

# A METHOD FOR DETERMINING HAZARDOUS WASTES COMPATIBILITY

by

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## FOREWORD

The 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 testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, and to preservation and treatment of 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; a most vital communications 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 constituents, 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 compatibility 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 for 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.



## 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-producing 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 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 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.

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## SECTION 1

### INTRODUCTION

Resource Recovery and Conservation Act of 1976 (PL 94-580) defines hazardous waste as solid waste or 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 in 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 produce 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 wastes 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 Histories (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 forty-one (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 5 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 wastes 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 matrices 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 FOR FURTHER RESEARCH

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 presently forty-one (41) reactivity groupings of the wastes to a smaller number based on general reactivity characteristics alone, instead of both on molecular functional groups and reactivities.

It is also recommended that a field test apparatus for determining wastes 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 procedures 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 as $N_2$ , $CO_2$ , 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, chlorobenzene, 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 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, Pyranon 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 (GTGF) are indicated if the wastes are mixed. Also solubilization (S) of metals may occur.



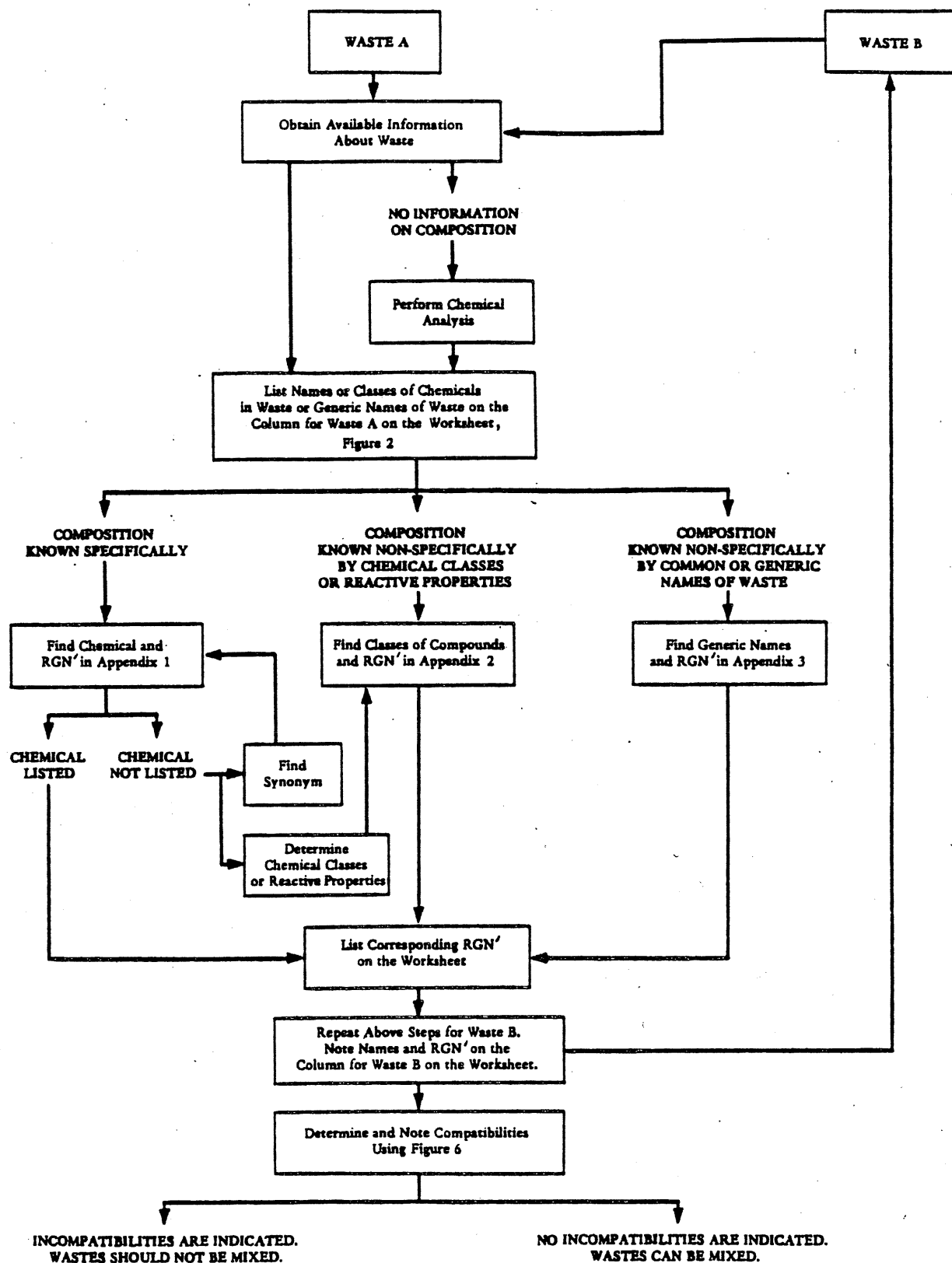
Step 1

Step 2

Step 3

Step 4

Step 5



Notes: 1. Reactivity Group Numbers

Figure 1

# FLOW DIAGRAM FOR DETERMINING HAZARDOUS WASTES COMPATIBILITY



Name of Waste Evaluation \_\_\_\_\_ Date \_\_\_\_\_

[illegible]

**Figure 2. Worksheet for determining hazardous wastes compatibility.**



## 1

Waste B \_\_\_\_\_ Source \_\_\_\_\_

Name of Waste \_\_\_\_\_ Date \_\_\_\_\_  
Evaluation \_\_\_\_\_

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



## EXAMPLE 2

Waste A \_\_\_\_\_ Source \_\_\_\_\_

Waste B \_\_\_\_\_ Source \_\_\_\_\_

Name of Waste Evaluation \_\_\_\_\_ Date \_\_\_\_\_

[illegible]

**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 compositions are known non-specifically by chemical classes.



### EXAMPLE 3

Waste A	Source

Waste B	Source

Name of Waste \_\_\_\_\_ Date \_\_\_\_\_  
Evaluation \_\_\_\_\_

[illegible]

**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 wastestreams 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 column 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







### HAZARDOUS WASTE COMPATIBILITY CHART (Continued)

<u>Reactivity Code</u>	<u>Consequences</u>
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:**

 $H_{FGT}$ 

Heat generation, fire, and toxic gas generation

[illegible]



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 Reaction 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 ( $HFE$ ), 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 ( $HFGT$ ). 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.



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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).

<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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	Acetoxypentane	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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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 trivinyll		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 disulfide	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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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 bromodiodide		24, 107
Boron dibromiodide		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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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
Butyl 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 peroxyvalate		30
t-Butyl perbenzoate	Butyl peroxyacetate	30
t-Butyl-3-phenyl oxazirane		34
Butyl trichlorosilane		107



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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
$\beta$ -Chlorovinyl dichloroarsine	Lewisite	24
Chlorpicrin	Trichloronitromethane	17, 27, 102
Chromic acid	Chromic anhydride, Chromium trioxide	2, 24, 104



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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 acetylde		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
Coumatetrayl		19
Cresol		31
Cresol glydicyl ether		34
Cresote		31
Crimidine	Castrix	7



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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	Nitroxylenes	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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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 I	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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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	Hydroxypropionitrile	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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
Fluorosulfonic acid	Fluosulfonic acid	1, 107
Fluosulfonic acid	Fluosulfonic acid	1, 107
Fluosilicic acid		1, 15
Fonofos*	Dyfonate*	32
Formaldehyde	Methanal - methylene oxide	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 acetylde		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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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		31
Hydroxyisobutyronitrile	Acetone cyanohydrin	19, 31
Hydroxyl amine		4, 26
Hydroxypropionitrile	Ethylene cyanohydrin	105
Hypochlorous acid		4, 26
Indene		2
Indium		16
Inerteen	Polychlorinated biphenyl	22, 23, 24
Iodine monochloride		17
Iodine pentoxide		107
		104



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
Lead trinitroresorcinat	Lead styphnate	24, 27, 102
Lewisite	$\beta$ -Chlorovinylchloroarsine	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 methylcyclopentadienyl- tricarbonyl		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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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
Mercuriol	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	Mercuriol	24
Mercury oleate	Mercuric oleate	24
Mercury sulfate	Mercuric sulfate	24
Mesitylene	1,3,5-trimethylbenzene	16
Mesityl oxide		19
Mesuiol*		9
Metasystox-R	Demeton-S-methyl sulfoxid	32
Metham		12
Methanal	Formaldehyde	5
Methane		29
Methanethiol	Methyl mercaptan	20
Methanoic acid	Formic acid	3



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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 <i>AAER</i>	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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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
Nitrocalcite	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
Nitroxylenes	Nitroxylol, Dimethylnitrobenzene	27
Nitroxylol	Nitroxylenes, 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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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, 102 105
Pentaborane		17, 31
Pentachlorophenol		27, 102
Pentaerythritol tetranitrate	Pentaerythrityl tetranitrate, PETN	16
Pentamethyl benzene		29
Pentane		20
Pentanethiol	Amyl mercaptan	5
Pentanal	Valeraldehyde	19
Pentanone		28
Pentene	Amylene	7
Pentylamine		28
Pentyne		3, 30
Peracetic acid	Peroxyacetic acid	2
Perbromic acid		2
Perchloric acid		17
Perchloroethylene	Tetrachloroethylene	17, 20
Perchloromethyl mercaptan	Trichloromethylsulfenylchloride	2
Perchlorous acid		104
Perchloryl fluoride		2
Periodic acid		1
Permonosulfuric acid		3, 30
Peroxyacetic acid	Peracetic acid	12
PETD	Polyram combi*	101
Petroleum naptha		101
Petroleum oil		16
Phenanthrene		7, 24
Phenarsazine chloride	Diphenylamine chloroarsine	



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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 valeryl nitrile		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 penta sulfide	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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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 tetrachloride		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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
Silver sulfide		24, 33, 105
Silver tetrazene		24, 102
Silver trinitroresorcinat	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 methyle	Sodium methoxide	10, 107
Sodium methoxide	Sodium methyle	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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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
Thallosulfate		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		24, 107
TMA	Titanic chloride	24, 107
TNB	Trimethylamine	7
TNT	Trinitrobenzene	27, 102
Tolualdehyde	Trinitrotoluene	27, 102
Toluene		5
Toluene diisocyanate	Toluol, Methylbenzene	16
Toluic acid		18, 107
		3



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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	2,4,5 T	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-aziridiny1) 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



<u>Names</u>	<u>Synonyms</u>	<u>RGN</u>
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 phosphoramidate	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



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

<u>Reactivity Group Number</u>	<u>Group Name</u>
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



<u>Reactivity Group Number</u>	<u>Group Name</u>
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,a'-Azodiisobutyronitrile  
Benzene diazonium chloride  
Benzotriazole  
t-Butyl azidoformate  
Chloroazodin  
Chlorobenzotriazole  
Diazodinitrophenol  
Diazoethane  
Dimethylamino azobenzene  
Dimethyl hydrazine



**GROUP 8** Azo Compounds, Diazo Com-  
pounds and Hydrazines (All  
Isomers) cont'd

Dinitrophenyl hydrazine  
Guanyl nitrosoaminoguanylidene 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  
Mesuro\*  
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 methyllate  
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  
Fluorboric acid  
Fluosilicic acid  
Hexafluorophosphoric acid  
Hydrofluoric acid  
Magnesium fluoride  
Potassium fluoride  
Selenium fluoride  
Silicon tetrafluoride  
Sodium fluoride  
Sulfur pentafluoride  
Tellurium hexafluoride  
Zinc fluoborate

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  
Chloroethylenimine  
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  
 $\alpha$ -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 tetraeroxochromate  
Ammonium trichromate  
Antimony  
Antimony nitride  
Antimony oxychloride



GROUP 24 Metals and Metal Com-  
pounds, 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 trivinyI  
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 dibromiodide  
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 Com-**  
**pounds, 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 acetylde  
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  
Mercuriol  
Mercurous bromide  
Mercurous gluconate  
Mercurous iodide  
Mercurous nitrate  
Mercurous oxide  
Mercurous sulfate  
Mercury  
Mercury fulminate  
Methoxyethylmercuric chloride  
Methyl dichloroarsine  
Molybdenum  
Molybdenum sulfide  
Molybdenum trioxide  
Molybdic acid  
Nickel



GROUP 24 Metals and Metal Com-  
pounds, 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 acetylde  
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  
Thalious 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 acetylde  
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 Com-  
pounds, 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 Iso-  
mers)

Acetyl nitrate  
Chlorodinitrofluorene  
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 Iso-  
mers) cont'd

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

**GROUP 28** Hydrocarbons, Aliphatic, Un-  
saturated (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, Sat-  
urated

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 Hydroperox-  
ides Organic (All Isomers)

Acetyl benzoyl peroxide  
Acetyl peroxide  
Benzoyl peroxide  
Butyl hydroperoxide  
Butyl peroxide  
Butyl peroxyacetate  
Butyl peroxybenzoate  
Butyl peroxyvalate  
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 Iso-**  
mers)

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, Phospho-**  
thioates, and Phosphodithio-  
ates

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\*  
 $\alpha$ -Isopropyl methylphosphoryl fluoride  
 Paraoxon  
 Parathion  
 Phorate  
 Phosphamidon  
 Phospholan  
 Potasan  
 Prothoate  
 Shradan  
 Sulfotepp  
 Supracide\*



**GROUP 32** Organophosphates, Phospho-  
thioates, and Phosphodithio-  
ates cont'd

Shradan  
Sulfotepp  
Supracide\*  
Surecide\*  
Tetraethyl dithionopyrophosphate  
Tetraethyl pyrophosphate  
Thionazin  
Tris-(1-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 acetylde  
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 nitrosaminoguanilydene 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  
Trimerccury dinitride  
Trinitrobenzene  
Trinitrobenzoic acid  
Trinitronaphthalene  
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 acetylde  
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 Con-**  
**taining 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 bromodiodide  
Boron dibromiodide  
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 WASTE-STREAMS

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

<u>Industry</u>	<u>SIC code</u>	<u>Industry</u>	<u>SIC code</u>
Chemical products, miscellaneous	289	Mining, bituminous coal and lignite	12
Chemicals, agricultural	287	Mining, metal	10
Chemicals, industrial inorganic	281	Paints, varnishes, lacquers, enamels	
Chemicals, industrial organic	286	and allied products	285
Drugs	283	Paper and allied products	26
Food and kindred products	20	Petroleum refining and related industries	29
Furniture and fixtures	25	Plastic materials and synthetic resins	282
Instruments, measuring		Printing, publishing and allied industries	27
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		Stone, clay, glass and concrete products	32
electrical and electronic	36	Textile mill products	22
Metal industries, primary	33	Transportation equipment	37
Metal products, fabricated	34		

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	Bituminous 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 & synthetics	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	Mercurial 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	Industrial 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



ENGINE  
AST LINE  
TENT

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 REACTIVITY GROUPS AND THE 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	<u>MINERAL ACIDS + ALCOHOLS AND GLYCOLS</u>  Dehydration reactions and displacement with the halide result in heat generation. Ref. 31.
1 + 5	<u>MINERAL ACIDS + ALDEHYDES</u>  Condensation reactions cause heat generation. Acrolein and other $\beta$ -unsaturated aldehydes polymerize readily. Ref. 32, 43.
1 + 6	<u>MINERAL ACIDS + AMIDE</u>  Hydrolysis of amide to the corresponding carboxylic acid results in an exotherm. Ref. 32, 43.
1 + 7	<u>MINERAL ACIDS + AMINES</u>  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	<u>MINERAL ACIDS + AZO COMPOUNDS</u>  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 decomposition 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 moiety of organic acids with resulting heat and gas formation.

2 + 4

OXIDIZING MINERAL ACIDS + ALCOHOLS and GLYCOLS

Oxidation of the hydrocarbon moiety 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 moiety 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  $\alpha$ -substituted halogens such as chloroacetic acid, and  $\alpha$ - and  $\beta$ -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 I 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<sub>2</sub> 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 moiety 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  $\beta$ -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  $\alpha$ -hydrogen. Extraction of the  $\alpha$ -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-polymerization can result. The labile  $\alpha$ -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  $\alpha$ -hydroxy peroxides which are unstable to heat and stock. Acyl peroxides such as diacetyl peroxide can decompose with slight heating resulting in formation of  $\text{CO}_2$  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  $\alpha$ -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 electron 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  $\alpha$ -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 polymerize 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 sulfides, bisulfides, and polysulfides results in explosions even at 8°C.

8 + 34

AZO COMPOUNDS + EPOXIDES

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.,  $\text{PbCO}_3$ ,  $\text{PbCrO}_4$ ,  $\text{Cd}(\text{CN})_2$ ,  $\text{As}_2\text{O}_3$ ,  $\text{AsF}_5$ ,  $\text{AgCrO}_4$ ,  $\text{ZuCO}_3$ ,  $\text{Zn}(\text{CN})_2$ .  
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 thiole 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 nitriles 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 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.

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  $\alpha$ -hydrogens can be easily scavenged by these metals yielding hydrogen gas and heat.  
Ref. 39
- 13 + 25      ESTERS + NITRIDES  
Nitrides can attack the  $\alpha$ -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 especially 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  $\alpha$ -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, mag-  
nesium, zinc, zirconium, and their alloys can abstract the labile  
 $\alpha$ -hydrogens from the alkyl isocyanates to yield hydrogen gas. Decom-  
position 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 recom-  
mended 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 isocyanates. Attack may occur at the carbonyl forming a thiocarbamate 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  $\alpha$ -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  $\alpha$ -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  $\alpha$ -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  $\alpha$ -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 thio form. Parathion and methy parathion are especially 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 especially 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, especially ethylene oxide and propylene oxide, can be initiated by Lewis acids such as  $\text{SnCl}_4$ ,  $\text{ZnCl}_2$ ,  $\text{SbCl}_3$ ,  $\text{ZrCl}_4$ ,  $\text{CrCl}_3$ ,  $\text{CoCl}_2$  and  $\text{HgCl}_2$ . 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 than 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  $\text{SnCl}_4$ ,  $\text{SnBr}_4$ ,  $\text{SbCl}_3$ , and  $\text{ZnCl}_2$ . Although a co-catalyst such as  $\text{H}_2\text{O}$ , or  $\text{HCl}$  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  $\alpha$ -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 flammable 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  $\text{LiAlH}_4$ , yielding much heat. Hydrogen gas can also be evolved from the abstraction of the labile  $\alpha$ -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 moiety. Shock sensitive salts can also form, which when dry, can decompose explosively.  
Ref. 32, 69.

27 + 105     NITRO COMPOUNDS + REDUCING AGENTS

The labile  $\alpha$ -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. Aryl 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 radical 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 violently 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.



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 OF 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 exploded. 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 subsequently 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 firefighters 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  $\text{NO}_2$  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 thiocloride and thionyl chloride were improperly 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 specialties 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 chromium. 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 materials in the waste was 95%  $\text{AlCl}_3$  condensate collected in the steel barrels. This condensate results from passing  $\text{Cl}_2$  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  $\text{CO}_2$  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  $\text{NaClO}_4$  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  $\text{NaClO}_4$  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  $\text{NaClO}_4$  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  $\text{CO}_2$  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  $\text{SiCl}_4$  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.