104
Sodium chromate		24
Sodium cyanide		11
Sodium dichloroisocyanurate		104
Sodium dichromate	Sodium bichromate	24, 104
Sodium dimethylarsenate	Sodium cacodylate	24
Sodium fluoride	Sodium acid fluoride	15
Sodium hydride		105, 107
Sodium hydroxide	Caustic soda, Lye	10
Sodium hypochlorite		10, 104
Sodium hyposulfite	Sodium thiosulfate	105
Sodium methylate	Sodium methoxide	10, 107
Sodium methoxide	Sodium methylate	10, 107
Sodium molybdate		24
Sodium monoxide	Sodium oxide	10, 107
Sodium nitrate	Soda niter	104
Sodium nitride		25
Sodium nitrite		104
Sodium oxide	Sodium monoxide	10, 107
Sodium pentachlorophenate		31
Sodium perchlorate		104
Sodium permanganate		24, 104
Sodium peroxide		104, 107
Sodium phenolsulfonate		31
Sodium picramate		27, 102
Sodium polysulfide		101
Sodium potassium alloy	Nak, Nack	21, 107
Sodium selenate		24

Names	Synonyms	RGN
Sodium sulfide		24, 33, 105
Sodium thiosulfate		105
Stannic chloride	Tin tetrachloride	24, 107
Stannic sulfide		33, 105
Starch nitrate	Nitrostarch	27, 102
Stilbene	Diphenyl ethylene	16
Stoddard solvent		101
Strontium		24
Strontium arsenate		24
Strontium dioxide	Strontium peroxide	24, 104
Strontium monosulfide		24, 33, 105
Strontium nitrate		24, 104
Strontium peroxide	Strontium dioxide	104
Strontium tetrasulfide		24, 33, 105
Styphnic acid	Trinitroresorcinol	27, 31, 102
Styrene	Vinylbenzene	16, 28, 103
Succinic acid		3
Succinic acid peroxide		30
Sulfonyl chloride	Sulfuryl chloride	107
Sulfonyl flouride		107
Sulfotepp	Dithione*, Blada-Fum*	32
Sulfur chloride	Sulfur monochloride	107
Sulfur (elemental)		101
Sulfuric acid	Oil of Vitriol, Oleum	2, 107
Sulfuric anhydride	Sulfur trioxide	104, 107
Sulfur monochloride	Sulfur chloride	107
Sulfur mustard		20
Sulfur oxychloride	Thionyl chloride	107
Sulfur pentafluoride		15, 107
Sulfur trioxide	Sulfuric anhydride	104, 107
Sulfuryl chloride	Sulfonyl chloride	107
Sulfuryl fluoride	Sulfonyl fluoride	107
Supracide*	Ultracide*	32
Surecide*	Cyanophenphos	32
Synthetic rubber		101
TCDD	Tetrachlorodibenzo-p-dioxin	14, 17
TEDP	Tetrethyl dithionopyrophosphate	32
TEL	Tetraethyl lead	24
TEPA	Tris-(1-aziridinyl) phosphine oxide	6, 32
TEPP	Tetraethyl pyrophosphate	32
THF	Tetrahydrofuran	14
TMA	Trimethylamine	7
TML	Tetramethyl lead	24
TNB	Trinitrobenzene	27, 102
TNT	Trinitrotoluene	27, 102
Tall oil		101
Tallow		101
Tar		101
Tellurium hexafluoride		15, 24
Temik*	Aldicarb	9, 20

Names	Synonyms	RGN
Tetraborane		105
Tetrachlorodibenzo-p-dioxin	TCDD	14, 17
Tetrachloroethane		17
Tetrachloroethylene	Perchloroethylene	17
Tetrachloromethane	Carbon tetrachloride	17
Tetrachlorophenol		17, 31
Tetrachloropropyl ether		14, 17
Tetradecene		28
Tetraethyl dithionopyrophosphate	TEDP	32
Tetraethyl lead	TEL	24
Tetraethyl pyrophosphate	TEPP	32
Tetrahydrofuran	THF	14
Tetramethylenediamine		7
Tetramethyl lead	TML	24
Tetramethyl succinonitrile		26
Tetranitromethane		27, 102
Tetraphenyl ethylene		16
Tetraphosphorus trisulfide	Phosphorus sesquisulfide	33, 105, 107
Tetraselenium tetranitride		24, 25, 102
Tetrasul	Animert* V-101	20
Tetrasulfur tetranitride		25, 102
Tetrazene		8, 102
Thallium		24
Thallium nitride		24, 25, 102
Thallium sulfide		24, 33, 105
Thallous sulfate		24
Thimet*	Phorate	32
Thionyl chloride	Sulfur oxychloride	107
Thiocarbonyl chloride	Thiophosgene	107
Thiodan*	Endosulfan	17, 20
Thionazin	Zinophos*	32
Thionyl chloride	Sulfur oxychloride	107
Thiophosgene	Thiocarbonyl chloride	107
Thiophosphoryl chloride		107
Thiram		12
Thorium		22, 23, 24
Tin tetrachloride	Stannic chloride	24, 107
Titanic chloride	Titanium tetrachloride	24, 107
Titanium		22, 23, 24
Titanium sesquisulfide		24, 33, 105
Titanium sulfate		24
Titanium sulfide		24, 33, 105
Titanium tetrachloride	Titanic chloride	24, 107
TMA	Trimethylamine	7
TNB	Trinitrobenzene	27, 102
TNT	Trinitrotoluene	27, 102
Tolualdehyde		5
Toluene	Toluol, Methylbenzene	16
Toluene diisocyanate		18, 107
Toluic acid		3

Names	Synonyms	RGN
Toluidine	Aminotoluene	7
Toluol	Toluene, Methylbenzene	16
Topcide*	Benzadox	6
Tranid*		9, 26
Triamphos	Wepsyn* 155	6, 32
Tribromomethane	Bromoform	17
Tri-n-butylaluminum		107
Tricadmium dinitride		24, 25
Tricalcium dinitride		25
Tricesium nitride		24, 25
Trichloroacetaldehyde	Chloral hydrate	5, 17
Trichloroborane		107
Trichloroethane		17
Trichloroethene	Trichloroethylene	17
Trichloroisocyanuric acid		104
Trichloromethane	Chloroform	17
Trichloromethyl sulfenyl chloride	Perchloromethyl mercaptan	17, 20
Trichloronitromethane	Chloropicrin	17, 27, 102
Trichlorophenoxyacetic acid		3, 17
Trichloropropane		17
Trichlorosilane	Silicochloroform	107
Tridecene		28
Triethanolamine		4, 7
Triethyl aluminum		105, 107
Triethyl antimony	Triethylstibine	24, 105, 107
Triethyl arsine		24, 107
Triethyl bismuthine		24
Triethylamine		7
Triethylene phosphoramide	Tris(1-aziridinyl) phosphine oxide	6, 32
Triethylene tetraamine		7
Triethyl stibine	Triethyl antimony	24, 105, 107
Trifluoroethane		17
Trifluoromethylbenzene	Benzotrifluoride	17
Triisobutyl aluminum		105, 107
Trilead dinitride		24, 25, 102
Trimercury dinitride		24, 25, 102
Trimethyl aluminum		105, 107
Trimethylamine	TMA	7
Trimethyl antimony	Trimethylstibine	24, 105
Trimethyl arsine		24, 107
1,2,4-Trimethylbenzene	Pseudocumene	16
1,3,5-Trimethylbenzene	Mesitylene	16
Trimethyl bismuthine		24
Trimethyl pentane	Isooctane	29
Trimethylstibine	Trimethyl antimony	24, 105, 107
Tri-n-butylborane		105, 107
Trinitroaniline	Picramide	7, 27, 102
Trinitroanisole	Trinitrophenylmethyl ether	14, 27
Trinitrobenzene	TNB	27, 102

Names	Synonyms	RGN
Trinitrobenzoic acid		3, 27, 102
Trinitroglycerin	Nitroglycerin	27, 102
Trinitronaphthalene	Naphtite	27, 102
Trinitrophenol	Picric acid	27, 31, 102
Trinitrophenyl methyl ether	Trinitroanisole	14, 27
Trinitroresorcinol	Styphnic acid	27, 31, 102
Trinitrotoluene	TNT	27, 102
Trioctyl aluminum		105, 107
Triphenyl ethylene		16
Triphenyl methane		16
Tripropylamine		7
Tripropyl stibine		24, 107
Trisilyl arsine		24, 107
Tris-(1-aziridinyl) phosphine oxide	TEPA, Triethylene phosphoramide	6, 32
Trithion		32
Trithorium tetranitride		24, 25
Trivinyl stibine		24, 107
Tsumacide*		9
Tungstic acid		24
Turpentine		101
UDMH	Dimethyl hydrazine	8
Ultracide*	Supracide*	32
Undecene		28
Unisolve		101
Uranium nitrate	Uranyl nitrate	24, 104
Uranium sulfide		24, 33, 105
Uranyl nitrate	Uranium nitrate	24, 104
Urea formaldehyde		5
Urea nitrate		27, 102, 104
VC	Vinylidene chloride	17, 103
Valeraldehyde	Pentanal	5
Valeramide		6
Valeric acid		3
Vanadic acid anhydride	Vanadium pentoxide	24
Vanadium oxytrichloride		24
Vanadium pentoxide	Vanadic acid anhydride	24
Vanadium sulfate	Vanadyl sulfate	24
Vanadium tetroxide		24
Vanadium trichloride		24, 107
Vanadium trioxide		24
Vanadyl sulfate	Vanadium sulfate	24
Vapona*	DDVP	32
Vinyl acetate		13, 103
Vinyl azide		102
Vinylbenzene	Styrene	16, 28, 103
Vinyl chloride		17, 103
Vinyl cyanide		26, 103
Vinyl ethyl ether		14
Vinyl isopropyl ether		17

Names	Synonyms	RGN
Vinylidene chloride	VC	17, 103
Vinyl toluene		28, 103
Vinyl trichlorosilane		107
VX		20, 32
Water		106
Waxes		101
Wepsyn* 155	Triamiphos	6, 32
Wood		101
Zectran*	Dowco 139*	9
Zinc		22, 23, 24
Zinc acetylide		24, 105, 107
Zinc ammonium nitrate		24, 104
Zinc arsenate		24
Zinc arsenite		24
Zinc chloride		24
Zinc dioxide	Zinc peroxide	24, 102, 104, 107
Zinc ethyl	Diethyl zinc	24, 105, 107
Zinc cyanide		11, 24
Zinc fluoborate		24, 15
Zinc nitrate		24, 104
Zinc permanganate		24, 104
Zinc peroxide	Zinc dioxide	24, 102, 104, 107
Zinc phosphide		24, 107
Zinc salts of dimethyl dithiocarbamic acid		12, 24
Zinc sulfate		24
Zinc sulfide		24, 33, 105
Zineb*		12, 24
Zinophos*	Thioazin	20
Ziram*		12, 24
Zirconium		22, 23, 24
Zirconium chloride	Zirconium tetrachloride	24
Zirconium picramate		24, 104
Zirconium tetrachloride	Zirconium chloride	24

APPENDIX 2. LIST OF WASTE CONSTITUENTS BY CHEMICAL CLASS AND REACTIVITY

This appendix categorizes the chemical substances in Appendix 1 into reactivity groups according to molecular functional groups, chemical classes, or chemical reactivities. The substances are divided into 41 Reactivity Group Numbers (RGN) and listed consecutively in the first two pages of this appendix. RGN 1 to 34 are categorized based on molecular functional groups, 101 to 107 on chemical reactivities. The reactivity groupings here are identical to those depicted in the Hazardous Wastes Compatibility Chart (Figure 6) in Section 5 of this report.

The succeeding pages of this appendix contain the tabulations of the chemical substances in Appendix 1 under their respective RGN. All trade names in the tables are denoted by asterisks (*) consistent with the notations used in Appendix 1.

This appendix is used to obtain the RGN of hazardous wastes when the waste constituents are known only by chemical classes, molecular functional groups, or chemical reactivities. The information is used to determine the compatibility of the combinations of the wastes according to the compatibility method in Section 4 of this report.

The listing was developed from the same primary references used in Appendix 1, namely Ref. 1, 7, 8, 10, 12, 13, 14, 32, 44, 52, and 77. The reactivity groupings of waste constituents presented here are not inclusive. Additions or deletions may be made in the future when more information is available from the management of hazardous wastes.

Reactivity Group Number	Group Name
1	Acids, Mineral, Non-oxidizing
2	Acids, Mineral, Oxidizing
3	Acids, Organic
4	Alcohols and Glycols
5	Aldehydes
6	Amides
7	Amines, Aliphatic and Aromatic
8	Azo Compounds, Diazo Compounds, and Hydrazines
9	Carbamates
10	Caustics
11	Cyanides
12	Dithiocarbamates
13	Esters
14	Ethers
15	Fluorides, Inorganic
16	Hydrocarbons, Aromatic

Reactivity Group Number	Group Name
17	Halogenated Organics
18	Isocyanates
19	Ketones
20	Mercaptans and Other Organic Sulfides
21	Metals, Alkali and Alkaline Earth, Elemental and Alloys
22	Metals Other Elemental and Alloys in the Form of Powders, Vapors or Sponges
23	Metals, Other Elemental, and Alloy, as Sheets, Rods, Moldings, Drops, etc
24	Metals and Metal Compounds, Toxic
25	Nitrides
26	Nitriles
27	Nitro Compounds
28	Hydrocarbon, Aliphatic, Unsaturated
29	Hydrocarbon, Aliphatic, Saturated
30	Peroxides and Hydroperoxides, Organic
31	Phenols and Creosols
32	Organophosphates, Phosphothioates and Phosphodithioates
33	Sulfides, Inorganic
34	Epoxides
101	Combustible and Flammable Materials, Miscellaneous
102	Explosives
103	Polymerizable Compounds
104	Oxidizing Agents, Strong
105	Reducing Agents, Strong
106	Water and Mixtures Containing Water
107	Water Reactive Substances

GROUP 1 Acids, Mineral, Non-Oxidizing

Boric acid
Chlorosulfonic acid
Difluorophosphoric acid
Disulfuric acid
Fluoroboric acid
Fluorosulfonic acid
Fluosilicic acid
Hexafluorophosphoric acid
Hydriodic acid
Hexafluorophosphoric acid
Hydriodic acid
Hydrobromic acid
Hydrochloric acid
Hydrocyanic acid
Hydrofluoric acid
Monofluorophosphoric acid
Permonosulfuric acid
Phosphoric acid
Selenous acid

GROUP 2 Acids, Mineral Oxidizing

Bromic acid
Chloric acid
Chromic acid
Hypochlorous acid
Nitric acid
Nitrohydrochloric acid
Oleum
Perbromic acid
Perchloric acid
Perchlorous acid

GROUP 2 Acids, Mineral Oxidizing cont'd

Periodic acid
Sulfuric acid

GROUP 3 Acids, Organic (All Isomers)

Acetic acid
Acrylic acid
Adipic acid
Benzoic acid
Butyric acid
Capric acid
Caproic acid
Caprylic acid
Chloromethylphenoxyacetic acid
Cyanoacetic acid
Dichlorophenoxyacetic acid
Endothal
Fluoroacetic acid
Formic acid
Fumaric acid
Glycolic acid
Hydroxydibromobenzoic acid
Maleic acid
Monochloroacetic acid
Oxalic acid
Peracetic acid
Phenyl acetic acid
Phthalic acid
Propionic acid
Succinic acid
Trichlorophenoxyacetic acid
Trinitrobenzoic acid
Toluic acid
Valeric acid

GROUP 4 Alcohols and Glycols (All Isomers)

Acetone cyanohydrin
Allyl alcohol
Aminoethanol
Amyl alcohol
Benzyl alcohol
Butanediol
Butyl alcohol
Butyl cellosolve*
Chloroethanol
Crotyl alcohol
Cyclohexanol
Cyclopentanol
Decanol
Diacetone alcohol
Dichloropropanol
Diethanol amine
Diisopropanolamine
Ethanol
Ethoxyethanol
Ethylene chlorohydrin
Ethylene cyanohydrin
Ethylene glycol
Ethylene glycol monomethyl ether
Glycerin
Heptanol
Hexanol
Isobutanol
Isopropanol
Mercaptoethanol
Methanol
Monoethanol amine
Monoisopropanol amine
Monoisopropanol amine
Nonanol
Octanol
Propanol
Propylene glycol
Propylene glycol monomethyl ether
Triethanolamine

GROUP 5 Aldehydes (All Isomers)

Acetaldehyde
Acrolein
Benzaldehyde
Butyraldehyde
Chloral hydrate
Chloroacetaldehyde
Crotonaldehyde
Formaldehyde
Furfural
Glutaraldehyde
Heptanal
Hexanal
Nonanal
Octanal
Propionaldehyde
Tolualdehyde
Urea formaldehyde
Valeraldehyde

GROUP 6 Amides (All Isomers)

Acetamide
Benzadox
Bromobenzoyl acetanilide
Butyramide
Carbetamide
Diethyltoluamide
Dimethylformamide
Dimefox
Diphenamide
Fluoroacetanilide
Formamide
Propionamide
Schradan
Tris-(1-aziridinyl) phosphine oxide
Wepsyn* 155
Valeramide

GROUP 7 Amines, Aliphatic and Aromatic (All Isomers)

Aminodiphenyl
Aminoethanol
Aminoethanolamine
Aminophenol
Aminopropionitrile
Amylamine
Aminothiazole
Aniline
Benzidine
Benzylamine
Butylamine
Chlorotoluidine
Crimidine
Cupriethylenediamine
Cyclohexylamine
Dichlorobenzidine
Diethanolamine
Diethylamine
Diethylenetriamine
Diisopropanolamine
Dimethylamine
Dimethylaminoazobenzene
Diphenylamine
Diphenylamine chloroarsine
Dipicrylamine
Dipropylamine
Ethylamine
Ethylenediamine
Ehtyleneimine
Hexamethylenediamine
Hexamethylenetetraamine
Hexylamine
Isopropylamine
Methylamine
N-Methyl aniline
4,4-Methylene bis(2-chloroaniline)
Methyl ethyl pyridine
Monoethanolamine
Monoisopropanolamine
Morpholine
Naphthylamine
Nitroaniline
Nitroaniline
Nitroaniline
Nitrogen mustard
Nitrosodimethylamine
Pentylamine
Phenylene diamine
Picramide
Picridine
Piperidine
Propylamine
Propyleneimine
Pyridine
Tetramethylenediamine
Toluidine
Triethanolamine
Triethylamine
Triethylenetetraamine
Trimethylamine
Tripropylamine

GROUP 8 Azo Compounds, Diazo Compounds and Hydrazines (All Isomers)

Aluminum tetraazidoborate
Aminothiazole
Azidocarbonyl guanidine
Azido-s-triazole
a,á-Azodiisobutyronitrile
Benzene diazonium chloride
Benzotriazole
t-Butyl azidoformate
Chloroazodin
Chlorobenzotriazole
Diazodinitrophenol
Diazidoethane
Dimethylamino azobenzene
Dimethyl hydrazine

GROUP 8 Azo Compounds, Diazo Compounds and Hydrazines (All Isomers) cont'd

Dinitrophenyl hydrazine
Guanyl nitrosoaminoguanylidine hydrazine
Hydrazine
Hydrazine azide
Methyl hydrazine
Mercaptobenzothiazole
Phenyl hydrazine hydrochloride
Tetrazene

GROUP 9 Carbamates

Aldicarb
Bassa*
Baygon*
Butacarb
Bux*
Carbaryl
Carbanolate
Dioxacarb
Dowco* 139
Formetanate hydrochloride
Furadan*
Hopcide*
N-Isopropylmethylcarbamate
Landrin*
Matacil*
Meobal
Mesurol*
Methomyl
Mipcin*
Mobam*
Oxamyl
Pirimicarb
Promecarb
Tranid*
Tsumacide*

GROUP 10 Caustics

Ammonia
Ammonium hydroxide
Barium hydroxide
Barium oxide
Beryllium hydroxide
Cadmium amide
Calcium hydroxide
Calcium oxide
Lithium amide
Lithium hydroxide
Potassium aluminate
Potassium butoxide
Potassium hydroxide
Sodium aluminate
Sodium amide
Sodium carbonate
Sodium hydroxide
Sodium hypochlorite
Sodium methylate
Sodium oxide

GROUP 11 Cyanides

Cadmium cyanide
Copper cyanide
Cyanogen bromide
Hydrocyanic acid
Lead cyanide
Mercuric cyanide
Mercuric oxycyanide
Nickel cyanide
Potassium cyanide
Silver cyanide
Sodium cyanide
Zinc cyanide

GROUP 12 Dithiocarbamates

CDEC
Dithane* M-45
Ferbam
Maneb
Metham
Nabam
Niacide*
Polyram-combi*
Selenium diethyl dithiocarbamate
Thiram
Zinc salts of dimethyl dithiocarbamic acid
Zineb
Ziram

GROUP 13 Esters (All Isomers)

Allyl chlorocarbonate
Amyl acetate
Butyl acetate

GROUP 13 Esters (All Isomers) cont'd

Butyl acrylate
Butyl benzyl phthalate
Butyl formate
Dibutyl phthalate
Diethylene glycol monobutyl ether acetate
Ethyl acetate
Ethyl acrylate
Ethyl butyrate
Ethyl chloroformate
Ethyl formate
2-Ethyl hexylacrylate
Ethyl propionate
Glycol diacetate
Isobutyl acetate
Isobutyl acrylate
Isodecyl acrylate
Isopropyl acetate
Medinoterb acetate
Methyl acetate
Methyl acrylate
Methyl amyl acetate
Methyl butyrate
Methyl chloroformate
Methyl formate
Methyl methacrylate
Methyl propionate
Methyl valerate
Propiolactone
Propyl acetate
Propyl formate
Vinyl acetate

GROUP 14 Ethers (All Isomers)

Anisole
Butyl cellosolve*
Bromodimethoxyaniline
Dibutyl ether
Dichloroethyl ether
Dimethyl ether
Dimethyl formal
Dioxane
Diphenyl oxide
Ethoxyethanol
Ethyl ether
Ethylene glycol monomethyl ether
Furan
Glycol ether
Isopropyl ether
Methyl butyl ether
Methyl chloromethyl ether
Methyl ethyl ether
Polyglycol ether
Propyl ether
Propylene glycol monomethyl ether
TCDD
Tetrachloropropyl ether
Tetrahydrofuran
Trinitroanisole
Vinyl ethyl ether
Vinyl isopropyl ether

GROUP 15 Fluorides, Inorganic

Aluminum fluoride
Ammonium bifluoride
Ammonium fluoride
Barium fluoride
Beryllium fluoride
Cadmium fluoride
Calcium fluoride
Cesium fluoride
Chromic fluoride
Fluoroboric acid
Fluorosilicic acid
Hexafluorophosphoric acid
Hydrofluoric acid
Magnesium fluoride
Potassium fluoride
Selenium fluoride
Silicon tetrafluoride
Sodium fluoride
Sulfur pentafluoride
Tellurium hexafluoride
Zinc fluoroborate

GROUP 16 Hydrocarbons, Aromatic (All Isomers)

Acenaphthene
Anthracene
Benz-a-pyrene
Benzene
n-Butyl benzene
Chrysene
Cumene
Cymene
Decyl benzene
Diethyl benzene
Diphenyl

GROUP 16 Hydrocarbons, Aromatic (All Isomers) cont'd

Diphenyl acetylene
Diphenyl ethane
Diphenyl ethylene
Diphenyl methane
Dodecyl benzene
Dowtherm
Durene
Ethyl benzene
Fluoranthrene
Fluorene
Hemimellitene
Hexamethyl benzene
Indene
Isodurene
Mesitylene
Methyl naphthalene
Naphthalene
Pentamethyl benzene
Phenanthrene
Phenyl acetylene
Propyl benzene
Pseudocumene
Styrene
Tetraphenyl ethylene
Toluene
Stilbene
Triphenylethylene
Triphenylmethane

GROUP 17 Halogenated Organics (All Isomers)

Acetyl bromide
Acetyl chloride
Aldrin
Allyl bromide
Allyl chloride
Allyl chlorocarbonate
Amyl chloride
Benzal bromide
Benzal chloride
Benzotribromide
Benzotrichloride
Benzyl bromide
Benzyl chloride
Benzyl chlorocarbonate
Bromoacetylene
Bromobenzyl trifluoride
Bromoform
Bromophenol
Bromopropyne
Bromotrichloromethane
Bromotrifluoromethane
Bromoxynil
Butyl fluoride
Carbon tetrachloride
Carbon tetrafluoride
Carbon tetraiodide
Chloral hydrate
Chlordane
Chloroacetaldehyde
Chloroacetic acid
Chloroacetophenone
Chloroacrylonitrile
Chloroazodin
Chlorobenzene
Chlorobenzotriazole
Chlorobenzoyl peroxide
Chlorobenzylidene malononitrile
Chlorobutyronitrile
Chlorocresol
Chlorodinitrotoluene
Chloroethanol
Chloroethylenimime
Chloroform
Chlorohydrin
Chloromethyl methyl ether
Chloromethyl phenoxyacetic acid
Chloronitroaniline
Chlorophenol
Chlorophenyl isocyanate
Chloropicrin
Chlorothion
Chlorotoluidine
CMME
Crotyl bromide
Crotyl chloride
DDD
DDT
DDVP
Dibromochloropropane
Dichloroacetone
Dichlorobenzene
Dichlorobenzidine
Dichloroethane
Dichloroethylene
Dichloroethyl ether
Dichloromethane

GROUP 17 Halogenated Organics (All Isomers) cont'd

Dichlorophenol
Dichlorophenoxy acetic acid
Dichloropropane
Dichloropropanol
Dichloropropylene
Dieldrin
Diethyl chloro vinyl phosphate
Dichlorophene
Dinitrochlorobenzene
Endosulfan
Endrin
Epichlorohydrin
Ethyl chloroformate
Ethylene chlorohydrin
Ethylene dibromide
Ethylene dichloride
Fluoroacetanilide
Freons*
Heptachlor
Hexachlorobenzene
Hydroxydibromobenzoic acid
Isopropyl chloride
α-Isopropyl methyl phosphoryl fluoride
Lindane
Methyl bromide
Methyl chloride
Methyl chloroform
Methyl chloroformate
Methyl ethyl chloride
Methyl iodide
Monochloroacetone
Nitrochlorobenzene
Nitrogen mustard
Pentachlorophenol
Perchloroethylene
Pechloromethylmercaptan
Picryl chloride
Polybrominated biphenyls
Polychlorinated biphenyls
Polychlorinated triphenyls
Propargyl bromide
Propargyl chloride
TCDD
Tetrachloroethane
Tetrachlorophenol
Tetrachloropropyl ether
Trichloroethane
Trichloroethylene
Trichlorophenoxyacetic acid
Trichloropropane
Trifluoroethane
Vinyl chloride
Vinylidene chloride

GROUP 18 Isocyanates (All Isomers)

Chlorophenyl isocyanate
Diphenylmethane diisocyanate
Methyl isocyanate
Methylene diisocyanate
Polyphenyl polymethylisocyanate
Toluene diisocyanate

GROUP 19 Ketones (All Isomers)

Acetone
Acetophenone
Acetyl acetone
Benzophenone
Bromobenzoyl acetanilide
Chloroacetophenone
Coumafuryl
Coumatetralyl
Cyclohexanone
Diacetone alcohol
Diacetyl
Dichloroacetone
Diethyl ketone
Diisobutyl ketone
Heptanone
Hydroxyacetophenone
Isophorone
Mesityl oxide
Methyl t-butyl ketone
Methyl ethyl ketone
Methyl isobutyl ketone
Methyl isopropenyl ketone
Methyl n-propyl ketone
Methyl vinyl ketone
Monochloroacetone
Nonanone
Octanone
Pentanone
Quinone

GROUP 20 Mercaptans and Other Organic Sulfides (All Isomers)

Aldicarb
Amyl mercaptan
Butyl mercaptan
Carbon disulfide
Dimethyl sulfide
Endosulfan
Ethyl mercaptan
Mercaptobenzothiazole
Mercaptoethanol
Methomyl
Methyl mercaptan
Naphthyl mercaptan
Perchloromethyl mercaptan
Phospholan
Polysulfide polymer
Propyl mercaptan
Sulfur mustard
Tetrasul
Thionazin
VX

GROUP 21 Metals, Alkali and Alkaline Earth, Elemental

Barium
Calcium
Cesium
Lithium
Magnesium
Potassium
Rubidium
Sodium
Sodium-potassium alloy
Strontium

GROUP 22 Metals, Other Elemental and Alloys in the Form of Powders, Vapors or Sponges

Aluminum
Bismuth
Cerium
Cobalt
Hafnium
Indium
Magnesium
Manganese
Mercury (vapor)
Molybdenum
Nickel
Raney nickel
Selenium
Titanium
Thorium
Zinc
Zirconium

GROUP 23 Metals, Other Elemental and Alloys as Sheets, Rods, Moldings, Drops, etc.

Aluminum
Antimony
Bismuth
Brass
Bronze
Cadmium
Calcium-manganese-silicon alloy
Chromium
Cobalt
Copper
Indium
Iron
Lead
Manganese
Molybdenum
Osmium
Selenium
Titanium
Thorium
Zinc
Zirconium

GROUP 24 Metals and Metal Compounds, Toxic

Ammonium arsenate
Ammonium dichromate
Ammonium hexanitrocobaltate
Ammonium molybdate
Ammonium nitridoosmate
Ammonium permanganate
Ammonium tetrachromate
Ammonium tetraperoxychromate
Ammonium trichromate
Antimony
Antimony nitride
Antimony oxychloride

GROUP 24 Metals and Metal Compounds, Toxic

Antimony pentachloride
Antimony pentafluoride
Antimony pentasulfide
Antimony perchlorate
Antimony potassium tartrate
Antimony sulfate
Antimony tribromide
Antimony trichloride
Antimony triiodide
Antimony trifluoride
Antimony trioxide
Antimony trisulfide
Antimony trivinyl
Arsenic
Arsenic pentaselenide
Arsenic pentoxide
Arsenic pentasulfide
Arsenic sulfide
Arsenic tribromide
Arsenic trichloride
Arsenic trifluoride
Arsenic triiodide
Arsenic trisulfide
Arsines
Barium
Barium azide
Barium carbide
Barium chlorate
Barium chloride
Barium chromate
Barium fluoride
Barium fluosilicate
Barium hydride
Barium hydroxide
Barium hypophosphide
Barium iodate
Barium iodide
Barium nitrate
Barium oxide
Barium perchlorate
Barium permanganate
Barium peroxide
Barium phosphate
Barium stearate
Barium sulfide
Barium sulfite
Beryllium
Beryllium-copper alloy
Beryllium fluoride
Beryllium hydride
Beryllium hydroxide
Beryllium oxide
Beryllium tetrahydroborate
Bismuth
Bismuth chromate
Bismuthic acid
Bismuth nitride
Bismuth pentafluoride
Bismuth pentoxide
Bismuth sulfide
Bismuth tribromide
Bismuth trichloride
Bismuth triiodide
Bismuth trioxide
Borane
Bordeaux arsenites
Boron arsenotribromide
Boron bromodiodide
Boron dibromoiodide
Boron nitride
Boron phosphide
Boron triazide
Boron tribromide
Boron triiodide
Boron trisulfide
Boron trichloride
Boron trifluoride
Cacodylic acid
Cadmium
Cadmium acetylide
Cadmium amide
Cadmium azide
Cadmium bromide
Cadmium chlorate
Cadmium chloride
Cadmium cyanide
Cadmium fluoride
Cadmium hexamine chlorate
Cadmium hexamine perchlorate
Cadmium iodide
Cadmium nitrate
Cadmium nitride
Cadmium oxide
Cadmium phosphate
Cadmium sulfide
Cadmium trihydrazine chlorate
Cadmium trihydrazine perchlorate
Calcium arsenate

GROUP 24 Metals and Metal Compounds, Toxic cont'd

Calcium arsenite
Chromic chloride
Chromic fluoride
Chromic oxide
Chromic sulfate
Chromium
Chromium sulfide
Chromium trioxide
Chromyl chloride
Cobalt
Cobaltous bromide
Cobaltous chloride
Cobaltous nitrate
Cobaltous sulfate
Cobaltous resinate
Copper
Copper acetoarsenite
Copper acetylide
Copper arsenate
Copper arsenite
Copper chloride
Copper chlorotetrazole
Copper cyanide
Copper nitrate
Copper nitride
Copper sulfate
Copper sulfide
Cupriethylene diamine
Cyanochloropentane
Diethyl zinc
Diisopropyl beryllium
Diphenylamine chloroarsine
Ethyl dichloroarsine
Ethylene chromic oxide
Ferric arsenate
Ferrous arsenate
Hydrogen selenide
Indium
Lead
Lead acetate
Lead arsenate
Lead arsenite
Lead azide
Lead carbonate
Lead chlorite
Lead cyanide
Lead dinitroresorcinate
Lead mononitroresorcinate
Lead nitrate
Lead oxide
Lead styphnate
Lead sulfide
Lewisite
London purple
Magnesium arsenate
Magnesium arsenite
Manganese
Manganese acetate
Manganese arsenate
Manganese bromide
Manganese chloride
Manganese methylcyclopentadienyl tricarbonyl
Manganese nitrate
Manganese sulfide
Mercuric acetate
Mercuric ammonium chloride
Mercuric benzoate
Mercuric bromide
Mercuric chloride
Mercuric cyanide
Mercuric iodide
Mercuric nitrate
Mercuric oleate
Mercuric oxide
Mercuric oxycyanide
Mercuric potassium iodide
Mercuric salicylate
Mercuric subsulfate
Mercuric sulfate
Mercuric sulfide
Mercuric thiocyanide
Mercurol
Mercurous bromide
Mercurous gluconate
Mercurous iodide
Mercurous nitrate
Mercurous oxide
Mercurous sulfate
Mercury
Mercury fulminate
Methoxyethylmercuric chloride
Methyl dichloroarsine
Molybdenum
Molybdenum sulfide
Molydbenum trioxide
Molybdic acid
Nickel

GROUP 24 Metals and Metal Compounds, Toxic cont'd

Nickel acetate
Nickel antimonide
Nickel arsenate
Nickel arsenite
Nickel carbonyl
Nickel chloride
Nickel cyanide
Nickel nitrate
Nickel selenide
Nickel subsulfide
Nickel sulfate
Osmium
Osmium amine nitrate
Osmium amine perchlorate
Phenyl dichloroarsine
Potassium arsenate
Potassium arsenite
Potassium dichromate
Potassium permanganate
Selenium
Selenium fluoride
Selenium diethyl dithiocarbamate
Selenous acid
Silver acetylide
Silver azide
Silver cyanide
Silver nitrate
Silver nitride
Silver styphnate
Silver sulfide
Silver tetrazene
Sodium arsenate
Sodium arsenite
Sodium cacodylate
Sodium chromate
Sodium dichromate
Sodium molybdate
Sodium permanganate
Sodium selenate
Stannic chloride
Stannic sulfide
Strontium arsenate
Strontium monosulfide
Strontium nitrate
Strontium peroxide
Strontium tetrasulfide
Tellurium hexafluoride
Tetraethyl lead
Tetramethyl lead
Tetraselenium tetranitride
Thallium
Thallium nitride
Thallium sulfide
Thallous sulfate
Thorium
Titanium
Titanium sulfate
Titanium sesquisulfide
Titanium tetrachloride
Titanium sulfide
Tricadmium dinitride
Tricesium nitride
Triethyl arsine
Triethyl bismuthine
Triethyl stibine
Trilead dinitride
Trimercury dinitride
Trimethyl arsine
Trimethyl bismuthine
Trimethyl stibine
Tripropyl stibine
Trisilyl arsine
Trithorium tetranitride
Trivinyl stibine
Tungstic acid
Uranium sulfide
Uranyl nitrate
Vanadic acid anhydride
Vanadium oxytrichloride
Vanadium tetroxide
Vanadium trioxide
Vanadium trichloride
Vanadyl sulfate
Zinc
Zinc acetylide
Zinc ammonium nitrate
Zinc arsenate
Zinc arsenite
Zinc chloride
Zinc cyanide
Zinc fluoborate
Zinc nitrate
Zinc permanganate
Zinc peroxide
Zinc phosphide
Zinc salts of dimethyldithio carbamic acid
Zinc sulfate
Zinc sulfide

GROUP 24 Metals and Metal Compounds, Toxic cont'd

Zirconium
Zirconium chloride
Zirconium picramate

GROUP 25 Nitrides

Antimony nitride
Bismuth nitride
Boron nitride
Copper nitride
Disulfur dinitride
Lithium nitride
Potassium nitride
Silver nitride
Sodium nitride
Tetraselenium tetranitride
Tetrasulfur tetranitride
Thallium nitride
Tricadmium dinitride
Ticalcium dinitride
Tricesium nitride
Trilead dinitride
Trimercury dinitride
Trithorium tetranitride

GROUP 26 Nitriles (All Isomers)

Acetone cyanohydrin
Acetonitrile
Acrylonitrile
Adiponitrile
Aminopropionitrile
Amyl cyanide
a,a'-Azodiisobutyronitrile
Benzonitrile
Bromoxynil
Butyronitrile
Chloroacrylonitrile
Chlorobenzylidene malononitrile
Chlorobutyronitrile
Cyanoacetic acid
Cyanochloropentane
Cyanogen
Ethylene cyanohydrin
Glycolonitrile
Phenyl acetonitrile
Phenyl valerylnitrile
Propionitrile
Surecide*
Tetramethyl succinonitrile
Tranid*
Vinyl cyanide

GROUP 27 Nitro Compounds (All Isomers)

Acetyl nitrate
Chlorodinitroluene
Chloronitroaniline
Chloropicrin
Collodion
Diazodinitrophenol
Diethylene glycol dinitrate
Dinitrobenzene
Dinitrochlorobenzene
Dinitrocresol
Dinitrophenol
Dinitrophenyl hydrazine
Dinitrotoluene
Dinoseb
Dipentaerythritol hexanitrate
Dipicryl amine
Ethyl nitrate
Ethyl nitrite
Glycol dinitrate
Glycol monolactate trinitrate
Guanidine nitrate
Lead dinitroresorcinate
Lead mononitroresorcinate
Lead styphnate
Mannitol hexanitrate
Medinoterb acetate
Nitroaniline
Nitrobenzene
Nitrobiphenyl
Nitrocellulose
Nitrochlorobenzene
Nitroglycerin
Nitrophenol
Nitropropane
N-Nitrosodimethylamine
Nitrosoguanidine
Nitrostarch
Nitroxylene
Pentaerythritol tetranitrate
Picramide
Picric acid
Picryl chloride

GROUP 27 Nitro Compounds (All Isomers) cont'd

Polyvinyl nitrate
Potassium dinitrobenzfuroxan
RDX
Silver styphnate
Sodium picramate
Tetranitromethane
Trinitroanisole
Trinitrobenzene
Trinitrobenzoic acid
Trinitronaphthalene
Trinitroresorcinol
Trinitrotoluene
Urea nitrate

GROUP 28 Hydrocarbons, Aliphatic, Unsaturated (All Isomers)

Acetylene
Allene
Amylene
Butadiene
Butadiyne
Butene
Cyclopentene
Decene
Dicyclopentadiene
Diisobutylene
Dimethyl acetylene
Dimethyl butyne
Dipentene
Dodecene
Ethyl acetylene
Ethylene
Heptene
Hexene
Hexyne
Isobutylene
Isooctene
Isoprene
Isopropyl acetylene
Methyl acetylene
Methyl butene
Methyl butyne
Methyl styrene
Nonene
Octadecyne
Octene
Pentene
Pentyne
Polybutene
Polypropylene
Propylene
Styrene
Tetradecene
Tridecene
Undecene
Vinyl toluene

GROUP 29 Hydrocarbons, Aliphatic, Saturated

Butane
Cycloheptane
Cyclohexane
Cyclopentane
Cyclopropane
Decalin
Decane
Ethane
Heptane
Hexane
Isobutane
Isohexane
Isooctane
Isopentane
Methane
Methyl cyclohexane
Neohexane
Nonane
Octane
Pentane
Propane

GROUP 30 Peroxides and Hydroperoxides Organic (All Isomers)

Acetyl benzoyl peroxide
Acetyl peroxide
Benzoyl peroxide
Butyl hydroperoxide
Butyl peroxide
Butyl peroxyacetate
Butyl peroxybenzoate
Butyl peroxypivalate
Caprylyl peroxide
Chlorobenzoyl peroxide
Cumene hydroperoxide
Cyclohexanone peroxide

GROUP 30 Peroxides and Hydroperoxides Organic (All Isomers) cont'd

Dicumyl peroxide
Diisopropylbenzene hydroperoxide
Diisopropyl peroxydicarbonate
Dimethylhexane dihydroperoxide
Isopropyl percarbonate
Lauroyl peroxide
Methyl ethyl ketone peroxide
Peracetic acid
Succinic acid peroxide

GROUP 31 Phenols, Cresols (All Isomers)

Amino phenol
Bromophenol
Bromoxynil
Carbacrol
Carbolic oil
Catecol
Chlorocresol
Chlorophenol
Coal tar
Cresol
Creosote
Cyclohexyl phenol
Dichlorophenol
Dinitrocresol
Dinitrophenol
Dinoseb
Eugenol
Guaiacol
Hydroquinone
Hydroxyacetophenone
Hydroxydiphenol
Hydroxyhydroquinone
Isoeugenol
Naphthol
Nitrophenol
Nonyl phenol
Pentachlorophenol
Phenol
o-Phenyl phenol
Phloroglucinol
Picric acid
Pyrogallol
Resorcinol
Saligenin
Sodium pentachlorophenate
Sodium phenolsulfonate
Tetrachlorophenol
Thymol
Trichlorophenol
Trinitroresorcinol

GROUP 32 Organophosphates, Phosphothioates, and Phosphodithioates

Abate*
Azinphos ethyl
Azodrin*
Bidrin*
Bomyl*
Chlorfenvinphos
Chlorothion*
Coroxon*
DDVP
Demeton
Demeton-s-methyl sulfoxid
Diazinon*
Diethyl chlorovinyl phosphate
Dimethyldithiophosphoric acid
Dimefox
Dioxathion
Disulfoton
Dyfonate*
Endothion
EPN
Ethion*
Fensulfothion
Guthion*
Hexaethyl tetraphosphate
Malathion
Mecarbam
Methyl parathion
Mevinphos
Mocap*
α-Isopropyl methylphosphoryl fluoride
Paraoxon
Parathion
Phorate
Phosphamidon
Phospholan
Potasan
Prothoate
Shradan
Sulfotepp
Supracide*

GROUP 32 Organophosphates, Phosphothioates, and Phosphodithioates cont'd

Shradan
Sulfotepp
Supracide*
Surecide*
Tetraethyl dithionopyrophosphate
Tetraethyl pyrophosphate
Thionazin
Tris-(l-aziridinyl) phosphine oxide
VX
Wepsyn* 155

GROUP 33 Sulfides, Inorganic

Ammonium sulfide
Antimony pentasulfide
Antimony trisulfide
Arsenic pentasulfide
Arsenic sulfide
Arsenic trisulfide
Barium sulfide
Beryllium sulfide
Bismuth sulfide
Bismuth trisulfide
Boron trisulfide
Cadmium sulfide
Calcium sulfide
Cerium trisulfide
Cesium sulfide
Chromium sulfide
Copper sulfide
Ferric sulfide
Ferrous sulfide
Germanium sulfide
Gold sulfide
Hydrogen sulfide
Lead sulfide
Lithium sulfide
Magnesium sulfide
Manganese sulfide
Mercuric sulfide
Molybdenum sulfide
Nickel subsulfide
Phosphorous heptasulfide
Phosphorous pentasulfide
Phosphorous sesquisulfide
Phosphorous trisulfide
Potassium sulfide
Silver sulfide
Sodium sulfide
Stannic sulfide
Strontium monosulfide
Strontium tetrasulfide
Thallium sulfide
Titanium sesquisulfide
Titanium sulfide
Uranium sulfide
Zinc sulfide

GROUP 34 Epoxides

Butyl glycidyl ether
t-Butyl-3-phenyl oxazirane
Cresol glycidyl ether
Diglycidyl ether
Epichlorohydrin
Epoxybutane
Epoxybutene
Epoxyethylbenzene
Ethylene oxide
Glycidol
Phenyl glycidyl ether
Propylene oxide

GROUP 101 Combustible and Flammable Materials, Miscellaneous

Alkyl resins
Asphalt
Bakelite*
Buna-N*
Bunker fuel oil
Camphor oil
Carbon, activated, spent
Cellulose
Coal oil
Diesel oil
Dynes thinner
Gas oil, cracked
Gasoline
Grease
Isotactic propylene
J-100
Jet oil
Kerosene
Lacquer thinner
Methyl acetone

GROUP 101 Combustible and Flammable Materials, Miscellaneous cont'd

Mineral spirits
Naphtha
Oil of bergamot
Orris root
Paper
Petroleum naphtha
Petroleum oil
Polyamide resin
Polyester resin
polyethylene
Polymeric oil
Polypropylene
Polystyrene
Polysulfide polymer
Polyurethane
Polyvinyl acetate
Polyvinyl chloride
Refuse
Resins
Sodium polysulfide
Stoddard solvent
Sulfur (elemental)
Synthetic rubber
Tall oil
Tallow
Tar
Turpentine
Unisolve
Waxes
Wood

GROUP 102 Explosives

Acetyl azide
Acetyl nitrate
Ammonium azide
Ammonium chlorate
Ammonium hexanitrocobaltate
Ammonium nitrate
Ammonium nitrite
Ammonium periodate
Ammonium permanganate
Ammonium picrate
Ammonium tetraperoxychromate
Azidocarbonyl guanidine
Barium azide
Benzene diazonium chloride
Benzotriazole
Benzoyl peroxide
Bismuth nitride
Boron triazide
Bromine azide
Butanetriol trinitrate
t-Butyl hypochlorite
Cadmium azide
Cadmium hexamine chlorate
Cadmium hexamine perchlorate
Cadmium nitrate
Cadmium nitride
Cadmium trihydrazine chlorate
Calcium nitrate
Cesium azide
Chlorine azide
Chlorine dioxide
Chlorine fluoroxide
Chlorine trioxide
Chloroacetylene
Chloropicrin
Copper acetylide
Cyanuric triazide
Diazidoethane
Diazodinitrophenol
Diethylene glycol dinitrate
Dipentaerithritol hexanitrate
Dipicryl amine
Disulfur dinitride
Ethyl nitrate
Ethyl nitrite
Fluorine azide
Glycol dinitrate
Glycol monolactate trinitrate
Gold fulminate
Guanyl nitrosaminoguanylidene hydrazine
HMX
Hydrazine azide
Hydrazoic acid
Lead azide
Lead dinitroresorcinate
Lead mononitroresorcinate
Lead styphnate
Mannitol hexanitrate
Mercuric oxycyanide
Mercury fulminate
Nitrocarbonitrate
Nitrocellulose
Nitroglycerin

GROUP 102 Explosives cont'd

Nitrosoguanidine
Nitrostarch
Pentaerythritol tetranitrate
Picramide
Picric acid
Picryl chloride
Polyvinyl nitrate
Potassium dinitrobenzfuroxan
Potassium nitrate
RDX
Silver acetylide
Silver azide
Silver nitride
Silver styphnate
Silver tetrazene
Smokeless powder
Sodium azide
Sodium picramate
Tetranitromethane
Tetraselenium tetranitride
Tetrasulfur tetranitride
Tetrazene
Thallium nitride
Trilead dinitride
Trimercury dinitride
Trinitrobenzene
Trinitrobenzoic acid
Trintironaphthalene
Trinitroresorcinol
Trinitrotoluene
Urea nitrate
Vinyl azide
Zinc peroxide

GROUP 103 Polymerizable Compounds

Acrolein
Acrylic acid
Acrylonitrile
Butadiene
n-Butyl acrylate
Ethyl acrylate
Ethylene oxide
Ethylenimine
2-Ethylhexyl acrylate
Isobutyl acrylate
Isoprene
Methyl acrylate
Methyl methacrylate
2-Methyl styrene
Propylene oxide
Styrene
Vinyl acetate
Vinyl chloride
Vinyl cyanide
Vinylidene chloride
Vinyl toluene

GROUP 104 Oxidizing Agents, Strong

Ammonium chlorate
Ammonium dichromate
Ammonium nitridoosmate
Ammonium perchlorate
Ammonium periodate
Ammonium permanganate
Ammonium persulfate
Ammonium tetrachromate
Ammonium tetraperoxychromate
Ammonium trichromate
Antimony perchlorate
Barium bromate
Barium chlorate
Barium iodate
Barium nitrate
Barium perchlorate
Barium permanganate
Barium peroxide
Bromic acid
Bromine
Bromine monofluoride
Bromine pentafluoride
Bromine trifluoride
t-Butyl hypochlorite
Cadmium chlorate
Cadmium nitrate
Calcium bromate
Calcium chlorate
Calcium chlorite
Calcium hypochlorite
Calcium iodate
Calcium nitrate
Calcium perchromate
Calcium permanganate
Calcium peroxide
Chloric acid
Chlorine
Chlorine dioxide
Chlorine fluoroxide
Chlorine monofluoride

GROUP 104 Oxidizing Agents, Strong cont'd

Chlorine monoxide
Chlorine pentafluoride
Chlorine trifluoride
Chlorine trioxide
Chromic acid
Chromyl chloride
Cobaltous nitrate
Copper nitrate
Dichloroamine
Dichloroisocyanuric acid
Ethylene chromic oxide
Fluorine
Fluorine monoxide
Guanidine nitrate
Hydrogen peroxide
Iodine pentoxide
Lead chlorite
Lead nitrate
Lithium hypochlorite
Lithium peroxide
Magnesium chlorate
Magnesium nitrate
Magnesium perchlorate
Magnesium peroxide
Manganese nitrate
Mercuric nitrate
Mercurous nitrate
Nickel nitrate
Nitrogen dioxide
Osmium amine nitrate
Osmium amine perchlorate
Oxygen difluoride
Perchloryl fluoride
Phosphorus oxybromide
Phosphorus oxychloride
Potassium bromate
Potassium dichloroisocyanurate
Potassium dichromate
Potassium nitrate
Potassium perchlorate
Potassium permanganate
Potassium peroxide
Silver nitrate
Sodium bromate
Sodium carbonate peroxide
Sodium chlorate
Sodium chlorite
Sodium dichloroisocyanurate
Sodium dichromate
Sodium hypochlorite
Sodium nitrate
Sodium nitrite
Sodium perchlorate
Sodium permanganate
Sodium peroxide
Strontium nitrate
Strontium peroxide
Sulfur trioxide
Trichloroisocyanuric acid
Uranyl nitrate
Urea nitrate
Zinc ammonium nitrate
Zinc nitrate
Zinc permanganate
Zinc peroxide
Zirconium picramate

GROUP 105 Reducing Agents, Strong

Aluminum borohydride
Aluminum carbide
Aluminum hydride
Aluminum hypophosphide
Ammonium hypophosphide
Ammonium sulfide
Antimony pentasulfide
Antimony trisulfide
Arsenic sulfide
Arsenic trisulfide
Arsine
Barium carbide
Barium hydride
Barium hypophosphide
Barium sulfide
Benzyl silane
Benzyl sodium
Beryllium hydride
Beryllium sulfide
Beryllium tetrahydroborate
Bismuth sulfide
Boron arsenotribromide
Boron trisulfide
Bromodiborane
Bromosilane
Butyl dichloroborane
n-Butyl lithium
Cadmium acetylide
Cadmium sulfide

GROUP 105 Reducing Agents, Strong cont'd

Calcium
Calcium carbide
Calcium hexammoniate
Calcium hydride
Calcium hypophosphide
Calcium sulfide
Cerium hydride
Cerium trisulfide
Cerous phosphide
Cesium carbide
Cesium hexahydroaluminate
Cesium hydride
Cesium sulfide
Chlorodiborane
Chlorodiisobutyl aluminum
Chlorodimethylamine diborane
Chlorodipropyl borane
Chlorosilane
Chromium sulfide
Copper acetylide
Copper sulfide
Diborane
Diethyl aluminum chloride
Diethyl zinc
Diisopropyl beryllium
Dimethyl magnesium
Ferrous sulfide
Germanium sulfide
Gold acetylide
Gold sulfide
Hexaborane
Hydrazine
Hydrogen selenide
Hydrogen sulfide
Hydroxyl amine
Lead sulfide
Lithium aluminum hydride
Lithium hydride
Lithium sulfide
Magnesium sulfide
Manganese sulfide
Mercuric sulfide
Methyl aluminum sesquibromide
Methyl aluminum sesquichloride
Methyl magnesium bromide
Methyl magnesium chloride
Methyl magnesium iodide
Molybdenum sulfide
Nickel subsulfide
Pentaborane
Phosphine
Phosphonium iodide
Phosphorus (red amorphous)
Phosphorus (white or yellow)
Phosphorus heptasulfide
Phosphorus pentasulfide
Phosphorus sesquisulfide
Phosphorus trisulfide
Potassium hydride
Potassium sulfide
Silver acetylide
Silver sulfide
Sodium
Sodium aluminate
Sodium aluminum hydride
Sodium hydride
Sodium hyposulfite
Sodium sulfide
Stannic sulfide
Strontium monosulfide
Strontium tetrasulfide
Tetraborane
Thallium sulfide
Titanium sesquisulfide
Titanium sulfide
Triethyl aluminum
Triethyl stibine
Triisobutyl aluminum
Trimethyl aluminum
Trimethyl stibine
Tri-n-butyl borane
Trioctyl aluminum
Uranium sulfide
Zinc acetylide
Zinc sulfide

GROUP 106 Water and Mixtures Containing Water

Aqueous solutions and mixtures
Water

GROUP 107 Water Reactive Substances

Acetic anhydride
Acetyl bromide
Acetyl chloride
Alkyl aluminum chloride

GROUP 107 Water Reactive Substances cont'd

Allyl trichlorosilane
Aluminum aminoborohydride
Aluminum borohydride
Aluminum bromide
Aluminum chloride
Aluminum fluoride
Aluminum hypophosphide
Aluminum phosphide
Aluminum tetrahydroborate
Amyl trichlorosilane
Anisoyl chloride
Antimony tribromide
Antimony trichloride
Antimony trifluoride
Antimony triiodide
Antimony trivinyl
Arsenic tribromide
Arsenic trichloride
Arsenic triiodide
Barium
Barium carbide
Barium oxide
Barium sulfide
Benzene phosphorus dichloride
Benzoyl chloride
Benzyl silane
Benzyl sodium
Beryllium hydride
Beryllium tetrahydroborate
Bismuth pentafluoride
Borane
Boron bromodiiodide
Boron dibromoiodide
Boron phosphide
Boron tribromide
Boron trichloride
Boron trifluoride
Boron triiodide
Bromine monofluoride
Bromine pentafluoride
Bromine trifluoride
Bromo diethylaluminum
n-Butyl lithium
n-Butyl trichlorosilane
Cadmium acetylide
Cadmium amide
Calcium
Calcium carbide
Calcium hydride
Calcium oxide
Calcium phosphide
Cesium amide
Cesium hydride
Cesium phosphide
Chlorine dioxide
Chlorine monofluoride
Chlorine pentafluoride
Chlorine trifluoride
Chloroacetyl chloride
Chlorodiisobutyl aluminum
Chlorophenyl isocyanate
Chromyl chloride
Copper acetylide
Cyclohexenyl trichlorosilane
Cyclohexyl trichlorosilane
Decaborane
Diborane
Diethyl aluminum chloride
Diethyl dichlorosilane
Diethyl zinc
Diisopropyl beryllium
Dimethyl dichlorosilane
Dimethyl magnesium
Diphenyl dichlorosilane
Diphenylmethane diisocyanate
Disulfuryl chloride
Dodecyl trichlorosilane
Ethyl dichloroarsine
Ethyl dichlorosilane
Ethyl trichlorosilane
Fluorine
Fluorine monoxide
Fluorosulfonic acid
Gold acetylide
Hexadecyl trichlorosilane
Hexyl trichlorosilane
Hydrobromic acid
Iodine monochloride
Lithium
Lithium aluminum hydride
Lithium amide
Lithium ferrosilicon
Lithium hydride
Lithium peroxide
Lithium silicon
Methyl aluminum sesquibromide
Methyl aluminum sesquichloride
Methyl dichlorosilane

GROUP 107 Water Reactive Substances cont'd

Methylene diisocyanate
Methyl isocyanate
Methyl trichlorosilane
Methyl magnesium bromide
Methyl magnesium chloride
Methyl magnesium iodide
Nickel antimonide
Nonyl trichlorosilane
Octadecyl trichlorosilane
Octyl trichlorosilane
Phenyl trichlorosilane
Phosphonium iodide
Phosphoric anhydride
Phosphorus oxychloride
Phosphorus pentasulfide
Phosphorus trisulfide
Phosphorus (amorphous red)
Phosphorus oxybromide
Phosphorus oxychloride
Phosphorus pentachloride
Phosphorus sesquisulfide
Phosphorus tribromide
Phosphorus trichloride
Polyphenyl polymethyl isocyanate
Potassium
Potassium hydride
Potassium oxide
Potassium peroxide
Propyl trichlorosilane
Pyrosulfuryl chloride
Silicon tetrachloride
Silver acetylide
Sodium
Sodium aluminum hydride
Sodium amide
Sodium hydride
Sodium methylate
Sodium oxide
Sodium peroxide
Sodium-potassium alloy
Stannic chloride
Sulfonyl fluoride
Sulfuric acid (>70%)
Sulfur chloride
Sulfur pentafluoride
Sulfur trioxide
Sulfuryl chloride
Thiocarbonyl chloride
Thionyl chloride
Thiophosphoryl chloride
Titanium tetrachloride
Toluene diisocyanate
Trichlorosilane
Triethyl aluminum
Triisobutyl aluminum
Trimethyl aluminum
Tri-n-butyl aluminum
Tri-n-butyl borane
Trioctyl aluminum
Trichloroborane
Triethyl arsine
Triethyl stibine
Trimethyl arsine
Trimethyl stibine
Tripropyl stibine
Trisilyl arsine
Trivinyl stibine
Vanadium trichloride
Vinyl trichlorosilane
Zinc acetylide
Zinc phosphide
Zinc peroxide

APPENDIX 3. INDUSTRY INDEX AND LIST OF GENERIC NAMES OF WASTESTREAMS

This appendix consists of two separate but related tables. Table 1 is the Industry Index which lists names of industries alphabetically with their corresponding Standard Industrial Classification (SIC) code numbers. Table 2 is the list of Generic Names of Wastestreams.

This appendix is used to determine the RGN of wastestreams when their compositions are not known specifically but are identified by their generic or common names. The SIC code number of one wastestream produced by a given industry is obtained from the Industry Index table (Table 1). This number is located in the List of Generic Names of Wastestreams (Table 2). Then the corresponding industry source, generic name of the waste, and its RGN are noted from the table. The process is repeated for the second waste. The RGN for the two types of wastes are entered in the compatibility worksheet (Figure 2) and the compatibility method in Section 4.

The primary references used in the compilation of the following tables are the same ones used in Appendix 1, namely Ref. 1, 7, 8, 10, 12, 13, 14, 32, 44, 52, and 77. The lists are in no way complete nor are the assignments of RGN to particular wastestreams absolute. Changes in manufacturing processes and practices may change the waste compositions thus resulting in different generic types of wastes.

TABLE 1. INDUSTRY INDEX TABLE

Industry	SIC code	Industry	SIC code
Chemical products, miscellaneous	289	Mining, bituminous coal and lignite	12
Chemicals, agricultural	287	Mining, metal	10
Chemicals, industrial inorganic	281	Paints, varnishes, lacquers, enamels and allied products	285
Chemicals, industrial organic	286	Paper and allied products	26
Drugs	283	Petroleum refining and related industries	29
Food and kindred products	20	Plastic materials and synthetic resins	282
Furniture and fixtures	25	Printing, publishing and allied industries	27
Instruments, measuring analyzing and control	38	Rubber and miscellaneous plastic products	30
Leather and leather products	31	Services, business	73
Lumber and wood products	24	Services, electrical, gas and sanitary	49
Machinery, except electrical	35	Soap, detergents and cleaning preparations	284
Machinery, equipment and supplies electrical and electronic	36	Stone, clay, glass and concrete products	32
Metal industries, primary	33	Textile mill products	22
Metal products, fabricated	34	Transportation equipment	37

TABLE 2. GENERIC NAMES OF WASTESTREAMS

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
10	Metal mining	Ore extraction wastes	1, 24
10	Metal mining	Ore flotation, leach, & electrolysis wastes	10, 24
12	Bituminus coal & lignite mining	Coal processing wastes	24, 31, 101

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
20	Food & kindred products	Coffee caffeine extraction chaff	17
20	Food & kindred products	Citrus pectin wastes	1, 4
22	Textile mill products	Cotton processing wastes	1, 10, 24
22	Textile mill products	Orlon production wastes	24, 31
22	Textile mill products	Wool processing wastes	1, 3, 24
22	Textile mill products	Textile dyeing & finishing wastewater sludge	17, 24
24	Lumber & wood products	Plywood production phenolic resin wastes	31
24	Lumber & wood products	Wood preserving spent liquors	15, 17, 24, 27, 31
24	Lumber & wood products	Softwood anti-stain process wastes	7, 17, 31
25	Furniture & fixtures	Furniture paint stripping wastes	10, 24, 101
26	Paper & allied products	Wood processing wastes	13, 16, 28, 29, 101
26	Paper & allied products	Chemical pulping wastes	1, 101
26	Paper & allied products	Dimethyl sulfate still bottoms	1
26	Paper & allied products	Paperboard productions wastes	24, 31
26	Paper & allied products	Paperboard caustic sludge	10, 33
26	Paper & allied products	Paper making & printing wastes	16, 24
27	Printing, publishing & allied ind.	Newspaper printing & equipment cleaning wastes	4, 14, 16, 29
27	Printing, publishing & allied ind.	Packaging materials paint sludge & solvent	4, 13, 24
27	Printing, publishing & allied ind.	Photofinishing wastes	10
27	Printing, publishing & allied ind.	Chromate printing wastes	24, 104
281	Industrial inorganic chemicals	Nitrous oxide mfg. wastes	10, 104
281	Industrial inorganic chemicals	Titanium dioxide mfg.-chloride process wastes	1, 24

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
281	Industrial inorganic chemicals	Acetylene mfg. sludge	10
281	Industrial inorganic chemicals	Industrial gas scrubber wastes	10
281	Industrial inorganic chemicals	Antimony oxide mfg. wastes	24, 33
281	Industrial inorganic chemicals	Antimony pentafluoride production wastes	15, 24
281	Industrial inorganic chemicals	Chrome & zinc pigments mfg. wastes	11, 24
281	Industrial inorganic chemicals	Hydrogen chloride mfg. wastes	1
281	Industrial inorganic chemicals	Chlorine fume control wastes	1
281	Industrial inorganic chemicals	Fluoride salt production wastes	15
281	Industrial inorganic chemicals	Mercuric cyanide mfg. wastes	11, 24
281	Industrial inorganic chemicals	Barium compounds mfg. wastes	11, 24, 33
281	Industrial inorganic chemicals	Dichromate production wastes	24
281	Industrial inorganic chemicals	Fluorine mfg. wastes	15, 104
282	Plastics materials & synthetics	Adhesives & coating mfg. wastes	10, 17, 19, 29
282	Plastics materials & synthetics	Polyvinyl acetate emulsion sludge	101, 103
282	Plastics materials & synthetics	Plywood liquid resin plant wastes	4, 5, 10, 31
282	Plastics materials & synthetics	Organic peroxide catalyst production wastes	3, 101
282	Plastics materials & synthetics	Latex mfg. wastes	13, 101, 103
282	Plastics materials & systhetics	Acrylic resin production wastes	3, 13, 26, 28, 103
282	Plastics materials & synthetics	Cellulose ester production wastes	1, 3, 4, 13, 14, 24, 103
282	Plastics materials & synthetics	Ethylene & vinyl chloride mfg. residue	17, 24, 29
282	Plastics materials & synthetics	Urea & melanine resin mfg. wastes	6, 10, 24
282	Plastics materials & synthetics	Vinyl resin mfg. wastes	17, 31
282	Plastics materials & synthetics	Adiponitrile production wastes	11, 26, 101, 103
282	Plastics materials & synthetics	Urethane mfg. wastes	16, 24
282	Plastics materials & synthetics	Synthetic rubber mfg. wastes	14, 16, 17, 27
282	Plastics materials & synthetics	Rayon fiber mfg. wastes	24
283	Drugs	Arsenic pharmaceutical wastes	24
283	Drugs	Blood plasma fractions production wastes	4

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
283	Drugs	Alkaloids extraction wastes	4, 16, 17, 19, 29, 101
283	Drugs	Mercurical pharmaceutical wastes	16, 24
283	Drugs	Antibiotic mfg. wastes	4, 13, 14, 19
284	Soaps & detergents	Chemical cleaning compounds mfg. wastes	24, 104
284	Soaps & detergents	Bleach & detergent mfg. wastes	10
285	Paints, varnishes, lacquers	Paint wash solvent wastes	101
285	Paints, varnishes, lacquers	Glycerin sludge	4
285	Paints, varnishes, lacquers	Solvent based paint sludge	11, 13, 16, 17, 19, 24, 101
285	Paints, varnishes, lacquers	Water based paint sludge	24, 101, 103
285	Paints, varnishes, lacquers	Lacquer paints mfg. wastes	13, 16, 19, 24
285	Paints, varnishes, lacquers	Putty & misc. paint products mfg. wastes	24, 101
286	Industrial organic chemicals	Benzene sulfonate phenol production waste	1, 16
286	Industrial organic chemicals	Phenol production wastes from cumene oxidation	17, 101
286	Industrial organic chemicals	Phenol production wastes from chlorination benzene	17, 31
286	Industrial organic chemicals	Organic dye mfg. wastes	1, 7, 24, 31
286	Industrial organic chemicals	Chromate pigments and dye wastes	7, 24, 27, 33
286	Industrial organic chemicals	Cadmium-selenium pigment wastes	24
286	Industrial organic chemicals	Nitrobenzene production wastes	27
286	Industrial organic chemicals	Toluene diisocyanate production wastes	18, 24, 101
286	Industrial organic chemicals	Pitch & creosote equipment cleaning wastes	10
286	Industrial organic chemicals	Chlorinated solvents refining wastes	4, 16, 17, 19
286	Industrial organic chemicals	Transformer oil mfg. wastes	17, 28
286	Industrial organic chemicals	Ethylene mfg. wastes by thermal pyrolysis	17, 31

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
286	Industrial organic chemicals	Ethylene chloride mfg. wastes from oxychlorination of ethylene	17
286	Industrial organic chemicals	Ethylene glycol mfg. wastes	4, 14, 17
286	Industrial organic chemicals	Freon mfg. wastes	1, 24
286	Industrial organic chemicals	Formaldehyde mfg. wastes	17, 24
286	Industrial organic chemicals	Epichlorohydrin mfg. wastes	4, 14, 17
286	Industrial organic chemicals	Mfg. wastes from n-butane dehydrogenation	17, 24, 33
286	Industrial organic chemicals	Acetaldehyde still bottoms from ethylene oxid.	5, 17
286	Industrail organic chemicals	Acetone mfg. wastes	17, 31
286	Industrial organic chemicals	Methanol mfg. wastes-carbon monoxide synthesis	17, 24
286	Industrial organic chemicals	Methyl methacrylate resin mfg. wastes	3, 13, 16, 26, 28, 31, 103
286	Industrial organic chemicals	Maleic anhydride production wastes	3, 4, 28, 103
286	Industrial organic chemicals	Lead alkyl production wastes	24
286	Industrial organic chemicals	Perchloroethylene production wastes	17, 28, 31
286	Industrial organic chemicals	Propylene glycol mfg. wastes	14, 17, 28
286	Industrial organic chemicals	Acrylonitrile production wastes	26, 101, 103
286	Industrial organic chemicals	Adipic acid production wastes-cyclohexane oxid.	3, 24
286	Industrial organic chemicals	Vinyl chloride mfg. wastes	17, 31
287	Agricultural chemicals	Buctril production caustic wash	3, 10, 16, 17, 31
287	Agricultural chemicals	DCP tar	17, 31
287	Agricultural chemicals	MCP production wastes	1, 3, 13, 17, 31
287	Agricultural chemicals	DDT formulation wastes	10, 16, 17
287	Agricultural chemicals	Arsenic pesticide formulation wastes	24
287	Agricultural chemicals	Atrazine production wastes	3, 10, 11
287	Agricultural chemicals	Malathion production wastes	16, 32
287	Agricultural chemicals	Parathion production wastes	1, 32
287	Agricultural chemicals	Trifluralin mfg. wastes	16, 17, 27

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
287	Agricultural chemicals	Phosphoric acid production wastes	1, 24
289	Misc. chemical products	TNT production wastes	8, 16, 24, 27, 102
289	Misc. chemical products	TNT red water wastes	3, 27, 102
289	Misc. chemical products	Penite production wastes	24
289	Misc. chemical products	Acidic cleaning compounds	1
29	Petroleum refining & related ind.	Coke product wastes	24, 101
29	Petroleum refining & related ind.	Catalyst wastes	24, 101
29	Petroleum refining & related ind.	Alkane production wastes	4, 7, 10, 16
29	Petroleum refining & related ind.	Wastewater treatment air floatation unit floc	10
29	Petroleum refining & related ind.	Spent caustic	10, 20, 24, 31, 33
29	Petroleum refining & related ind.	Dissolved air floatation emulsion	16, 24, 31, 33, 101
29	Petroleum refining & related ind.	Catacarb rinse water	24
29	Petroleum refining & related ind.	Catalyst sludge	10, 24
29	Petroleum refining & related ind.	API separator sludge	11, 16, 24, 31, 33, 101
29	Petroleum refining & related ind.	Liquified petroleum gas proc. wastes	16, 101
29	Petroleum refining & related ind.	VLE alkylation sludge	10, 15
29	Petroleum refining & related ind.	Fluid catalytic cracker fines	11, 16, 24, 31
29	Petroleum refining & related ind.	Spent lime from boiler feed water treatment	10, 24, 31
29	Petroleum refining & related ind.	HF alkylation sludge, neutralized	15, 24, 31, 101
29	Petroleum refining & related ind.	Non-leaded gasoline tank bottoms	16, 24, 31, 101
29	Petroleum refining & related ind.	Leaded-gasoline tank bottoms	16, 24, 31, 101
29	Petroleum refining & related ind.	Refinery storm water run off silt	11, 16, 24, 31, 101
29	Petroleum refining & related ind.	Waste biodegradation sludge	11, 24, 31
29	Petroleum refining & related ind.	Coke fines	24, 31
29	Petroleum refining & related ind.	Lube oil filter clays	16, 24, 31
29	Petroleum refining & related ind.	Kerosene filter clays	16, 24, 31, 101
29	Petroleum refining & related ind.	Cooling tower sludge	11, 16, 24, 31, 101
29	Petroleum refining & related ind.	Slop oil emulsion solids	16, 24, 31, 101
29	Petroleum refining & related ind.	Exchange bundle cleaning sludge	16, 24, 31, 101

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
29	Petroleum refining & related ind.	Once through cooling water sludge	24, 31, 101
29	Petroleum refining & related ind.	Crude tank bottoms	16, 24, 31, 101
29	Petroleum refining & related ind.	Sour refinery waste	10, 11, 20, 31, 33
29	Petroleum refining & related ind.	Still bottoms	24
29	Petroleum refining & related ind.	Waste brine sludge	24
29	Petroleum refining & related ind.	Gasoline blending wastes	24, 101
29	Petroleum refining & related ind.	Soda ash alkaline solution	10
29	Petroleum refining & related ind.	Acid sludge	1
29	Petroleum refining & related ind.	Caustic cleaning solution	10
29	Petroleum refining & related ind.	Alky spent caustic	10
29	Petroleum refining & related ind.	Lime sludge from raw water treatment	10
29	Petroleum refining & related ind.	Lube oil & grease reclaimer's residue	24
29	Petroleum refining & related ind.	Waste lube oil & grease	24
29	Petroleum refining & related ind.	Recycled oil spent sulfuric acid	1
29	Petroleum refining & related ind.	Recycled oil acid sludge	1, 16, 28
29	Petroleum refining & related ind.	Recycled oil caustic sludge	10, 24
29	Petroleum refining & related ind.	Recycled oil spent clays	101
29	Petroleum refining & related ind.	Recycled oil still bottoms	31
29	Petroleum refining & related ind.	Recycled oil wastewater	31
30	Rubber & misc. plastic products	Tires & inner tube mixing process wastes	17, 24, 101
30	Rubber & misc. plastic products	Tires & inner tube mixing preparation wastes	18
30	Rubber & misc. plastic products	Tires & inner tube cleaning process wastes	17
30	Rubber & misc. plastic products	Tires & inner tube mfg. wastes	5, 16, 17, 24, 28
30	Rubber & misc. plastic products	Medical product washings	4
30	Rubber & misc. plastic products	Medical product dispersion casting	16
31	Leather and leather products	Tanning solvents	4, 19
31	Leather and leather products	Sulfide dehairing sludges	33
31	Leather and leather products	Tanning wastes	10, 13, 24, 101
31	Leather and leather products	Chrome tan liquor	24, 33

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
32	Stone, clay, glass & concrete prod.	Glass etching wastes	1, 4
32	Stone, clay, glass & concrete prod.	Mirror production wastes	24
32	Stone, clay, glass & concrete prod.	Piezoelectric ceramics compounding process wastes	24
32	Stone, clay, glass & concrete prod.	Piezoelectric ceramics calcining process wastes	24
32	Stone, clay, glass & concrete prod.	Piezoelectric ceramics grinding wastes	24
32	Stone, clay, glass & concrete prod.	Piezoelectric ceramics pressing wastes	24
32	Stone, clay, glass & concrete prod.	Piezoelectric ceramics polarization wastes	24
33	Primary metal industries	Steel mfg. waste oil	24, 101
33	Primary metal industries	Stainless steel pickling liquor	1, 2, 24
33	Primary metal industries	Pig iron production wastes	10, 11, 31
33	Primary metal industries	Steel finishing wastes	11, 24
33	Primary metal industries	Steel mfg. wastes	1, 24, 31
33	Primary metal industries	Coke plant raw waste sludge	7, 11, 16, 31
33	Primary metal industries	Carbon tubing undercoating process wastes	3, 24
33	Primary metal industries	Metal smelting & refining wastes	1, 24
33	Primary metal industries	Spent battery acid	1
33	Primary metal industries	Barium compounds smelting & refining wastes	24
33	Primary metal industries	Aluminum scrap melting wastes	23, 25, 107
33	Primary metal industries	Metal reclaiming wastes	1, 2, 24
33	Primary metal industries	Brass mill wastes	1, 24, 104
33	Primary metal industries	Aluminum extrusion solvents	4
33	Primary metal industries	Aluminum degreasing solvents	19
33	Primary metal industries	Aluminum fluodizing process wastes	1
33	Primary metal industries	Aluminum extrusion equipment cleaning wastes	10, 101
33	Primary metal industries	Aluminum foundry wastes	15, 101
33	Primary metal industries	Wire & cable fiber spinning wash	1
33	Primary metal industries	Wire & cable spent scrubber solution	15

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
34	Fabricated metal products	Metal cleaning wastes	1, 2, 3, 24
34	Fabricated metal products	Can mfg. wastes	1, 29, 101
34	Fabricated metal products	Steel pickling bath wastes	1
34	Fabricated metal products	Metal drum reconditioning wastes	10, 24
34	Fabricated metal products	Submerged burnishing wastes	11, 24
34	Fabricated metal products	Acid plating solution	2
34	Fabricated metal products	Programate sludge	10, 11, 24
34	Fabricated metal products	Metal stripping wastes	11, 24
34	Fabricated metal products	Plating rack stripping wastes	2
34	Fabricated metal products	Oxidizing sludge	24
34	Fabricated metal products	Plating wastes	11, 24
34	Fabricated metal products	Steel fabrication waste oil	101
34	Fabricated metal products	Metal plating degreasing solvents	19, 101
34	Fabricated metal products	Copper plating wastes	11, 24
34	Fabricated metal products	Brass plating wastes	11, 24
34	Fabricated metal products	Aluminum anodizing wastes	1, 24
34	Fabricated metal products	Chrome plating wastes	11, 24
34	Fabricated metal products	Metal coating phosphate sludge	24, 101
34	Fabricated metal products	Aluminum pickling bath	1, 2
34	Fabricated metal products	Nickel stripping wastes	11
34	Fabricated metal products	Anodizing tank wastes	1
34	Fabricated metal products	Chemical milling spent caustic	10, 24, 33
34	Fabricated metal products	Galvanizing pickling bath	10
34	Fabricated metal products	Galvanizing wastes	1
34	Fabricated metal products	Wire products metal milling wastes	1, 2, 24
34	Fabricated metal products	Rolling mill solvents	24, 101
35	Machinery except electrical	Rotogravure printing plate wastes	10, 24
35	Machinery except electrical	Duplicating & photoequipment mfg. wastes	10, 24
35	Machinery except electrical	Electric circuits mfg. acid solution	1, 2, 24
35	Machinery except electrical	Electric circuits mfg. solvents	4, 16, 19

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
35	Machinery except electrical	Chromic acid bath	1, 24, 104
35	Machinery except electrical	Electric computer metal plating wastes	1, 2, 24
35	Machinery except electrical	Computer mfg. wastes	11, 15, 17, 24, 101
35	Machinery except electrical	Machinery chemical milling acids	1, 2, 24
36	Electrical & electronic equip. & sup.	Electronic equipment dip & cleaning wastes	10, 17, 24, 101
36	Electrical & electronic equip & sup.	Electronic components plating wastes	1, 2, 24
36	Electrical & electronic equip. & sup.	Fiberglass form mfg. wastes	17, 19, 101
36	Electrical & electronic equip. & sup.	Electronic components mfg. solvents	4, 13, 16, 17, 19, 101
36	Electrical & electronic equip. & sup.	Machine parts cleaning solvents	4, 17, 19
36	Electrical & electronic equip. & sup.	Electronic components etching solution	10, 15
36	Electrical & electronic equip. & sup.	Copper plating cyanide stripping solution	11
36	Electrical & electronic equip. & sup.	T.V. picture tube mfg. wastes	1, 2
36	Electrical & electronic equip. & sup.	Miniature equip. chemical milling wastes	10, 16
36	Electrical & electronic equip. & sup.	Telephone answering device mfg. wastes	4, 17
36	Electrical & electronic equip. & sup.	Electronic tube production wastes	1, 24
36	Electrical & electronic equip. & sup.	Metal finishing wastewater treatment sludge	10, 24
36	Electrical & electronic equip. & sup	Semi-conductor mfg. wastes	1, 2, 24, 104

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
36	Electrical & electronic equip. & sup.	Silicon etching solution	1, 2
36	Electrical & electronic equip. & sup.	Electronic components paint sludge	4, 16, 19, 101, 107
36	Electrical & electronic equip. & sup.	Ceramic capacitor production waste solvent	16, 17, 19
36	Electrical & electronic equip. & sup.	Magnetic tape mfg. wastes	24, 104
36	Electrical & electronic equip. & sup.	Magnetic recorder head laminating proc. wastes	4, 14, 17, 19
36	Electrical & electronic equip. & sup.	Battery reclamation wastes	1
36	Electrical & electronic equip. & sup.	Storage battery mfg. wastes	10, 24
37	Transportation equipment	Automobile paint application & clean up wastes	24, 31
37	Transportation equipment	Automobile electro deposition primer paint wastes	19, 24, 31
37	Transportation equipment	Automobile paint sludge	10, 24, 31
37	Transportation equipment	Automobile mfg. wastewater treatment residue	24, 31
37	Transportation equipment	Aircraft alkaline cleaning solution	10, 104
37	Transportation equipment	Aircraft aluminum etching wastes	10, 33
37	Transportation equipment	Aircraft parts acid plating wastes	1, 24, 104
37	Transportation equipment	Aircraft parts anodizing wastes	1
37	Transportation equipment	Chrome plating wastes	24, 104
37	Transportation equipment	Aluminum hot-seal wastes	24, 104
37	Transportation equipment	Chrome destruct sludge	10, 24
37	Transportation equipment	Rail car metal cleaning wastes	1, 24, 101
38	Measuring, analyzing & controlling instruments	Chlorinated cleaning solvents	17
38	Measuring, analyzing & controlling instruments	Microfilm production wastes	4, 14, 19

Table 2. (Continued)

SIC code	Industry source	Generic name of wastes	Reactivity group nos.
38	Measuring, analyzing & controlling instruments	Graphic arts adhesive mfg. wastes	16, 28, 101
49	Electric gas & sanitary service	Askarel liquid	17
73	Business services	Printed circuit board laboratory wastes	24
73	Business services	Photographic fixing solution	10, 11
73	Business services	Film processing acid wastes	3, 5
73	Business services	Ship line flush wastes	4, 10, 13, 16
73	Business Services	Equipment & floor cleaning caustic wastes	10
73	Business services	Acidic chemical cleaning solution	1
73	Business services	Railroad equipment cleaning caustic wastes	10, 101
73	Business services	Boiler wash	1
73	Business services	Solvent recovery tank bottoms	4, 19, 24, 101
73	Business services	Solvent recovery sludge	4, 17, 19, 27, 101
73	Business services	Chlorinated solvent recovery still bottoms	17, 24, 101

APPENDIX 4. LIST OF INCOMPATIBLE BINARY COMBINATIONS OF HAZARDOUS WASTES BY REACTIVITY GROUPS AND POTENTIAL ADVERSE REACTION CONSEQUENCES

This appendix describes in detail the potential adverse reaction consequences predicted in the Hazardous Wastes Compatibility Chart (Figure 6) in Section 5. The list of reactions do not in any way represent all the possible incompatible reactions that can occur between any two given types of wastes.

The first column of the list identifies the binary combinations of the wastes by Reactivity Group Numbers (RGN). The second column lists the corresponding adverse reaction consequences. For every reaction, the supporting references are given for the users information.

Reactivity Group No. Combination	Adverse Reaction and Consequences
1 + 4	MINERAL ACIDS + ALCOHOLS AND GLYCOLS Dehydration reactions and displacement with the halide result in heat generation. Ref. 31.
1 + 5	MINERAL ACIDS + ALDEHYDES Condensation reactions cause heat generation. Acrolein and other β-unsaturated aldehydes polymerize readily. Ref. 32, 43.
1 + 6	MINERAL ACIDS + AMIDE Hydrolysis of amide to the corresponding carboxylic acid results in an exotherm. Ref. 32, 43.
1 + 7	MINERAL ACIDS + AMINES The acid base reaction between these two types of compounds forming the ammonium salts may be sufficiently exothermic to cause a hazard. Ref. 16, 32.
1 + 8	MINERAL ACIDS + AZO COMPOUNDS Amyl azo and diazo compounds decompose exothermically upon mixing

1 + 8 MINERAL ACIDS + AZO COMPOUNDS (Continued)

with strong mineral acids to yield nitrogen gas and the corresponding amyl cation. Aliphatic azo and diazo compounds, particularly diazoalkanes, can polymerize violently with heat generation. Organo azides can also decompose exothermically with strong acid to form nitrogen gas and the respective cations. An exotherm also results from the acid-base reaction of hydrazines with mineral acids as hydrazines are comparable in base strength to ammonia. Diazomethane is a particularly reactive compound in this group.
Ref. 22, 79.

1 + 9 MINERAL ACIDS + CARBAMATES

Carbamates can undergo hydrolysis as well as decarboxylation upon mixing with strong mineral acids. Both reactions are exothermic and the latter can generate pressure if it occurs in a closed container.
Ref. 49, 55.

1 + 10 MINERAL ACIDS + CAUSTICS

The acid-base reaction between strong mineral acids and strong caustics is extremely exothermic and many times violent. Fires can result if the caustic substance is an alkoxide.

1 + 11 MINERAL ACIDS + CYANIDE

Inorganic cyanides rapidly form extremely toxic and flammable hydrogen cyanide gas upon contact with mineral acids.
Ref. 69.

1 + 12 MINERAL ACIDS + DITHIOCARBAMATES

Acid hydrolysis of dithiocarbamate heavy metal salts with strong mineral acids yields extremely flammable and toxic carbon disulfide gas. An exotherm can be expected from the reaction.
Ref. 50.

1 + 13 MINERAL ACIDS + ESTERS

Strong mineral acids in excess will cause hydrolysis and decomposition of esters with heat generation.
Ref. 55.

1 + 14 MINERAL ACIDS + ETHERS

Ether may undergo hydrolysis with strong acids exothermically.
Ref. 31, 55.

1 + 15 MINERAL ACIDS + FLUORIDES

Most inorganic fluorides yield toxic and corrosive hydrogen fluoride

1 + 15 MINERAL ACIDS + FLUORIDES (Continued)

gas upon reaction with strong mineral acids.
Ref. 54, 69.

1 + 17 MINERAL ACIDS + HALOGENATED ORGANICS

Strong mineral acids in excess may cause decomposition with generation of heat and toxic fumes of hydrogen halides.
Ref. 69.

1 + 18 MINERAL ACIDS + ISOCYANATES

Acid catalyzed decarboxylation as well as vigorous decomposition can occur upon mixing of isocyanates with strong mineral acids.
Ref. 55.

1 + 19 MINERAL ACID + KETONE

Acid catalyzed aldol condensation occurs exothermically.
Ref. 55.

1 + 20 MINERAL ACIDS + MERCAPTANS

Alkyl mercaptans are particularly reactive with mineral acids yielding extremely toxic and flammable hydrogen sulfide gas. Other mercaptans can yield hydrogen sulfide with excess strong acids. Excess strong acid can also result in decomposition and generation of toxic fumes of sulfur oxides.
Ref. 69.

1 + 21 MINERAL ACIDS + ALKALI and ALKALINE EARTH METALS

The reaction of strong mineral acids with alkali and alkaline earth metals in any form will result in a vigorous exothermic generation of flammable hydrogen gas and possible fire.
Ref. 69.

1 + 22 MINERAL ACIDS + METAL POWDERS, VAPORS, OR SPONGES

Reactions of strong mineral acids with finely divided metals or metals in a form with high surface area will result in vigorous generation of flammable hydrogen gas and possible explosion caused by the heat of reaction.
Ref. 69.

1 + 23 MINERAL ACIDS + METAL SHEETS, RODS, DROPS, ETC.

Strong mineral acids will form flammable hydrogen gas upon contact with metals in the form of plates, sheets, chunks, and other bulk forms. The heat of reaction may ignite the gas formed.
Ref. 69.

1 + 24 MINERAL ACIDS + TOXIC METALS

Mineral acids tend to solubilize toxic metals and metal compounds releasing previously fixed toxic constituents to the environment. Ref. 23, 69.

1 + 25 MINERAL ACIDS + NITRIDES

The aqueous fraction of strong mineral acids will react with nitrides evolving caustic and flammable ammonia gas. The acid-base reaction of mineral acids and nitrides can also evolve much heat and ammonia. Ref. 7, 69.

1 + 26 MINERAL ACIDS + NITRILES

Exothermic hydrolysis of nitriles to the corresponding carboxylic acid and ammonium ion is known to occur with mineral acids. Extremely toxic and flammable hydrogen cyanide gas may be evolved with such compounds as acetone, cyanohydrin and propionitriles.
Ref. 54, 69.

1 + 28 MINERAL ACIDS + UNSATURATED ALIPHATICS

Addition of mineral acids to alkenes usually results in exothermic acid catalyzed hydration and partial addition of the hydrogen halide or sulfates. Acetylenes are also susceptible to exothermic acid catalyzed hydration forming the corresponding aldehyde or ketone, with possible addition of the hydrogen halide in the case of halogen acids.
Ref. 55, 67.

1 + 30 MINERAL ACIDS + ORGANIC PEROXIDES

Strong mineral acids can react with organic peroxides and hydroperoxides with enough heat generated to cause explosive decomposition in the more unstable compounds. Oxygen can also be generated. Ref. 7, 14.

1 + 31 MINERAL ACIDS + PHENOLS AND CRESOLS

Exothermic sulfonation reactions can occur with addition of sulfonic acid to phenols and cresols. substitution of the hydroxyl with a halide can occur with addition of the halogen acids. Excess strong acid can decompose phenols and cresols with heat generation.
Ref. 55, 57.

1 + 32 MINERAL ACID + ORGANOPHOSPHATES

Excess strong mineral acid can cause decompostion of organophosphates, phosphothioate and phosphodithioates with heat generation and possibly toxic gas formation.
Ref. 69.

1 + 33 MINERAL ACIDS + SULFIDES

Extremely toxic and flammable hydrogen sulfide gas results from the combination of mineral acids and sulfides.
Ref. 69.

1 + 34 MINERAL ACIDS + EPOXIDES

Acid catalyzed cleavage can occur initiating polymerization with much heat generated.
Ref. 55.

1 + 101 MINERAL ACIDS + COMBUSTIBLE MATERIALS

Dehydration and decomposition on addition of excess strong mineral acid can cause heat and possibly toxic gas generation.
Ref. 69, 70.

1 + 102 MINERAL ACIDS + EXPLOSIVES

Many explosives are extremely heat sensitive and can be detonated by heat generated from the action of strong mineral acids on these compounds.
Ref. 69, 70.

1 + 102 MINERAL ACIDS + POLYMERIZABLE COMPOUNDS

Strong mineral acids can act as initiators in the polymerization of these compounds. The reactions are exothermic and can occur violently.
Ref. 51.

1 + 104 MINERAL ACIDS + STRONG OXIDIZING AGENTS

Many combinations of strong mineral acids and strong oxidizing agents are sensitive to heat and shock and may decompose violently. The halogen acids may be oxidized yielding highly toxic and corrosive halogen gases, accompanied by heat generation.
Ref. 7, 22, 54, 69, 71, 76.

1 + 105 MINERAL ACIDS + STRONG REDUCING AGENTS

Many reducing agents form flammable hydrogen gas on contact with mineral acids. The heat generated can cause spontaneous ignition. Some reducing agents such as metal phosphides and inorganic sulfides evolve extremely toxic and flammable fumes of phosphine and hydrogen sulfides, respectively.
Ref. 7, 22, 54, 69, 71, 76.

1 + 106 MINERAL ACIDS + WASTE AND MISCELLANEOUS AQUEOUS MIXTURES

Much heat can be evolved upon solubilization and hydrolysis of these acids.

1 + 107 MINERAL ACIDS + WATER REACTIVES

Group 107 compounds not only share the characteristic that hazardous consequences can result from their contact with water; they are also generally extremely reactive with most of the other compounds listed. In many cases much heat is generated along with toxic and/or flammable gases. Explosions may occur, or highly unstable mixtures may result. For this reason, it is recommended that Group 107 compounds be completely isolated from the other compounds. Many of these Group 107 compounds are also pyrophoric, especially those which are also classed as strong reducing agents.
Ref. 7, 22, 54, 69, 71, 76.

2 + 3 OXIDIZING MINERAL ACIDS + ORGANIC ACIDS

These mineral acids can oxidize the hydrocarbon moeity of organic acids with resulting heat and gas formation.

2 + 4 OXIDIZING MINERAL ACIDS + ALCOHOLS and GLYCOLS

Oxidation of the hydrocarbon moeity can occur resulting in heat and gas formation. Nitration with nitric acid can take place in the presence of sulfuric acid forming extremely unstable nitro compounds.
Ref. 55. 69.

2 + 5 OXIDIZING MINERAL ACIDS + ALDEHYDES

Oxidation of the hydrocarbon moeity can occur resulting in heat and gas formation.
Ref. 69.

2 + 6 OXIDIZING MINERAL ACIDS + AMIDES

Oxidation with excess acid can result in heat generation and formation of toxic fumes of nitrogen oxides.
Ref. 69.

2 + 7 OXIDIZING MINERAL ACIDS + AMINES

The acid-base reaction produces much heat and exhaustive oxidation results in generation of heat and toxic fumes of nitrogen oxide.
Ref. 55, 69.

2 + 8 OXIDIZING MINERAL ACIDS + AZO COMPOUNDS

Azo compounds and diazo compounds are easily decomposed by strong

2 + 8 OXIDIZING MINERAL ACIDS + AZO COMPOUNDS (continued)

acids evolving much heat and nitrogen gas. They are very susceptible to oxidation and can evolve toxic fumes of nitrogen oxides upon exhaustive oxidation. Hydrazines are especially susceptible to oxidation and inflame upon contact with oxidizing agents. Many of the compounds in this group such as diazomethane and the azides are very unstable and can decompose explosively upon heating.
Ref. 7, 54, 69.

2 + 9 OXIDIZING MINERAL ACIDS + CARBAMATES

Carbamates can undergo exothermic hydrolysis and decarboxylation upon mixing with these acids. Exhaustive oxidation can also result in formation of toxic fumes of nitrogen oxides, and sulfur oxides in the case of thiocarbamates.
Ref. 49, 54, 69.

2 + 10 OXIDIZING MINERAL ACIDS + CAUSTICS

The neutralization reaction can be violent with evolution of much heat.
Ref. 69.

2 + 11 OXIDIZING MINERAL ACIDS + CYANIDES

Evolution of extremely toxic and flammable hydrogen cyanide gas will occur before oxidation.
Ref. 69.

2 + 12 OXIDIZING MINERAL ACIDS + DITHIOCARBAMATES

Acids will cause decomposition of dithiocarbamates with evolution of extremely flammable carbon disulfide. Significant heat may be generated by the oxidation and decomposition to ignite the carbon disulfide.
Ref. 50.

2 + 13 OXIDIZING MINERAL ACIDS + ESTERS

Exhaustive oxidation of esters can cause decomposition with heat and possible ignition of the more flammable esters. Conversion to the organic acid and decarboxylation can also occur.
Ref. 55, 69.

2 + 14 OXIDIZING MINERAL ACIDS + ETHERS

Heat generated from the exhaustive oxidation of ethers can ignite the more flammable ethers. These compounds can also undergo exothermic acid catalyzed cleavage.
Ref. 55, 69.

2 + 15 OXIDIZING MINERAL ACIDS + FLUORIDES

Gaseous hydrogen fluoride can result from a combination of inorganic fluorides and these acids. Hydrogen fluoride is extremely corrosive and toxic. Some heat can also be evolved.
Ref. 69.

2 + 16 OXIDIZING MINERAL ACIDS + AROMATIC HYDROCARBONS

Oxidation of the hydrocarbon may produce enough heat to ignite the mixture.
Ref. 69.

2 + 17 OXIDIZING MINERAL ACIDS + HALOGENATED ORGANICS

These acids can cause oxidation and decomposition of halogenated organics resulting in heat and generation of extremely toxic fumes of hydrogen chloride, phosgene, and other gaseous halogenated compounds.
Ref. 69.

2 + 18 OXIDIZING MINERAL ACIDS + ISOCYANATES

Isocyanates may be hydrolyzed by the water in concentrated acids to yield heat and carbon dioxide. They may also be oxidized by these acids to yield heat and toxic nitrogen oxides.
Ref. 69, 71.

2 + 19 OXIDIZING MINERAL ACIDS + KETONES

Ketones can undergo exothermic aldol condensations under acidic conditions. Oxidizing acids can cleave the ketone to give a mixture of acids. Excess acid can cause complete decomposition yielding much heat and gas. Fire can also result.
Ref. 55, 69.

2 + 20 OXIDIZING MINERAL ACIDS + MERCAPTANS

Extremely toxic and flammable hydrogen sulfide gas can be formed by the action of the acid on mercaptans. Oxidation of mercaptans and other sulfur compounds can result in formation of toxic sulfur dioxide and heat.
Ref. 69.

2 + 21 OXIDIZING MINERAL ACIDS + ALKALI and ALKALINE EARTH METALS

Extremely flammable hydrogen gas can be generated upon contact of acids and these metals. The reaction of such a strong oxidizing agent and strong reducing agents can be so violent as to cause a fire and possibly an explosion.
Ref. 69.

2 + 22 OXIDIZING MINERAL ACIDS + METAL POWDERS, VAPORS, and SPONGES

The action of acid on these metals produces hydrogen gas and heat. Due to the large surface area of these forms of metals, the reaction can occur with explosive violence.
Ref. 7, 69.

2 + 23 OXIDIZING MINERAL ACIDS + METAL SHEETS, RODS, DROPS, ETC.

The reaction of acids on metals as sheets, plates, and other bulk forms can evolve hydrogen gas and some heat. Although the reaction proceeds much slower than in the case of powders, a definite fire hazard exists. Of the metals listed in Group 23, only zirconium is not attacked by nitric acid.
Ref. 54.

2 + 24 OXIDIZING MINERAL ACIDS + TOXIC METALS

Many of the compounds in Group 24 are very easily solubilized by strong acids, consequently, the toxic metal compounds are converted into forms which are more easily transported and assimilated. Some of these compounds have other hazardous properties and are classified elsewhere.
Ref. 54, 69.

2 + 25 OXIDIZING MINERAL ACIDS + NITRIDES

Nitrides are extremely strong bases and will participate in an acid-base reaction evolving much heat. This reaction can proceed with explosive violence due to the instability of metal nitrides and the generation of flammable ammonia gas.
Ref. 7, 69.

2 + 26 OXIDIZING MINERAL ACIDS + NITRILES

The primary hazard in mixing these types of compounds appears to be oxidation of the nitriles with generation of heat and toxic fumes of nitrogen oxides. In some cases such as acetone cyanohydrin and propionitrile, extremely toxic hydrogen cyanide gas is known to result from mixing with strong acids. These fumes are also flammable. Mixtures of nitric acid and acetonitrile are high explosives.
Ref. 7, 54, 69.

2 + 27 OXIDIZING MINERAL ACIDS + NITRO COMPOUNDS

These acids can decompose nitro compounds to produce heat and toxic fumes of nitrogen oxide. This oxidation can be extremely violent. Mixtures of nitric acid and nitroaromatics are known to exhibit explosive properties. Mixtures of some nitroalkanes (nitromethane) with nitric acid can also be detonated.
Ref. 7, 69.

2 + 28 OXIDIZING MINERAL ACIDS + UNSATURATED ALIPHATICS

Aliphatic unsaturated hydrocarbons are extremely susceptible to oxidation resulting in heat generation and fire.
Ref. 55, 69.

2 + 29 OXIDIZING MINERAL ACIDS + SATURATED ALIPHATICS

Aliphatic saturated hydrocarbons are easily oxidized by these acids yielding heat and carbon dioxide.
Ref. 31, 69.

2 + 30 OXIDIZING MINERAL ACIDS + ORGANIC PEROXIDES

The lower molecular weight organic peroxides and hydroperoxides are very sensitive to heat and shock. Mixing of oxidizing mineral acids with such unstable compounds can cause heat generation due to the oxidizing capacity of the acids and acid catalyzed hydrolysis. These reactions can cause explosive decomposition.
Ref. 7, 40.

2 + 31 OXIDIZING MINERAL ACIDS + PHENOLS AND CRESOLS

Phenols and cresols are easily oxidized and excess oxidizing acids can result in much heat generation.
Ref. 55, 69.

2 + 32 OXIDIZING MINERAL ACIDS + ORGANOPHOSPHATES

Excess oxidizing acid can decompose these compounds to yield heat and toxic fumes of nitrogen oxides, sulfur oxides, and phosphorous oxides.
Ref. 69.

2 + 33 OXIDIZING MINERAL ACIDS + SULFIDES

Toxic and flammable hydrogen sulfide gas can be generated by the action of these acids on inorganic sulfides. These sulfides can also be oxidized exothermically to sulfur dioxide, also a toxic gas. This reaction can occur very violently.
Ref. 69.

2 + 34 OXIDIZING MINERAL ACIDS + EPOXIDES

Epoxides are very easily cleaved by acids with heat generation. This ring opening can be the initiating step in the formation of epoxy resins, and uncontrolled polymerization can result in extreme heat generation. The oxidation capacity of these acids can cause ignition of the epoxides.
Ref. 51, 55.

2 + 101 OXIDIZING MINERAL ACIDS + COMBUSTIBLE MATERIALS

Oxidizing mineral acids can decompose substances in Group 101 with heat generation and possibly fire. Toxic gases may also be formed as combustion products, but the type of gas will depend upon the composition of these miscellaneous substances.
Ref. 69.

2 + 102 OXIDIZING MINERAL ACIDS + EXPLOSIVES

Such strong acids can easily detonate compounds in this group of explosives due to the heat generated upon mixing. The oxidizing character of these acids merely enhances the possibility of detonation.
Ref. 69, 70.

2 + 103 OXIDIZING MINERAL ACIDS + POLMERIZABLE COMPOUNDS

As in note 1 + 102, these acids can act as initiators in the polymerization of many compounds. These reactions are exothermic and can occur violently. In addition, these acids can oxidize the compounds of Group 103, producing more heat and possible toxic fumes.
Ref. 51, 69, 76.

2 + 105 OXIDIZING MINERAL ACIDS + STRONG REDUCING AGENTS

Mixing of compounds in these two groups can result in very violent, extremely exothermic reactions. Fires and explosions can result.
Ref. 23, 69.

2 + 106 OXIDIZING MINERAL ACIDS + WATER and WATER MIXTURES

Much heat can be evolved from the dissolution of these acids by water.
Ref. 69.

3 + 4 ORGANIC ACIDS + ALCOHOLS and GLYCOLS

The organic acids of primary concern in this combination are those with α-substituted halogens such as chloroacetic acid, and α- and β-substituted carboxyl groups such as oxalic acid and malonic acid. These acids are comparable in strength to strong mineral acids and can catalyze dehydration and esterification in alcohols and glycols with heat generation. Polyhydric alcohols and polybasic acids can polymerize by esterification with much heat evolved. Due to their acid strength, these halo organic acids would be more accurately compared to acids of Group 1 in terms of reactivity. Hereafter, refer to Group 1 to find the reactivity of these acids. The non-substituted monobasic aliphatic and aromatic acids are relatively nonreactive with alcohols and glycols and esterify only with strong mineral acids or other catalysts present.
Ref. 31, 54, 55.

3 + 5 ORGANIC ACIDS + ALDEHYDES

Exothermic condensation reactions can occur between these two types of compounds. The acidic character of the organic acids may be sufficient to catalyze the reaction. Polybasic and unsaturated acids are susceptible to polymerization under these conditions, resulting in much heat generated.
Ref. 31.

3 + 7 ORGANIC ACIDS + AMINES

An acid-base reaction between the stronger acids and amines can generate some heat. Discarboxylic acids and diamines can copolymerize with heat generation.
Ref. 25, 64.

3 + 8 ORGANIC ACIDS + AZO COMPOUNDS

Aliphatic and aromatic diazo compounds are readily decomposed by organic acids releasing heat and nitrogen gas as reaction products. Azo compounds are not sensitive to such decomposition. Hydrazine azide is extremely sensitive to heat or shock. An acid-base reaction with hydrazine can produce some heat.
Ref. 22, 71.

3 + 10 ORGANIC ACIDS + CAUSTICS

Acid-base reactions produce heat.
Ref. 55.

3 + 11 ORGANIC ACIDS + CYANIDES

Hydrogen cyanide, an extremely toxic and flammable gas, is generated upon mixing.
Ref. 69.

3 + 12 ORGANIC ACIDS + DITHIOCARBAMATES

Toxic and flammable carbon disulfide can be formed upon contact of dithiocarbamate with the stronger organic acids. Although CS_2 is a liquid at room temperature, it has a very high vapor pressure. Some heat can be generated from the hydrolysis of the dithiocarbamate salts.
Ref. 50.

3 + 15 ORGANIC ACIDS + FLUORIDES

Toxic and corrosive hydrogen fluoride fumes can be generated by the action of strong organic acids upon metal fluoride salts. Alkali metal fluorides are especially susceptible to decomposition in this manner.
Ref. 22, 69.

3 + 18 ORGANIC ACIDS + ISOCYANATES

Some water is normally associated with organic acids, and this can cause hydrolysis of isocyanates to carbon dioxide and amines with some heat generated.
Ref. 55.

3 + 21 ORGANIC ACIDS + ALKALI and ALKALINE EARTH METALS

Reaction of organic acids with these metals in any form can result in exothermic generation of flammable hydrogen gas and possible fire.
Ref. 57.

3 + 22 ORGANIC ACIDS + METAL POWDERS, VAPORS, and SPONGES

The stronger organic acids can liberate flammable hydrogen gas upon contact with metals in these forms. The heat of reaction can cause explosions.
Ref. 69.

3 + 24 ORGANIC ACIDS + TOXIC METALS

The stronger organic acids can solubilize some of these metal compounds and complex with the metal.
Ref. 55.

3 + 25 ORGANIC ACIDS + NITRIDES

An acid-base reaction can occur resulting in heat and possible evolution of flammable ammonia gas. Many of these nitrides are explosively unstable and can be detonated by the heat of reaction.
Ref. 7, 22.

3 + 26 ORGANIC ACIDS + NITRILES

Strong organic acids can convert nitriles to their corresponding organic acid with some heat generation.
Ref. 57.

3 + 33 ORGANIC ACIDS + SULFIDES

Extremely toxic and flammable hydrogen sulfide and some heat can be generated.
Ref. 69.

3 + 34 ORGANIC ACIDS + EPOXIDES

Acid catalyzed cleavage of the epoxide ring can initiate violent polymerization with much heat generated.
Ref. 55.

3 + 102 ORGANIC ACIDS + EXPLOSIVES

Strong organic acids can decompose compounds in this group resulting in enough heat to cause detonation.
Ref. 69.

3 + 103 ORGANIC ACIDS + POLYMERIZABLE COMPOUNDS

Strong organic acids can initiate cationic polymerization. Dicarboxylic acids can copolymerize with diamines as in the reaction of adipic acid and hexamethylene diamine to form nylon 6, 6.
Ref. 25, 51, 70.

3 + 104 ORGANIC ACIDS + OXIDIZING AGENTS

The hydrocarbon moeity of the organic acids are susceptible to decomposition by strong oxidizing agents releasing heat and gas. The gas produced can be toxic if the acid contains halogens such as dichlorophenoxy acetic acid, or if it contains other hetero atoms.
Ref. 69.

3 + 105 ORGANIC ACIDS + REDUCING AGENTS

Carboxylic acids are easily reduced by lithium aluminum hydride to the corresponding alcohols with some heat generation. Other reducing agents require more vigorous reaction conditions. Flammable hydrogen gas can be produced from the extractions of the hydroxyl proton and the β-hydrogens.

4 + 8 ALCOHOLS and GLYCOLS + AZO COMPOUNDS

Alkyl and aryl diazo compounds are susceptible to replacement by alkoxy groups yielding nitrogen gas and various ether compounds. Literature indicates that organic azides and hydrazines are generally immiscible with alcohols and glycols and do not react violently.
Ref. 54, 71.

4 + 18 ALCOHOLS and GLYCOLS + ISOCYANATES

Polyhydric alcohols and polyisocyanates polymerize very readily due to the ease of addition reactions at the isocyanate group. Much heat can be evolved. Monohydric alcohols form carbamates with isocyanates with some evolution of heat.
Ref. 54, 71.

4 + 21 ALCOHOLS and GLYCOLS + ALKALI and ALKALINE EARTH METALS

Alcohols and glycols decompose these active metals yielding flammable hydrogen gas and the corresponding metal alkoxides. The reaction with alkali metals can be violent with much heat generated and fire. These metal alkoxides are strongly caustic and easily hydrolyzed by water and acids yielding heat.

4 + 21 ALCOHOLS and GLYCOLS + ALKALI and ALKALINE EARTH METALS (Continued)

Ref. 54, 55, 57.

4 + 25 ALCOHOLS and GLYCOLS + NITRIDES

Flammable ammonia gas is generated by the action of alcohols and glycols on nitrides. Most nitrides are very unstable and may be detonated by the heat of reaction.
Ref. 71.

4 + 30 ALCOHOLS and GLYCOLS + ORGANIC PEROXIDES

Alcohols and glycols may be oxidized by these organic peroxides and hydroperoxides to yield heat and possibly fire.
Ref. 76.

4 + 34 ALCOHOLS and GLYCOLS + EPOXIDES

Traces of acid or base can catalyze polymerization of these compounds with heat.
Ref. 55.

4 + 104 ALCOHOLS and GLYCOLS + OXIDIZING AGENTS

Oxidation of alcohols and glycols with these strong oxidizing agents can produce heat and inflame or can form explosively unstable compounds.
Ref. 32.

4 + 105 ALCOHOLS and GLYCOLS + REDUCING AGENTS

The hydroxyl proton is easily extracted by these strong reducing agents to yield flammable hydrogen gas. In many cases, ignition occurs and sometimes explosions may also occur.
Ref. 7, 22, 32, 54, 55, 76.

4 + 107 ALCOHOLS and GLYCOLS + WATER REACTIVES

See Note 1 + 107.

5 + 7 ALDEHYDES + AMINES

Exothermic condensation to form amines can occur. The reaction can be catalyzed by acid.
Ref. 55.

5 + 8 ALDEHYDES + AZO COMPOUNDS

Aliphatic diazo compounds, especially diazomethane, react with aldehydes to give ketones, ethylene oxide derivatives, and nitrogen gas.

5 + 8 ALDEHYDES + AZO COMPOUNDS (Continued)

Aromatic diazo compounds can effect an electrophilic substitution on an aldehyde with heat and generation of nitrogen gas. Aldehydes and hydrazines can condense exothermically to form hydrazones.
Ref. 43, 71.

5 + 10 ALDEHYDES + CAUSTICS

Aldehydes undergo self-condensation in combination with caustics and, in the case of acrolein, can result in violent polymerization. Much heat is evolved.
Ref. 43, 57.

5 + 12 ALDEHYDES + DITHIOCARBAMATES

Not much is known about this combination. If these compounds do react, an amide and toxic and flammable carbon disulfide can result. This reaction may be acid catalyzed.
Ref. 50.

5 + 21 ALDEHYDES + ALKALI and ALKALINE EARTH METALS

Owing to the extreme reactivity of these metals and the carbonyl functionality of aldehydes, attack of the metal radical can occur at a number of sites including the oxygen and the α-hydrogen. Extraction of the α-hydrogens can result in generation of flammable hydrogen gas. Various other condensation reactions can be initiated by this substitution resulting in heat generation.
Ref. 39.

5 + 25 ALDEHYDES + NITRIDES

Nitrides are known to be extremely strong bases and can consequently catalyze condensation reactions liberating heat. With acrolein, uncontrolled self-polmerization can result. The labile α-hydrogens of aldehydes may be extracted forming flammable ammonia gas.
Ref. 54, 76.

5 + 27 ALDEHYDES + NITRO COMPOUNDS

The aliphatic nitro compounds are somewhat susceptible to condensation with aldehydes resulting in some heat generation. Formaldehyde and nitromethane can react readily in this manner.
Ref. 31.

5 + 28 ALDEHYDES + UNSATURATED ALIPHATICS

At elevated temperatures, a Diels-Alder type reaction can take place between acrolein and 1, 3-butadiene and may be exothermic.
Ref. 55.

5 + 30 ALDEHYDES + ORGANIC PEROXIDES

A mixture of aldehydes and hydroperoxides results in formation of α-hydroxy peroxides which are unstable to heat and stock. Acyl peroxides such as diacetyl peroxide can decompose with slight heating resulting in formation of CO_2 and methyl radicals. These radicals can abstract hydrogen from aldehydes and initiate a chain reaction and produce much heat. Alkyl and acyl peroxides can decompose in the same manner and initiate free radical reactions involving aldehydes to yield heat. Peroxy acids are very strong oxidizers in themselves and can react violently with aldehydes.
Ref. 32, 40.

5 + 33 ALDEHYDES + SULFIDES

Aqueous sulfides can react readily with aldehydes to form gemhydroxythiols with much heat generated.
Ref. 20

5 + 34 ALDEHYDES + EPOXIDES

An electrophilic ring opening is possible, but information is very scarce on this type of reaction.

5 + 104 ALDEHYDES + OXIDIZING AGENTS

Aldehydes are very easily oxidized by these compounds resulting in formation of the corresponding carboxylic acid or complete decomposition. In both cases, heat is evolved, and fires can result.
Ref. 55, 69.

5 + 105 ALDEHYDES + REDUCING AGENTS

The labile α-hydrogens of the aldehydes may be extracted by some reducing agents to yield flammable hydrogen gas with some heat.
Ref. 43, 55.

6 + 21 AMIDES + ALKALI and ALKALINE EARTH METALS

Alkali and alkaline earth metals can abstract a N-hydrogen forming flammable hydrogen gas. Some heat may be generated.
Ref. 57.

6 + 24 AMIDES + TOXIC METALS

Lower molecular weight amides which are liquid at room temperature are used as ionizing solvents and can solubilize salts of many toxic metal compounds.
Ref. 54.

6 + 104 AMIDES + OXIDIZING AGENTS

Exhaustive oxidation of amides can result in heat generation and evolution of toxic nitrogen oxide fumes.
Ref. 69.

6 + 105 AMIDES + REDUCING AGENTS

The N-hydrogen can be easily extracted by these reducing agents to yield heat and flammable hydrogen gas.
Ref. 57.

7 + 12 AMINES + DITHIOCARBAMATES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous consequences. It is recommended that mixing be avoided pending laboratory assessment of safety.

7 + 17 AMINES + HALOGENATED ORGANICS

Amines are particularly susceptible to alkylation by alkyl halides resulting in formation of secondary and tertiary amines and some heat.
Ref. 16.

7 + 18 AMINES + ISOCYANATES

Amines act as organic bases in catalyzing the polymerization of isocyanates. The uncontrolled reaction can be violent and produce much heat.
Ref. 76.

7 + 21 AMINES + ALKALI and ALKALINE EARTH METALS

These metals can dissolve in amines yielding strongly reducing metal amide solutions and flammable hydrogen gas.
Ref. 22.

7 + 24 AMINES + TOXIC METALS

Amines act as surfactants in increasing the solubility of toxic metal compounds in water.
Ref. 64.

7 + 30 AMINES + ORGANIC PEROXIDES

Upon exhaustive oxidation with peroxy acids, amines can yield heat and toxic fumes of nitrogen oxides. Treatment of amines with peroxides and hydroperoxides can result in hydrogen abstraction and initiation of polymerization reactions with heat generated.
Ref. 40.

7 + 34 AMINES + EPOXIDES

Condensation and ring opening can generate heat. Such a reaction can initiate polymerizations which, if uncontrolled, can generate much heat.
Ref. 27.

7 + 104 AMINES + OXIDIZING AGENTS

Exhaustive oxidation of amines with these oxidizing agents can result in heat generation and evolution of toxic nitrogen oxide fumes.
Ref. 69.

7 + 105 AMINES + REDUCING AGENTS

Alkyl metal halides can undergo a Grignard reaction with primary and secondary amines forming the corresponding alkanes. Enough heat may be evolved to cause a fire hazard. See Note 7 + 21 for the combination of amines and alkali and alkaline earth metals. Other reducing agents may also react with amines in a similar manner yielding heat and hydrogen gas.
Ref. 4, 71.

8 + 9 AZO COMPOUNDS + CARBAMATES

Diazo alkanes could add to the carbonyl group of the carbamate with liberation of N_2. Aryl diazonium compounds can react with the nitrogen of the carbamate group, also yielding nitrogen. Azo compounds appear to be relatively inert towards reaction with carbamates while hydrazines may form hydrazones with the carbonyl with heat generated. Information regarding these reactions, however, is very scarce.
Ref. 55, 71.

8 + 11 AZO COMPOUNDS + CYANIDES

Aryl dianonium salts can react with metallic cyanides to form the corresponding nitrile, an inorganic salt, and gaseous nitrogen. Diazo alkanes, however, are much less subject to addition of a base like cyanide. Azo alkanes, azo aromatic compounds, and hydrazine and its derivatives do not appear to react with metallic cyanides.
Ref. 57, 71, 79.

8 + 12 AZO COMPOUNDS + DITHIOCARBAMATES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

8 + 13 AZO COMPOUNDS + ESTERS

Aliphatic diazo compounds, especially diazomethane, are extremely reactive as alkylating agents and may react with esters in some manner to yield heat. The reaction, however, is not substantiated in the literature reviewed. Aromatic diazo and azo compounds do not appear to undergo potentially hazardous reactions with ester.
Ref. 71, 79.

8 + 17 AZO COMPOUNDS + HALOGENATED ORGANICS

Aliphatic diazo compounds can act as nucleophiles in substituting for the halogen in aliphatic halogenated organics. Nitrogen gas is evolved from such a reaction. Although hydrazines are relatively weak nucleophiles, they can react with primary and some secondary halides with some heat generated.
Ref. 43, 71.

8 + 18 AZO COMPOUNDS + ISOCYANATES

Isocyanates are susceptible to nucleophilic attack at the carbon and can consequently react with diazo alkanes in this manner. Gaseous nitrogen can result. Hydrazines may also attack the carbon but with less vigor.
Ref. 71.

8 + 19 AZO COMPOUNDS + KETONES

Although ketones are not as reactive as aldehydes with diazo alkanes, alkylation can occur with water as a catalyst releasing nitrogen gas. Electrophilic substitution of quinones can occur with aromatic dizonium cations yielding nitrogen gas. Although hydrazines form hydrazines with ketones, the reaction requires heating.
Ref. 43, 71.

8 + 20 AZO COMPOUNDS + MERCAPTANS

Aromatic diazonium salts can form thioethers with mercaptans resulting in evolution of nitrogen gas. Aliphatic diazo compounds may undergo the same reaction.
Ref. 71, 79.

8 + 21 AZO COMPOUNDS + ALKALI and ALKALINE EARTH METALS

Molecules which react with these metals are characterized by having centers of high elctron density which can induce a localized positive charge in the metal. The subsequent electron transfer is highly exothermic. The compounds in Group 8 all have centers of high electron density in the nitrogen and in the α-carbon in the case of diazo alkanes. The reaction of these compounds with the active metals of Group 21 can thus be very exothermic and may produce

8 + 21 AZO COMPOUNDS + ALKALI and ALKALINE EARTH METALS (Continued)

hydrogen and/or nitrogen.
Ref. 39.

8 + 22 AZO COMPOUNDS + METAL POWDERS

Due to the high surface area of these forms of metals and the high flammability of hydrazine and some of its organic derivatives, a combination of these substances in air can result in spontaneous ignition. Toxic nitrogen oxide fumes can be formed. Diazo alkanes polmerize very readily in the presence of copper and other metal powders releasing much heat.
Ref. 32, 79.

8 + 23 AZO COMPOUNDS + METAL SHEETS, RODS, DROPS, ETC.

Hydrazine and some of its organic derivatives can inflame on contact with surfaces of metals in forms of sheets, rods, drops, etc.
Ref. 32.

8 + 25 AZO COMPOUNDS + NITRIDES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

8 + 30 AZO COMPOUNDS + ORGANIC PEROXIDES

Hydrazones are explosively oxidized by organic peroxides and hydroperoxides yielding toxic nitrogen oxide fumes. Diazo compounds may form more unstable peroxides with hydroperoxides. Organic peroxides and azo compounds are both relatively sensitive to homolytic fission by heat or light. Any situation where either factor is applied to this mixture might result in extremely fast and exothermic free radical reactions.
Ref. 43, 71, 79.

8 + 31 AZO COMPOUNDS + PHENOLS and CRESOLS

Aromatic and aliphatic diazo compounds react readily with phenols and cresols forming ethers and nitrogen gas and releasing heat.
Ref. 71.

8 + 32 AZO COMPOUNDS + ORGANOPHOSPHATES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

8 + 33 AZO COMPOUNDS + SULFIDES

Addition of diazonium salts to solutions of sodium sufides, bisulfides, and polysulfides results in explosions even at 8°C.

8 + 34 AZO COMPOUNDS + EXPOXIDES

Since epoxides are very susceptible to ring cleavage and polymerization by acidic or basic reagents, such reactions are possible with diazonium compounds and hydrazines. In the case of the diazonium compounds, attack of the aryl cation could occur on the oxygen with evolution of nitrogen gas and heat. Hydrazines can act as bases in attacking one of the ring carbons releasing heat. Being strong nucleophiles, diazo alkanes may also cleave the ring at a carbon with generation of heat and nitrogen gas.
Ref. 71, 79.

8 + 102 AZO COMPOUNDS + EXPLOSIVES

Aliphatic and aromatic diazo compounds and hydrazines are extremely reactive and can undergo numerous interactions with explosives. Any heat or shock generated can detonate the mixture.
Ref. 69.

8 + 103 AZO COMPOUNDS + POLYMERIZABLE COMPOUNDS

The diazonium ion can act as a Lewis acid in catalyzing various cationic polymerizations. Diazo alkanes are very strong nucleophiles and may add to double bond systems to initiate polymerization. All of the monomers listed in Group 103 may be susceptible to polymerization in combination with diazo alkanes. Hydrazines may be basic enough to catalyze anionic polymerization in combination with diazo alkanes. Hydrazines may be basic enough to catalyze anionic polymerization.
Ref. 51, 54, 76.

8 + 104 AZO COMPOUNDS + OXIDIZING AGENTS

Exhaustive oxidation of azo, diazo, and hydrazines with these strong oxidizing agents can result in extreme heat generation and evolution of toxic nitrogen oxide fumes. Hydrazines can react with explosive violence.
Ref. 69.

8 + 105 AZO COMPOUNDS + REDUCING AGENTS

Various reactions producing much heat and evolving nitrogen gas can result from a combination of diazonium compounds and these strong reducing agents. Diazo alkanes are so reactive that they may produce any number of products upon reaction with these compounds. Extreme heat evolution is very probable.
Ref. 71.

8 + 106 AZO COMPOUNDS + WATER and MISCELLANEOUS AQUEOUS MIXTURES

Both diazo alkanes and diazo aromatic liberate nitrogen gas upon reaction with water.
Ref. 71.

8 + 107 AZO COMPOUNDS + WATER REACTIVES

See Note 1 + 107.

9 + 10 CARBAMATES + CAUSTICS

Alkaline hydrolysis of carbamates generally yield heat, amines, and carbon dioxide by spontaneous decomposition of N-alkyl or N-aryl carbamic acid.
Ref. 49.

9 + 21 CARBAMATES + ALKALI and ALKALINE EARTH METALS

These metals are very susceptible to reaction with compounds containing centers of high electron density. A redox reaction can occur by an induced positive charge on the metal. The electron transfer is very energetic and may result in fire from formation of hydrogen gas.
Ref. 39.

9 + 22 CARBAMATES + METAL POWDERS, VAPORS, OR SPONGES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

9 + 25 CARBAMATES + NITRIDES

Since nitrides are extremely strong bases, they can easily extract the N-protons from carbamates forming flammable ammonia gas and initiating decomposition to various nitrogen containing products.
Ref. 22.

9 + 30 CARBAMATES + ORGANIC PEROXIDES

Selective oxidation may occur at double bonded nitrogen sites with some heat generated. Exhaustive oxidation, however, can liberate toxic nitrogen oxide fumes with much heat. Initial reaction may cause decomposition of the more unstable peroxides.
Ref. 69.

9 + 104 CARBAMATES + OXIDIZING AGENTS

Exhaustive oxidation of carbamates can result in extreme heat gener-

9 + 104 CARBAMATES + OXIDIZING AGENTS (Continued)

ation and formation of toxic nitrogen oxide fumes.
Ref. 69.

10 + 13 CAUSTICS + ESTERS

Esters are easily hydrolyzed by caustics to a salt and alcohol with heat generation.
Ref. 55.

10 + 17 CAUSTICS + HALOGENATED ORGANICS

Aliphatic halides can undergo substitution or dehydrohalogenation upon treatment with strong caustics. Both processes involve some heat generation while the second evolves flammable olefins and acetylenes, especially with the lower molecular weight compounds. Halogenated aromatics, however, are relatively stable to strong caustics.
Ref. 10, 55.

10 + 18 CAUSTICS + ISOCYANATES

Caustics catalyze the polymerization of diisocyanates yielding much heat. The mono isocyanates decompose to amines and carbon dioxide upon contact with caustics.
Ref. 71, 79.

10 + 19 CAUSTICS + KETONES

Caustics can catalyze the self-condensation of ketones yielding heat.
Ref. 55.

10 + 21 CAUSTICS + ALKALI and ALKALINE EARTH METALS

Heat and flammable hydrogen gas can be generated due to the aqueous nature of most caustics.
Ref. 32, 54.

10 + 22 CAUSTICS + METAL POWDERS, VAPORS, and SPONGES

Heat and flammable hydrogen gas may be generated with some metals such as aluminum, magnesium, zinc, and beryllium. Explosions may also occur due to the high surface area of these forms.
Ref. 7, 22.

10 + 23 CAUSTICS + METAL SHEETS, RODS, DROPS, ETC.

Heat and flammable hydrogen gas are liberated upon dissolution of these metals in caustics. The reaction, however, is much slower than those in Note 10 + 22 above.
Ref. 22.

10 + 24 CAUSTICS + TOXIC METALS

Many toxic metals and metal compounds are soluble in caustics, i.e., $PbCO_3$, $PbCrO_4$, $Cd(CN)_2$, As_2O_3, AsF_5, $AgCrO_4$, $ZuCO_3$, $Zn(CN)_2$. Ref. 23.

10 + 25 CAUSTICS + NITRIDES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

10 + 26 CAUSTICS + NITRILES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

10 + 27 CAUSTICS + NITRO COMPOUNDS

Nitro alkanes and caustics form salts in the presence of water. The dry salts are explosive.
Ref. 32.

10 + 32 CAUSTICS + ORGANOPHOSPHATES

Alaline hydrolysis of phosphorothioates can generate enough heat to cause explosive rearrangement from the thiono to the thiolo form. Hydrolysis of other organophosphates can generate heat.
Ref. 50.

10 + 34 CAUSTICS + EPOXIDES

Base catalyzed cleavage can result in polymerization with much heat.
Ref. 55.

10 + 102 CAUSTICS + EXPLOSIVES

Alkaline hydrolysis or other reactions can generate enough heat to detonate these compounds.
Ref. 69.

10 + 103 CAUSTICS + POLYMERIZABLE COMPOUNDS

These compounds can undergo anionic polymerization with caustics as initiators yielding much heat.
Ref. 51, 76.

10 + 107 CAUSTICS + WATER REACTIVES

See Note 1 + 107.

11 + 17 CYANIDES + HALOGENATED ORGANICS

Nucleophilic substitution can result in some heat with formation of nitriles.
Ref. 55.

11 + 18 CYANIDES + ISOCYANATES

Cyanide solution can cause decomposition of isocyanates yielding heat and carbon dioxide. This decomposition is due to the water as well as the basic character of the cyanide anion.
Ref. 71.

11 + 19 CYANIDES + KETONES

Some heat may be evolved from the formation of cyanohydrins with alkaline cyanide solution.
Ref. 71.

11 + 21 CYANIDES + ALKALI and ALKALINE EARTH METALS

Hydrogen cyanide can react with these metals to yield heat and flammable hydrogen gas.
Ref. 22.

11 + 25 CYANIDES + NITRIDE

Hydrogen cyanides and nitrides may react to form flammable ammonia gas.
Ref. 22.

11 + 30 CYANIDES + ORGANIC PEROXIDES

Metal cyanides and hydrogen cyanide are readily oxidized and may react explosively with these organic peroxides, and hydroperoxides. Toxic nitrogen oxide fumes can result.
Ref. 7, 76.

11 + 34 CYANIDES + EPOXIDES

Due to its basicity in aqueous solution, ring cleavage can occur with heat generation and possible polymerization of the epoxides.
Ref. 55.

11 + 104 CYANIDES + OXIDIZING AGENTS

Metal cyanides and hydrogen cyanides are readily oxidized. Toxic nitrogen oxide fumes may be produced.

11 + 104 CYANIDES + OXIDIZING AGENTS (Continued)

Ref. 7, 71.

11 + 107 CYANIDES + WATER REACTIVES

See Note 1 + 107.

12 + 18 DITHIOCARBAMATES + ISOCYANATES

A reaction involving the disulfide group and the isocyanate group may be possible. However, there is little evidence in the literature reviewed to substantiate this reaction.

12 + 21 DITHIOCARBAMATES + ALKALI and ALKALINE EARTH METALS

Due to the high electron density about the disulfide group, a reaction may occur between these two groups of compounds yielding heat and toxic fumes. However, substantiation is scarce in the literature reviewed.
Ref. 39.

12 + 30 DITHIOCARBAMATES + PEROXIDES

Oxidation can result in heat generation and formation of toxic oxides of nitrogen and sulfur.
Ref. 69.

12 + 34 DITHIOCARBAMATES + POLYMERIZABLE COMPOUNDS

Little information ia available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

12 + 104 DITHIOCARBAMATES + STRONG OXIDIZING AGENTS

Oxidation can result in heat generation and formation of toxic nitrogen oxides and sulfur oxides.
Ref. 69.

12 + 105 DITHIOCARBAMATES + STRONG REDUCING AGENTS

Reductive cleavage of the carbon sulfur bonds may occur yielding extremely toxic hydrogen sulfide fumes. However, the reaction cannot be substantiated with the reference used.
Ref. 69.

12 + 106 DITHIOCARBAMATES + WATER

Extremely flammable and toxic carbon disulfide may be generated.
Ref. 50.

12 + 107 DITHIOCARBAMATES + WATER REACTIVES

See Note 1 + 107.

13 + 21 ESTERS + ALKALI and ALKALINE EARTH METALS

The α-hydrogens can be easily scavenged by these metals yielding hydrogen gas and heat.
Ref. 39

13 + 25 ESTERS + NITRIDES

Nitrides can attack the α-hydrogens forming flammable ammonia gas and generating heat. The transition metal nitrides, however, are chemically very inert.
Ref. 22.

13 + 102 ESTERS + EXPLOSIVES

Esters may form highly oxygenated compounds with some of these explosives (metal nitrates) to form even more unstable compounds. They may react exothermically with others to cause explosive decomposition and yield extremely toxic fumes.
Ref. 7, 69.

13 + 104 ESTERS + STRONG OXIDIZERS

Vigorous oxidation of the hydrocarbon moiety can occur yielding much heat.
Ref. 69.

13 + 105 ESTERS + STRONG REDUCING AGENTS

See 13 + 21.

14 + 104 ETHERS + STRONG OXIDIZERS

These compounds can react violently upon contact yielding much heat and causing ignition and explosions.
Ref. 32.

14 + 107 ETHERS + WATER REACTIVES

See 1 + 107.

15 + 107 FLUORIDES + WATER REACTIVES

See 1 + 107.

16 + 104 AROMATIC HYDROCARBONS + STRONG OXIDIZING AGENTS

Violent reactions can occur between these types of compounds resulting in heat and fire.
Ref. 69.

17 + 20 HALOGENATED ORGANICS + MERCAPTANS

Alkyl halides and mercaptans can react to form thioethers with some heat generation.
Ref. 43.

17 + 21 HALOGENATED ORGANICS + ALKALI and ALKALINE EARTH METALS

Halogenated organics, especially alkyl halides form explosive mixtures with alkali and alkaline earth metals.
Ref. 32.

17 + 22 HALOGENATED ORGANICS + METAL POWDERS, VAPORS, OR SPONGES

Metals in these forms are highly reactive and can result in violent reactions on contact with halogenated hydrocarbons. Explosions can occur with aluminum, magnesium, zinc, zirconium and their alloys in combination with alkyl halides.
Ref. 7.

17 + 23 HALOGENATED ORGANICS + METAL SHEETS, RODS, DROPS, ETC.

Aluminum and magnesium in bulk forms are expecially reactive with halogenated hydrocarbons releasing much heat. The formation of the metal halide catalyzes further decomposition of the metals. Fire and explosions may occur.
Ref. 7.

17 + 25 HALOGENATED ORGANICS + NITRIDES

Substitution can occur yielding heat. However, generation of ammonia gas will be more likely.
Ref. 22, 43.

17 + 30 HALOGENATED ORGANICS + ORGANIC PEROXIDES

Peroxides and hydroperoxides generate radicals which can initiate chain decomposition of alkyl halides. Such a reaction can be explosively violent with the more reactive peroxides.
Ref. 40.

17 + 104 HALOGENATED ORGANICS + OXIDIZING AGENTS

Halogenated organics can be easily oxidized by these compounds

17 + 104 HALOGENATED ORGANICS + OXIDIZING AGENTS (Continued)

yielding heat and toxic and corrosive hydrogen halide fumes.
Ref. 69.

17 + 105 HALOGENATED ORGANICS + REDUCING AGENTS

Boranes are known to form explosive mixtures with alkyl halides. See also Note 17 + 21.
Ref. 32.

17 + 107 HALOGENATED ORGANICS + WATER REACTIVES

See Note 1 + 107.

18 + 20 ISOCYANATES + MERCAPTANS

Mercaptans may add to isocyanates yielding some heat. Diisocyanates and dimercaptans may polymerize with much heat generated.
Ref. 35, 71.

18 + 21 ISOCYANATES + ALKALI and ALKALINE EARTH METALS

These metals can abstract the α-hydrogens from aliphatic isocyanates to yield hydrogen gas. The isocyanate group may also induce sufficient charge separation in the metals to cause exothermic transfer of electrons.
Ref. 39.

18 + 22 ISOCYANATES + METAL POWDERS, VAPORS and SPONGES

The most highly reactive of these metals such as aluminum, magnesium, zinc, zirconium, and their alloys can abstract the labile α-hydrogens from the alkyl isocyanates to yield hydrogen gas. Decomposition of the isocyanate group is also possible.
Ref. 7.

18 + 25 ISOCYANATES + NITRIDES

Little information is available in the literature reviewed. Reaction of these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

18 + 30 ISOCYANATES + ORGANIC PEROXIDES

Isocyanates may form peroxy carbamates with hydroperoxides which in turn can decompose yielding carbon dioxide and free radicals upon slight heating. Peroxides may form carbamates with slight heating. Peroxides may form carbamates with isocyanates yielding some heat. In both cases, the radicals have to be generated pyrolytically or by metal catalysts for these reactions to occur. Contaminants and heat

18 + 30 ISOCYANATES + ORGANIC PEROXIDES (Continued)

of solution may be sufficient to generate radicals in wastes.
Ref. 40.

18 + 31 ISOCYANATES + PHENOLS AND CRESOLS

Isocyanates and phenols can combine to form carbamic esters yielding some heat. With multifunctional isocyanates and phenols, polymerization can result yielding much heat. This reaction is especially catalyzed by metal compounds.
Ref. 71.

18 + 33 ISOCYANATES + SULFIDES

If sulfide salts are soluble in isoyanates. Attack may occur at the carbonyl forming a thiocarbamage and yielding heat. If the sulfides are in aqueous solution, the isocyanates will react preferentially with the water and decompose yielding carbon dioxide.
Ref. 71.

18 + 104 ISOCYANATES + OXIDIZING AGENTS

Exhaustive oxidation of isocyanates can yield heat, fire, and toxic fumes of nitrogen oxides.
Ref. 69.

18 + 105 ISOCYANATES + STRONG REDUCING AGENTS

See Notes 18 + 21, and 18 + 33. Other reducing agents may react in a similar manner.

18 + 106 ISOCYANATES + WATER

Isocyanates form carbamic acids with water which decompose immediately to carbon dioxides yielding some heat.
Ref. 71.

18 + 107 ISOCYANATES + WATER REACTIVES

See Note 1 + 107.

19 + 20 KETONES + MERCAPTANS

Ketones and mercaptans can form gem-hydroxy thioethers yielding some heat.
Ref. 66.

19 + 21 KETONES + ALKALI and ALKALINE EARTH METALS

These metals can readily abstract the labile α-hydrogens forming

19 + 21 KETONES + ALKALI and ALKALINE EARTH METALS (Continued)

flammable hydrogen gas and heat.
Ref. 39.

19 + 25 KETONES + NITRIDES

Nitrides which are somewhat soluble in ketones, may generate flammable ammonia gas upon reaction with the labile α-hydrogens of the ketones. Various other reactions can also generate heat.
Ref. 22.

19 + 30 KETONES + PEROXIDES and HYDROPEROXIDES

Peroxides and ketones may form diperoxides which can decompose with slight increase in temperature or in the presence of water. Hydroperoxides are also formed by this interaction. Hydroperoxides form hydroxyperoxides and diperoxides with ketones. Many of the reaction products as well as the peroxy reactants are extremely sensitive to heat and shock.
Ref. 40.

19 + 104 KETONES + STRONG OXIDIZING AGENTS

Exhaustive oxidation can generate much heat and ignite the mixture.
Ref. 69.

19 + 105 KETONES + STRONG REDUCING AGENTS

See Note 19 + 21. Other reducing agents may also react with ketones in the same manner.

19 + 107 KETONES + WATER REACTIVES

See Note 1 + 107.

20 + 21 MERCAPTANS + ALKALI and ALKALINE EARTH METALS

These active metals can easily abstract the sulfhydryl hydrogen to form flammable hydrogen gas and the mercaptide with heat.
Ref. 51.

20 + 22 MERCAPTANS + METAL POWDERS, VAPORS OR SPONGES

Metals in these forms can react with mercaptans to form flammable hydrogen gas, and mercaptides with heat. Aluminum, beryllium, magnesium, zinc, and zirconium are especially reactive in this manner. The reaction can be explosive.
Ref. 7, 57.

20 + 25 MERCAPTANS + NITRIDES

Nitrides which are soluble in mercaptans, may form ammonia gas with heat generation.
Ref. 22, 66.

20 + 30 MERCAPTANS + ORGANIC PEROXIDES

The sulfhydryl hydrogen can be easily abstracted by radicals produced from the decomposition of peroxides and hydroperoxides. The resulting chain reaction can be highly exothermic. The lower molecular weight peroxy compounds are extremely unstable and explosions can occur.
Ref. 49, 57.

20 + 34 MERCAPTANS + EPOXIDES

Mercaptans may cleave epoxides with heat generation. Difunctional mercaptans may polymerize with epoxides in this manner yielding much heat.
Ref. 55.

20 + 104 MERCAPTANS + OXIDIZING AGENTS

Exhaustive oxidation can result in much heat generation and formation of toxic sulfur oxide fumes.
Ref. 69.

20 + 105 MERCAPTANS + REDUCING AGENTS

See Note 20 + 21. Other strong reducing agents may react in the same manner generating hydrogen.

20 + 107 MERCAPTANS + WATER REACTIVES

See Note 1 + 107.

21 + 25 ALKALI and ALKALINE EARTH METALS + NITRIDES

Many nitrides are explosively unstable and may react violently with these extremely reactive metals.
Ref. 7.

21 + 26 ALKALI and ALKALINE EARTH METALS + NITRILES

These metals can abstract the labile α-hydrogen to yield flammable hydrogen gas and heat. Polymerization may be initiated in this manner yielding much heat.
Ref. 39.

21 + 27 ALKALI and ALKALINE EARTH METALS + NITRO COMPOUNDS

Aliphatic nitro compounds have labile α-hydrogens which can easily

21 + 27 ALKALI and ALKALINE EARTH METALS + NITRO COMPOUNDS (Continued)

be extracted by these active metals. The resulting alkali or alkaline earth metal salts are highly unstable to heat and shock and may be detonated by the heat of reaction. The redox reaction between aromatic nitro compounds and these metals can be highly exothermic. Ref. 71.

21 + 30 ALKALI and ALKALINE EARTH METALS + ORGANIC PEROXIDES

The redox reaction can be explosively exothermic.
Ref. 32, 69

21 + 31 ALKALI and ALKALINE EARTH METALS + PHENOLS and CRESOLS

Flammable hydrogen gas can be liberated by abstraction of the phenolic hydrogen. The heat of reaction may ignite the gas.
Ref. 55.

21 + 32 ALKALI and ALKALINE EARTH METALS + ORGANOPHOSPHATES

The high electron density of the organophosphate group can initiate a reaction with these active metals resulting in exothermic transfer of electrons from the metals. In the case of phosphorothioates and phosphorodithioates, this heat of reaction may be sufficient to cause explosive rearrangement from the thiono to the thiolo form. Parathion and methy parathion are expecially sensitive to heat.
Ref. 39, 50.

21 + 101 ALKALI and ALKALINE EARTH METALS + COMBUSTIBLE MATERIALS

Many of these miscellaneous materials may contain various substances such as water which are extremely reactive with the active metals. Heat and various hazardous gases may be evolved. Enough heat may be evolved to ignite the materials if air or some other source of oxygen is present.

21 + 102 ALKALI and ALKALINE EARTH METALS + EXPLOSIVES

Many explosives are highly oxygenated and will react on contact with these active metals with explosive violence. These active metals can also react exothermically with the other unstable compounds to cause detonation.

21 + 103 ALKALI and ALKALINE EARTH METALS + POLYMERS

Radicals from these metals readily attack unsaturated carbons and can initiate polymerization of many of the compounds in Group 103. Much heat can be evolved.
Ref. 68.

21 + 104 ALKALI and ALKALINE EARTH METALS + OXIDIZING AGENTS

Alkali and alkaline earth metals are extremely effective reducing agents. They will react violently with oxidizing agents evolving much heat, and resulting in fires and explosions.
Ref. 69.

21 + 106 ALKALI and ALKALINE EARTH METALS + WATER

These metals react violently with water evolving flammable hydrogen gas and resulting in formation of strong caustics. Enough heat can be generated to cause ignition.
Ref. 69.

21 + 107 ALKALI and ALKALINE EARTH METALS + WATER REACTIVES

See Note 1 + 107.

22 + 28 METAL POWDERS + UNSATURATED ALIPHATICS

Finely divided metals, especially copper and silver, can form acetylides with acetylenes. These acetylides are very sensitive to shock and heat and can regenerate flammable acetylene upon contact with water.
Ref. 69.

22 + 30 METAL POWDERS + ORGANIC PEROXIDES

Diacyl peroxides and ozonides are particularly reactive with metals in these forms. They can decompose violently yielding heat and various gases. The peroxy acids are expecially strong oxidizing agents and can produce much heat upon reaction with these metals. Other peroxy compounds may decompose violently upon contact yielding oxygen.
Ref. 40, 54.

22 + 34 METAL POWDERS + EPOXIDES

The metal oxide coating of these finely divided particles can catalyze ring opening and polymerization with much heat evolved.
Ref. 68.

22 + 102 METAL POWDERS + EXPLOSIVES

Many of these unstable compounds are extremely vigorous oxidizing agents and can react explosively with these metals.
Ref. 69.

22 + 103 METAL POWDERS + POLYMERIZABLE COMPOUNDS

The oxide coatings of these metals can catalyze the polymerization of the monomers in Group 102. See also Note 22 + 30. Much heat can be evolved.

22 + 103 METAL POWDERS + POLYMERIZABLE COMPOUNDS (Continued)

Ref. 68.

22 + 104 METAL POWDERS + OXIDIZING AGENTS

These metals are readily oxidized by the substances in Group 104 yielding much heat. Fires and explosions can also result.
Ref. 69.

22 + 106 METAL POWDERS + WATER

Some of these metals evolve flammable hydrogen gas with some heat on contact with water. In enclosed areas, explosions can occur.
Ref. 76.

22 + 107 METAL POWDERS + WATER REACTIVES

See Note 1 + 107.

23 + 103 METAL SHEETS, ETC + POLYMERIZABLE COMPOUNDS

Polymerization may be catalyzed by these metal surfaces yielding much heat. Although not as reactive as Group 22, chunks or containers made of these metals may be reactive enough to initiate polymerization.
Ref. 32.

23 + 104 METAL SHEETS, ETC + OXIDIZING AGENTS

These metals can react vigorously with oxidizing agents generating heat and possibly resulting in fires.
Ref. 32.

23 + 107 METAL SHEETS, ETC + WATER REACTIVES

See Note 1 + 107.

24 + 26 TOXIC METALS + NITRILES

Acetonitrile and ethylene cyanohydrin are used as nonaqueous solvents for many inorganic salts.
Ref. 54.

24 + 30 TOXIC METALS + ORGANIC PEROXIDES

Many metal salts can catalyze the decomposition of organic peroxides and hydroperoxides yielding heat and various gases such as oxygen and carbon dioxide. Diacyl peroxides are especially susceptible to explosive decomposition in the presence of heavy metals and metal salts. Hydroperoxides are more stable than diacyl peroxides but do

24 + 30 TOXIC METALS + ORGANIC PEROXIDES (Continued)

undergo similar reactions with these metals.
Ref. 40, 68.

24 + 34 TOXIC METALS + EPOXIDES

Polymerization of epoxides, expecially ethylene oxide and propylene oxide, can be initiated by Lewis acids such as $SnCl_4$, $ZnCl_2$, $SbCl_3$, $ZrCl_4$, $CrCl_3$, $CoCl_2$ and $HgCl_2$. Organometallic zinc compounds can also initiate much heat.
Ref. 68.

24 + 102 TOXIC METALS + EXPLOSIVES

These various metal salts may react exothermically with explosives to cause detonation. Much of this reactivity is associated with the anion rather that the metal cation.

24 + 103 TOXIC METALS + POLYMERS

See Note 24 + 34. Vinyl monomers and dienes are susceptible to cationic polymerization by Lewis acid catalysts such as $SnCl_4$, $SnBr_4$, $SbCl_2$, and $ZnCl_4$. Although a co-catalyst such as H_2O, or HCl is required, only trace amounts need be present.
Ref. 51, 68.

24 + 106 TOXIC METALS + WATER

Some of these compounds are very soluble in water. See the specific compounds for solubilities.
Ref. 23.

24 + 107 TOXIC METALS + WATER REACTIVES

See Note 1 + 107.

25 + 26 NITRIDES + NITRILES

If the ionic nitrides are soluble in aliphatic nitriles, they can extract the α-hydrogens from the nitriles to form flammable ammonia gas. Some heat can be evolved.
Ref. 22, 71.

25 + 27 NITRIDES + NITRO COMPOUNDS

If soluble, nitrides can extract a hydrogen from aliphatic nitro compounds to yield flammabe ammonia gas and heat. Many polynitrated aromatics and ionic nitrides are unstable to heat and shock. However, the nitrides are much more unstable and may initiate the explosive decomposition of such nitro compounds.
Ref. 32, 71.

25 + 30 NITRIDES + ORGANIC PEROXIDES

On combination with hydroperoxides, nitrides can abstract the peroxy hydrogen and initiate the decomposition with generation of ammonia. The anion formed can further decompose upon reaction with more hydroperoxides to yield oxygen gas. This decomposition can proceed with fire and explosions. Some hydroperoxides may form relatively stable salts, however, these salts can decompose violently upon heating. Ammonia gas can also be formed with peroxides due to abstraction of hydrogen on the peroxy carbon. The peroxide then undergoes homolytic fission with some heat evolved. Nitrides and the lower molecular weight peroxides are both extremely unstable.
Ref. 40

25 + 31 NITRIDES + PHENOLS and CRESOLS

Flammable ammonia gas can be formed from the acid-base reaction of the aromatic hydroxy group and ionic nitrides also yielding heat.
Ref. 22.

25 + 34 NITRIDES + EPOXIDES

Base catalyzed ring opening initiating polymerization of epoxides can occur with nitrides. Much heat can be evolved.
Ref. 55.

25 + 101 NITRIDES + COMBUSTIBLE MATERIALS

Many of these miscellaneous mixtures may also contain water which will form ammonia gas with nitrides. Moreover, since nitrides are also pyrophoric, any air present can initiate combustion.
Ref. 22, 32.

25 + 102 NITRIDES + EXPLOSIVES

Ionic nitrides are pyrophoric and extremely sensitive to shock and heat. They can act as initiating explosives for many of the high explosives listed in Group 102.

25 + 103 NITRIDES + POLYMERIZABLE COMPOUNDS

Ionic nitrides may initiate anionic polymerization of vinyl monomers and dienes yielding much heat. See also Note 25 + 34.

25 + 104 NITRIDES + OXIDIZING AGENTS

Ionic nitrides are pyrophoric and can inflame or explode on contact with strong oxidizing agents.
Ref. 32, 69.

25 + 106 NITRIDES + WATER

Ionic nitrides are easily hydrolyzed to caustic and flammable ammonia gas.
Ref. 22.

25 + 107 NITRIDES + WATER REACTIVES

See Note 1 + 107.

26 + 30 NITRILES + ORGANIC PEROXIDES

Amyl nitriles such as phenyl acetonitrile are converted to peroxyesters and hydrogen cyanide gas upon treatment with hydroperoxides. The polymerization of acrylonitriles can be initiated by organic peroxides. Dibenzoyl peroxide is widely used for this purpose. Upon exhaustive oxidation with peroxy acids, much heat and toxic nitrogen oxide fumes can be evolved.
Ref. 40, 68, 69.

26 + 104 NITRILES + OXIDIZING AGENTS

Exhaustive oxidation can result in evolution of heat and toxic fumes of nitrogen oxides, and ignition.
Ref. 32, 69.

26 + 105 NITRILES + REDUCING AGENTS

Nitriles are readily reduced by metal hydrides, especially $LiAlH_4$ yielding much heat. Hydrogen gas can also be evolved from the abstraction of the labile α-hydrogens.
Ref. 18.

26 + 107 NITRILES + WATER REACTIVES

See Note 1 + 107.

27 + 104 NITRO COMPOUNDS + OXIDIZING AGENTS

Many nitro compounds can decompose explosively. Strong oxidizing agents can catalyze this decomposition by oxidizing the hydrocarbon moeity. Shock sensitive salts can also form, which when dry, can decompose explosively.
Ref. 32, 69.

27 + 105 NITRO COMPOUNDS + REDUCING AGENTS

The labile α-hydrogens of nitro aliphatics can be extracted and evolved as flammable hydrogen gas with some heat.
Ref. 39, 71.

27 + 107 NITRO COMPOUNDS + WATER REACTIVES

See Note 1 + 107.

28 + 30 UNSATURATED ALIPHATICS + ORGANIC PEROXIDES

Olefinic hydrocarbons are susceptible to oxidation by peroxy acids to epoxides and glycol ester. The reaction may evolve some heat. Alkyl and aryl peroxides attack olefins by a free radical mechanism sometimes resulting in highly exothermic polymerizations. Aroyl peroxides also participate in a free radical reaction with olefins, but attack can occur at the allylic methylene or the double bond. In either case, polymeric hydrocarbons result. Acetylenic hydrocarbons undergo similar reactions, but rates are much slower.
Ref. 40.

28 + 104 UNSATURATED ALIPHATICS + STRONG OXIDIZER

Exhaustive oxidation can result in ignition of the hydrocarbons.
Ref. 69.

28 + 107 UNSATURATED HYDROCARBONS + WATER REACTIVE

See Note 1 + 107.

29 + 104 SATURATED ALIPHATICS + OXIDIZING AGENTS

These hydrocarbons can be easily oxidized to yield heat and may ignite.
Ref. 69.

29 + 107 SATURATED ALIPHATICS + WATER REACTIVES

See Note 1 + 107.

30 + 31 ORGANIC PEROXIDES + PHENOLS AND CRESOLS

Some heat may be evolved from the oxidation of phenols and cresols to quinones and from free radical substitution on the aromatic ring. These oxidations are greatly enhanced by the presence of metal ions.
Ref. 40, 65.

30 + 32 ORGANIC PEROXIDES + ORGANOPHOSPHATES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

30 + 33 ORGANIC PEROXIDES + SULFIDES

Inorganic sulfides may be oxidized to toxic sulfur dioxide by these

30 + 33 ORGANIC PEROXIDES + SULFIDES (Continued)

organic peroxides. The metal ions may also catalyze the decomposition of the more unstable peroxides and hydroperoxides yielding gas and heat.
Ref. 40, 69.

30 + 34 ORGANIC PEROXIDES + EXPOXIDES

Hydroperoxides are known to cleave epoxide rings by nucleophilic attack of the peroxy anion. Some heat may be evolved, but there is no evidence of polymerization. Polymerization can occur with a combination of peroxides and allylic epoxides by a free readical mechanism.
Ref. 40, 68.

30 + 101 ORGANIC PEROXIDES + COMBUSTIBLE MATERIALS

Many of these materials are susceptible to oxidation by organic peroxides and can evolve toxic gases. Heat and fire can also result.
Ref. 69.

30 + 102 ORGANIC PEROXIDES + EXPLOSIVES

If these explosives are not detonated upon contact with organic peroxides, the mixture can be extremely unstable and sensitive to any shock or slight heating.
Ref. 69.

30 + 103 ORGANIC PEROXIDES + POLYMERIZABLE COMPOUNDS

Olefinic bonds are particularly susceptible to attack by free radicals generated from organic peroxides and hydroperoxides. The polymerization of vinyl, acrylic, and olefinic monomers listed in Group 103 can be initiated by these radicals with heat generated.
Ref. 68.

30 + 104 ORGANIC PEROXIDES + OXIDIZING AGENTS

Strong oxidizing agents can cause violent decomposition of organic peroxides and hydroperoxides yielding heat and oxygen or carbon dioxide. The decomposition can be catalyzed by the metallic character as well as the oxidizing properties of these compounds.
Ref. 40, 69.

30 + 105 ORGANIC PEROXIDES + REDUCING AGENTS

These compounds can react explosively.
Ref. 69.

30 + 107 ORGANIC PEROXIDES + WATER REACTIVES

See Note 1 + 107.

31 + 34 PHENOLS and CRESOLS + EPOXIDES

Epoxides may be cleaved by phenols and cresols in the presence of traces of acid or base. Some heat can be evolved. Polymerization is possible.
Ref. 55.

31 + 103 PHENOLS and CRESOLS + POLYMERIZABLE COMPOUNDS

See Note 18 + 31 and Also Note 31 + 34.

31 + 104 PHENOLS and CRESOLS + OXIDIZING AGENTS

Mild oxidation can yield ketones, carboxylic acids, and carbon dioxide with some heat. Exhaustive oxidation can yield much more heat and possibly fire.
Ref. 69, 75.

31 + 105 PHENOLS and CRESOLS + REDUCING AGENTS

See Note 21 + 31. The phenolic hydrogen is readily extracted by reducing agents, especially hydrides to yield flammable hydrogen gas and heat.
Ref. 78.

31 + 107 PHENOLS and CRESOLS + WATER REACTIVES

See Note 1 + 107.

32 + 34 ORGANOPHOSPHATES + EPOXIDES

Little information is available in the literature reviewed. Reaction between these two groups may produce hazardous conditions. It is recommended that mixing be avoided pending laboratory assessment of safety.

32 + 104 ORGANOPHOSPHATES + OXIDIZING AGENTS

Exhaustive oxidation of these organophosphorous compounds can yield toxic and corrosive fumes of oxides of phosphorous, sulfur, and nitrogen with heat.
Ref. 28, 69.

32 + 105 ORGANOPHOSPHATES + REDUCING AGENTS

The phosphothioates and phosphodithioates can evolve toxic and flammable hydrogen sulfide upon reduction. See Note 21 + 32.
Ref. 28.

32 + 107 ORGANOPHOSPHATES + WATER REACTIVES

See Note 1 + 107.

33 + 34 SULFIDES + EPOXIDES

Soluble sulfides can cleave epoxides by a nucleophilic attack, possibly initiating polymerization and yielding much heat.
Ref. 54, 55.

33 + 102 SULFIDES + EXPLOSIVES

Sulfides are strong reducing agents and can react explosively with the highly oxygenated compounds in Group 102.
Ref. 69.

33 + 103 SULFIDES + POLYMERIZABLE COMPOUNDS

Soluble sulfides may initiate anionic polymerization with some heat generated. See Note 33 + 34.
Ref.

33 + 104 SULFIDES + OXIDIZING AGENTS

Sulfides are strong reducing agents and can react violently with oxidizing agents yielding toxic fumes of sulfur dioxide and heat.
Ref. 69.

33 + 106 SULFIDES + WATER

Toxic and flammable hydrogen sulfide gas can be generated.
Ref. 69.

33 + 107 SULFIDES + WATER REACTIVES

See Note 1 + 107.

34 + 102 EPOXIDES + EXPLOSIVES

The lower molecular weight epoxides are extremely flammable and can react explosively with the highly oxygenated members of Group 102.
Ref. 69.

34 + 104 EPOXIDES + OXIDIZING AGENTS

Exhaustive oxidation can result in heat and ignition of the flammable epoxides.
Ref. 69.

34 + 105 EPOXIDES + REDUCING AGENTS

Reductive cleavage of epoxides occurs readily with metal hydrides and other agents yielding much heat. See Note 21 + 34.
Ref. 45.

34 + 107 EPOXIDES + WATER REACTIVES

See Note 1 + 107.

101 + 102 COMBUSTIBLES + EXPLOSIVES

Many of these explosives are very strong oxidizing agents and can react violently with these combustibles. If they do not react immediately, these mixtures may be unstable.
Ref. 69, 70.

101 + 104 COMBUSTIBLES + OXIDIZING AGENTS

Heat, fire, and possibly explosions can result from this combination. Toxic gases can result if the combustible material contains compounds of nitrogen, sulfur, or phosphorous.
Ref. 69.

101 + 105 COMBUSTIBLES + REDUCING AGENTS

These miscellaneous combustibles may contact water which can react with many reducing agents to form flammable hydrogen gas. The reducing agents are also pyrophoric and can ignite the combustibles in the presence of air.
Ref. 69.

101 + 107 COMBUSTIBLES + WATER REACTIVES

See Note 1 + 107.

102 + 103 EXPLOSIVES + POLYMERIZABLE COMPOUNDS

Many explosives are strong oxidizing agents and can react explosively with these organic compounds. Many of these monomers such as ethylene oxide, vinyl chloride, butadiene, and others are extremely flammable.
Ref. 32.

102 + 104 EXPLOSIVES + OXIDIZING AGENTS

Extremely sensitive mixtures can result from this combination. The presence of another oxidizing agent can catalyze the decomposition of many of the highly oxygenated explosives. Others such as the nitrides, azides, and carbides are easily oxidized and can react explosively.
Ref. 32, 69.

102 + 105 EXPLOSIVES + REDUCING AGENTS

Since many explosives are strong oxidizing agents, their reaction with reducing agents can be extremely violent.
Ref. 32, 69.

102 + 107 EXPLOSIVES + WATER REACTIVES

See Note 1 + 107.

103 + 104 POLYMERIZABLE COMPOUNDS + OXIDIZING AGENTS

These monomers are readily combustible organic compounds and can react violantly with strong oxidizing agents to yield heat and fire. The halogenated monomers or those containing nitrogen can evolve toxic fumes.
Ref. 32, 69.

103 + 105 POLYMERIZABLE COMPOUNDS + REDUCING AGENTS

Many reducing agents are also widely used as initiators for anionic polymerization. The reaction can yield much heat. Competing reactions may also produce flammable hydrogen gas.
Ref. 51, 69.

103 + 107 POLYMERIZABLE COMPOUNDS + WATER REACTIVES

See Note 1 + 107.

104 + 105 OXIDIZING AGENTS + REDUCING AGENTS

These compounds can react with explosive violence upon contact.
Ref. 69.

104 + 107 OXIDIZING AGENTS + WATER REACTIVES

See Note 1 + 107.

105 + 106 REDUCING AGENTS + WATER

These strong reducing agents can liberate extremely flammable and/or toxic gases such as phosphine, hydrogen sulfide, ammonia, hydrogen, and acetylene upon contact with water. The heat generated can ignite these gases.
Ref. 32, 54, 69.

105 + 107 REDUCING AGENTS + WATER REACTIVES

See Note 1 + 107.

106 + 107 **WATER + WATER REACTIVES**

This combination can result in violent reactions evolving flammable and/or toxic gases with heat. Often fires and explosions result. Ref. 32, 54, 69.

APPENDIX 5. CASE HISTORIES OF ACCIDENTS CAUSED BY MIXING INCOMPATIBLE WASTES

The format of the whole handbook was developed around the information obtained from the following documented case histories of accidents that resulted from the mixing of incompatible hazardous wastes. The list is not extensive, but the following case histories definitely indicate that insufficient or inaccurate information about the wastes and indiscriminate handling and disposal of the wastes are the primary causes of accidents resulting from the mixing of incompatible hazardous wastes.

The case histories are not arranged in any particular order. The adverse reaction consequences from the mixing of the wastes are given as the titles followed by the references where they were reported. For more detailed discussions of the case histories, the user is referred to these references.

The information from these case histories are particularly useful as starting blocks in the development of the Hazardous Wastes Compatibility Chart (Figure 6), and the List of Incompatible Binary Combinations of Hazardous Wastes and the Potential Adverse Reaction Consequences (Appendix 4).

1. Violent Reaction, Pressure Generation in Tank Truck (Ref. 8)

   In Richmond, California, a hazardous waste hauler mixed, in his 30-barrel tank truck, a liquid waste containing butyl acetate in xylene with an etching waste containing sulfuric acid, nitric acid and hydrofluoric acid. A hydrolysis reaction took place. The reaction generated pressure in the tank and blew the safety relief valve while the truck was travelling through a residential area. A private residence was sprayed with the hazardous mixture. No one was injured, but considerable clean-up and repainting of the house was required.

2. Heat Generation and Explosion from Reuse of Contaminated Drums (Ref. 12)

   An employee transferred two 5-gallon cans of waste vinyl cyanide and water from a still to a supposedly empty waste drum. As the employee rolled the drum to a storage area across the road, it expoded. Waste material sprayed out on the employee. He believed that he saw a flash at the time of the explosion. The drum was thrown approximately 48 feet, wrapping around a steel guard post. The employee received thermal and possible chemical burns to both feet.

   The waste drum contained still bottoms from the stripping of a vinylation mixture. The exothermic reaction, causing the drum to rupture, was probably a combination of cyanoethylation and polymerization.

3. Formation of Toxic Gas in Sanitary Landfill (Ref. 8)

In Los Angeles County, a tank truck emptied several thousand gallons of cyanide waste onto refuse at a sanitary landfill. Another truck subseqently deposited several thousand gallons of acid waste at the same location. Reaction between the acid and the cyanide evolved large amounts of toxic hydrogen cyanide gas. A potential disaster was averted when a local chlorine dealer was quickly called to oxidize the cyanide with chlorine solution.

4. Formation of Toxic Gas in Excavated Site (Ref. 58)

A load of acidic aluminum sulfate waste was inadvertently discharged into an excavation already containing some sulfide waste. Hydrogen sulfide was released, and the lorry driver died in his cab at the landfill site.

5. Formation of Toxic Gas and Explosion in Waste Tank (Ref. 58)

Sulfide waste was added to soluble oil waste in a tanker and subsequently added to other oily wastes in a tank. Later treatment of the oil with acid to break the emulsified oil resulted in evolution of hydrogen sulfide. Two operators were briefly affected by the gas. There was also an explosion in the tank.

6. Formation of Toxic Gas at a Landfill (Ref. 42)

At a sanitary landfill near Dundalk, Maryland, a 2,000-gallon liquid industrial waste load containing iron sulfide, sodium sulfide, sodium carbonate and sodium thiosulfate—along with smaller quantities of organic compounds—was discharged into a depression atop an earth-covered area of the fill. When it reached 8 to 10 feet below the point of discharge, the liquid started to bubble and fumed blue smoke. The smoke cloud quickly engulfed the truck driver and disabled him. Several nearby workers rushed to his aid and were also felled. During the clean-up operation, one of the county firefighteres also collapsed. All six of the injured were hospitalized and treated for hydrogen sulfide poisoning. It was not determined whether the generation of hydrogen sulfide was due to the instability of the waste or the incompatibility of the waste with some of the landfill materials. The pH of the waste was measured to be 13 before it left the plant.

7. Formation of Toxic Gas in a Disposal Well (Ref. 8)

At a land disposal site in southern California, a tanker was observed unloading a waste listed as "waste acid (5% HCl)" into a subsurface, bottomless tank through an open stack above the ground. Shortly after the unloading operation commenced, yellowish-brown clouds of nitrogen dioxide began to emanate from the open stack. The reactions appeared to have subsided when the discharging of the wastes ceased. However, an hour later, more NO_2 started to spew from the stack. The emission was halted by filling the stack with soil. There were no injuries, but the incident created a significant air pollution problem such that complaints from nearby businesses were received and a factory was evacuated.

8. Fire, Dispersal of Toxic Dusts from Leaky Containers (Ref. 8)

At a dump in Contra Costa County, California, a large number of drums containing solvents were deposited in a landfill. In the immediate area were leaky containers of concentrated mineral acids and several bags containing beryllium wastes in dust form. The operators failed to cover the waste at the end of the day. The acids reacted with the solvents during the night, ignited them, and started a large chemical fire. There was possible dispersion of beryllium dust into the environment. Inhalation, ingestion, or contact with beryllium dust by personnel could have led to serious health consequences.

9. Volatilization of Toxic Chemicals Due to Heat Generation from Ruptured, Buried Containers (Ref. 8)

A load of empty pesticide containers was delivered to a disposal site in Fresno County, California. Unknown to the site operator, several full drums of an acetone-methanol mixture was included in the load. When the load was compacted by a bulldozer, the barreled waste ignited, engulfing the bulldozer in flames. The operator escaped unharmed, but the machine was seriously damaged. The ensuing fire, which also involved dispersion of pesticide wastes, was extinguished by firemen. The firemen were examined to ensure that they were not exposed to pesticide dusts.

10. Violent Eruption in Waste Drum (Ref. 58)

At an engineering work, hot chromic acid waste was inadvertently added to a drum containing methylene chloride waste from degreasing operations. There was a violent eruption resulting in chemicals being sprayed locally in the workshop. Fortunately, no one was harmed.

11. Fire from Sodium Waste Disposal (Ref. 12)

A fire occurred in a laboratory when a few pieces of scrap sodium, which had been placed in alcohol to effect decomposition, flashed when discarded in a sink. Evidently the sodium had not been completely decomposed and reacted with the water in the sink.

12. Formation of Shock and Friction Sensitive Substances (Ref. 12)

When a laboratory drain at a Los Angeles hospital was being cleaned by scraping, the drain pipe exploded scattering fragments of metal from the pipe. Two subsequent attempts to remove the residual piping with screwdriver and hacksaw resulted in explosions in both instances. Fortunately, no one was injured in these explosions. The cause was later attributed to shock-sensitive lead azide formed in the lead pipes. Apparently, used test solutions, containing sodium azide as a preservative, was routinely poured into the sewer drain line. The chemical accumulated in the pipes and reacted with the lead in the pipe to form shock-sensitive, explosive deposits of lead azide.

13. Formation of Water Soluble Toxic Substances from Ruptured Drums (Ref. 8)

In Riverside County, California, several drums of phosphorus oxychloride, phosphorus thiochloride and thionyl chloride were inproperly dropped off at a dump. Later, during a flood, the drums were unearthed, ruptured, and washed downstream, releasing hydrogen chloride gas.

14. Fire at a Disposal Site (Ref. 8)

A disposal site in central California accepted a load of solid dichromate salts and was dumped in a pit along with pesticide formulations and empty pesticide containers. For several days thereafter, small fires erupted in the pit because of the oxidation of the pesticide formulations by the dichromate. Fortunately, the site personnel were able to extinguish these fires before they burned out of control. No injuries or property and equipment damage resulted from the fires.

15. Nitrogen Oxide Generation at a Sanitary Landfill (Ref. 8)

A vacuum truck driver picked up a load of "nitric acid" from an automotive specialities manufacturing company in early July 1976 and delivered it to a site in southern California for well disposal. The well was able to accept only about 50 gallons of the waste. The driver then took the remainder of the load to another landfill in southern California for trench disposal. Upon unloading, a reaction took place that generated brown nitrogen dioxide fumes that were carried by the wind and interfered with traffic 500 yards away.

Towards the end of the month the same driver picked up another load of the same type from the same company and delivered it directly to the second landfill site. Upon arrival at the weigh station, he was instructed to tell the caterpillar driver to "dig a deep hole." The caterpillar operator dug a hole approximately 12 ft deep, 12 ft wide, and 20 ft long into a previously filled area. The truck driver said that he observed damp ground and decomposing refuse in the trench. The driver then unloaded his truck and backed away from the trench because he did not want to be exposed to the hazard he had observed on a previous occasion. Sure enough he observed a dense brown cloud emanating from the trench and could not return to his truck until its contents had been drained and the hazard reduced.

A chemical analysis of a retained sample from the load showed that it contained approximately 70% nitric acid and 5% hydrofluoric acid along with aluminum and chrominum. The sample was fuming when it was taken from the truck.

16. Violent Reaction of $AlCl_3$ Wastes from Smelting Processes (Ref. 8)

Five steel barrels were picked up from a reclaimed aluminum and zinc smelting company and delivered to a Class I disposal site in southern California. While rolling the drums off the truck, one of the barrels ruptured and its contents reacted violently with the liquid in the pond at the working face of the fill. The other four barrels were buried separately. No injuries resulted from the accident.

One of the vice presidents of the company confirmed that the reactive material in the waste was 95% $AlCl_3$ condensate collected in the steel barrels. This condensate results from passing Cl_2 gas through the molten aluminum metal to remove magnesium.

17. Explosion of Waste TDI Containing Drums (Ref. 8)

A company using toluene diisocyanate (TDI) in the manufacture of plastic and foam rubber automobile products collected and stored on-site its TDI wastes in 55-gallon metal drums with clamp-type lids. After an extended period of time, thirty such drums had been accumulated. A hauler was contacted to transport the wastes to a Class I site in Southern California. The hauler stored the drums in an open area at his facility for approximately 2 weeks. Heavy rainfall occurred during this period. Upon delivery of the drums to a disposal site, a violent explosion ruptured one of the drums. Apparently, during storage some water condensed or leaked into the drums through the clamp-type lids. Transportation of the drums then provided the agitation and accelerated the reaction between water and TDI. The rapid production of CO_2 caused extreme pressure build-up in one of the drums and subsequent violent rupture.

There were no injuries associated with this incident.

18. Dirt Contaminated with $NaClO_4$ Causes Fire (Ref. 8)

In 1972 at a disposal site in Southern California, reaction of sodium chlorate with refuse started a fire that lasted for 2 hours. There were no injuries associated with the incident.

Dirt contaminated with $NaClO_4$ was drummed and transported as "NaCl" to the sanitary landfill. The drums were emptied on refuse. The contents of the drums were wet but reacted with the refuse to cause a fire.

A similar incident involving $NaClO_4$ and refuse producing a fire occurred in 1973. This incident involved containerized material that reacted with refuse when a container ruptured during the covering operation.

19. Cyanide Generation at a Sanitary Landfill (Ref. 8)

A standard procedure at a Southern California disposal site for handling liquid wastes containing cyanides and spent caustic solutions was to inject these loads into covered wells dug into a completed section of a sanitary landfill. Routine air sampling in the vicinity of the wells detected low levels of HCN. Sampling in the well head detected more than 1000 ppm HCN. No cyanide was detected during addition of the spent caustic to a new well. On the basis of these discoveries, use of the wells was discontinued. Cyanide gas apparently formed in the well as a result of lowering of the pH of the waste by CO_2, and organic acids that were produced in the decomposition of refuse.

20. Phosphorus Oxychloride and Water Caused Fatality (Ref. 12)

A delayed reaction between phosphorus oxychloride and water in a 55-gallon drum caused violent rupture of the drum and killed a plant operator. The steam and hydrogen chloride gas generated by the reaction caused an explosion that propelled the bottom head of the drum approximately 100 yards from the scene.

21. Nitric Acid and Alcohol Cause Explosion of Tank Car (Ref. 12)

During the process of transferring 64% nitric acid to a supposedly empty tank car, the tank car exploded. An investigation revealed that the tank car contained a small residual of alcohol that was converted to acetaldehyde by the acid. The heat of reaction vaporized the acetaldehyde and subsequently ignited the acetaldehyde-air mixture causing an explosion. No injuries or fatalities resulted.

22. Nitric Acid - Ammonia Fire Generate Toxic Fumes (Ref. 8)

In a fertilizer warehouse in Carroll County, Arkansas, a mixture of ammonia and nitric acid ignited and destroyed the plant. Toxic fumes generated by the blaze forced the evacuation of the town's residents. No injuries or fatalities were reported.

23. Vacuum Truck Rupture Caused by Formation of Hydrogen Gas (Ref. 8)

In Los Angeles a vacuum truck containing an unknown quantity of residual wastes picked-up a spent sulfuric acid metal stripping solution. On the way to the disposal site a violent explosion occurred, rupturing the tank and injuring the driver. Subsequent investigation revealed that the residue in the tank before the pick-up of the acid solution contained aluminum and magnesium turnings and fines. The action of the acid on these metal particles produced hydrogen gas and heat. Extreme pressure build-up resulted in the violent rupture of the tank.

24. Toxic Gas Generation From Buried Drums of Silicon Tetrachloride (Ref. 8)

Drums of silicon tetrachloride were buried in a hazardous waste disposal site in northern California. After about a year and a period of intense rains, dense fumes of toxic and corrosive hydrogen chloride permeated the soil cover and spread over the vicinity of the burial area. The metal drums had apparently rusted through and the water reacted with $SiCl_4$ forming hydrogen chloride gas. No injuries were reported, and the gas evolution was controlled by covering the trench with a layer of limestone and soil.

CAUTION NOTICE FOR COMPATIBILITY CHART

A METHOD FOR DETERMINING THE COMPATIBILITY OF HAZARDOUS WASTES
(EPA-600/2-80-076, April 1980)

The enclosed caution notice label should be peeled off and placed on the chart inserted in the envelope in the back of the above report. This label reads:

CAUTION!!

This chart is intended as an indication of **some** of the hazards that can be expected on mixing chemical wastes. Because of the differing activities of the thousands of compounds that may be encountered, it is **not** possible to make any chart definitive and all inclusive. It **cannot** be assumed to ensure compatibility of wastes because wastes are not classified as hazardous on the chart nor do blanks necessarily mean that the mixture could not result in a hazard occurring. **Detailed instructions as to hazards involved in handling and disposing of any given waste should be obtained from the originator of the waste.**

In an effort to reach all persons who received this report, this caution notice may be received by some who already have the notice on their chart or by others who did not order the report.

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

November 1980