Technical Guidance for Hazards Analysis

Emergency Planning for Extremely Hazardous Substances

U.S. Environmental Protection Agency
Federal Emergency Management Agency
U.S. Department of Transportation
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Preface

This guide was developed by the U.S. Environmental Protection Agency in conjunction with the Federal Emergency Management Agency (FEMA) and the Department of Transportation (DOT) .

In November 1985, as part of its National Strategy for Toxic Air Pollutants, EPA published the Chemical Emergency Preparedness Program (CEPP) Interim Guidance and invited public review and comment. The Interim Guidance contained information on how to organize planning committees, write a plan, and conduct a hazards analysis on a site-specific basis. In April 1986, EPA began collaborating with FEMA and other Federal agency members of the National Response Team (NRT) in the revision of FEMA's widely-distributed Planning Guide and Checklist for Hazardous Materials Contingency Plans (popularly known as "FEMA-10"). In October 1986, during the time that a revised FEMA-10 was being prepared, the Superfund Amendments and Reauthorization Act of 1986 (SARA) was enacted. Title Ill of SARA is also known as the Emergency Planning and Community Right-to-Know Act. Section 303 of SARA required the NRT to publish guidance to assist local emergency planning committees (LEPCs) with the development and implementation of comprehensive hazardous materials emergency response plans. The Federal agencies revising FEMA-10 prepared a document that included guidance for meeting the SARA Title Ill planning requirements. The NRT published this document as the Hazardous Materials Emergency Planning Guide (NRT-1) on March 17, 1987.

This current guide supplements NRT-1 by providing technical assistance to LEPCs to assess the lethal hazards related to potential airborne releases of extremely hazardous substances (EHSs) as designated under Section 302 of Title Ill of SARA. Future revisions of this guidance (scheduled for publication in 1988) will consider flammables, corrosives, explosives, and other hazards. Anyone using this guide also needs to acquire and use NRT-1.

There are many definitions of "hazards analysis." In an effort to develop and maintain consistency among Federal guidance documents, this guide adopts the approach to community level hazards analysis adopted by 14 Federal agencies in NRT-1. NRT-1 defines "hazards analysis" as a three step process: hazards identification, vulnerability analysis, and risk analysis, and provides general descriptions and specific procedures for each. This guide provides a technical discussion of, and specific procedures for, a method that can be employed in conducting a hazards analysis that will allow planners to consider the potential risks in their local communities.

Although the use of this guide is not mandatory, it does have many advantages, some of which are the following:

- It enables local planners to conduct a hazards analysis, which is an essential step in the planning process, and thereby assists local planners in meeting planning requirements of SARA Title Ill;
- It will facilitate community awareness of the potential risks of chemical releases while helping the community to plan for, respond to, and reduce those risks.
- It is consistent with NRT-1 mandated under SARA and approved by 14 Federal agencies:
- It is consistent with training programs (e.g. contingency planning) that are being conducted by the Emergency Management Institute in Emmitsburg, Maryland:
- It can be used by software developers who want their products to be consistent with the planning requirements of Title Ill of SARA: and
- It will promote consistency among local emergency plans.

Techniques presented in this guide and NRT-1 will also be helpful to LEPCs during the annual review and updating of their plans, as required by SARA Title Ill.

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1. Introduction and Overview

1.1 Purpose of This Guide

The purpose of this guide is to help local emergency planning committees (LEPCs) conduct site-specific hazards analyses for airborne releases of extremely hazardous substances (EHSs) as required by Title Ill of the Superfund Amendments and Reauthorization Act of 1986 (SARA), also known as the Emergency Planning and Community Right-to-Know Act (EPCRA) . Although these substances may also threaten property and the environment, this guide is primarily concerned with lethal effects of airborne substances on humans. An expanded version of this document which will also address hazards such as flammability, explosivity, corrosivity, and reactivity, is planned. The hazards analysis guidance in this present document will help to identify potential problems and serve as the foundation for planning and prevention efforts with emphasis on EHSs. (See Section 1.3 for a definition and brief description of "hazards analysis. " See Section 1.5.3 for a description of "extremely hazardous substance. ")

This document represents a joint effort by the Environmental Protection Agency (EPA), the Federal Emergency Management Agency (FEMA), and the Department of Transportation (DOT) to provide coordinated and coherent technical guidance. Although this guide can be useful to all community and industry planners, it is intended especially for LEPCs established under the provisions of SARA. The three steps of hazards analysis--hazards identification, vulnerability analysis, and risk analysis--provide a decision-making process for the LEPCs to follow as they undertake the development of comprehensive emergency plans mandated by SARA Title Ill. This chapter includes a description of: the relationship of this guide to general planning guidance, a general description of hazards analysis, the legislative and programmatic background for this technical guidance, and an overview of the remaining chapters.

1.2 Emergency Planning; the National Response Team Planning Guide

Title Ill of SARA requires each LEPC to prepare a comprehensive emergency plan by October 17, 1988. For general assistance in preparing a comprehensive emergency plan, planners should consult the Hazardous Materials Emergencv Planning Guide (NRT-1) prepared by the National Response Team (NRT). NRT-1 is a statutory requirement under SARA and was published on March 17, 1987. It is available free of charge from:

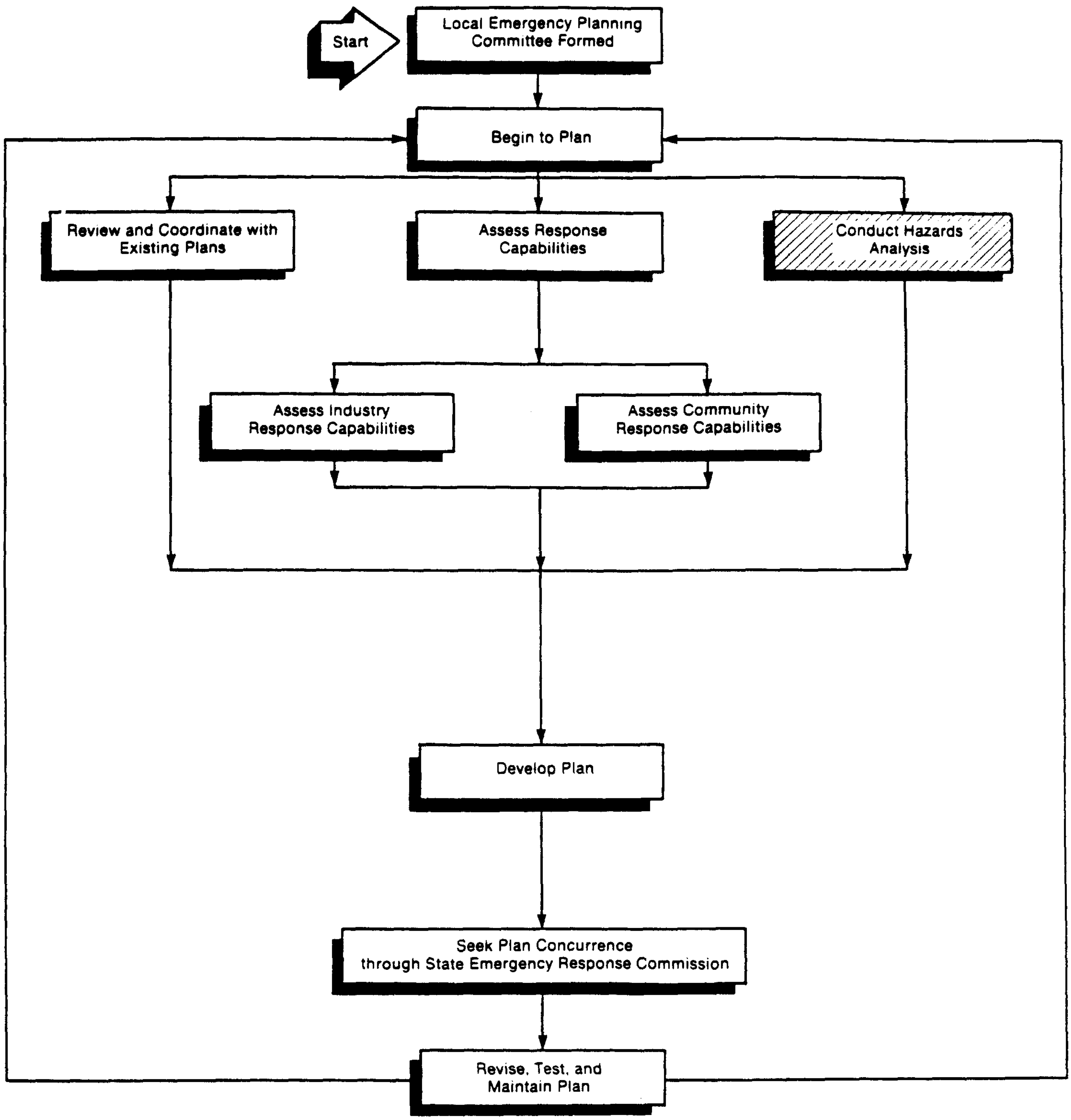
Hazardous Materials Emergency
Planning Guide
WH-562A
401 M Street, S.W.
Washington, DC 20460

LEPCs should obtain, read, and understand NRT-1 before using this technical guide.

Exhibit I-l illustrates the various activities that are part of the emergency planning process.

Exhibit l-l

Overview of Planning Process*



*From NRT-1

NRT-1 offers general guidance on how to accomplish all of these planning activities. This present document offers specific technical guidante for conducting a hazards analysis for the airborne release of EHSs, as well as a general consideration of other hazardous substances. The shaded box in Exhibit l-l indicates where the material in this technical guide fits into the overall planning process described in NRT-1,

1.3 Beginning to Plan

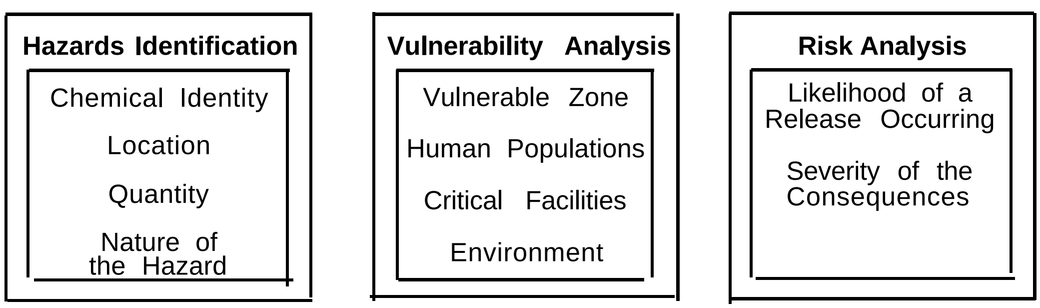
Before actually developing a plan, the LEPC should: review existing plans, review existing response capabilities, and conduct a hazards analysis.

Information from existing plans will prove helpful in the development of an emergency plan under Title Ill. Existing plans may have been prepared by individual facilities, by communities, by the State, or by the Regional Response Team (RRT) of the Federal government. The plans can be reevaluated and information in them can be tailored to present needs.

NRT-1 and Appendix I of this guide include lists of questions that LEPCs can use to identify what prevention and response capabilities are present at facilities, among transporters, and within local communities.

LEPCs should conduct a hazards analysis of all facilities reporting that they have EHSs in quantities greater than the threshold planning quantity (TPQ). This hazards analysis should help planners identify what additional response capabilities are needed. This analysis serves as the basis for development or revision of the emergency response plans that are mandatory under Title Ill of SARA.

1.4 Hazards Analysis



A hazards analysis[1] is a necessary step in comprehensive emergency planning for a community. Comprehensive planning depends upon a clear understanding of what hazards exist and what risk they pose for various members of the community. This guide follows the definition of “hazards analysis” used in NRT-1 and focuses principally on hazards analysis for airborne releases of EHSs.

[1] Hazards analysis as presented in this guidance is intended for use in emergency response planning for EHSs. Its purpose and the meaning of its terminology are different from the purpose and terms used in “risk assessment” as defined by NAS. Because local communities will be conducting hazards analyses (as described in this guide) and risk assessments under different sections of SARA, a discussion of risk assessment can be found in NAS Press, ***1983, Risk Assessment in the Federal Government: Managing the Process.*** Washington D.C. 191 pp.

The hazards analysis described in this guide is a 3-step decision-making process to identify the potential hazards facing a community with respect to accidental releases of EHSs. All three steps should be followed even though the level of detail will vary from site to site. The hazards analysis is designed to consider all potential acute health hazards within the planning district and to identify which hazards are of high priority and should be addressed in the emergency response planning process. The Title III emergency response plan must address all EHSs that are reported to the State Emergency Response Commission (SERC), but other substances including EHSs below their TPQs may also be included. Depending upon the size and nature of a planning district, the hazards analysis may be complex or relatively easy. LEPCs that have access to the necessary experts might want to conduct a detailed quantitative hazards analysis. Such a complete analysis of all hazards may not always be feasible or practical, however, given resource and time constraints in individual planning districts.

General information and an approach to understanding the three components of hazards analysis as it is applied to the EHSs are discussed in Chapter 2. A brief overview is presented below.

A. Hazards identification typically provides specific information on situations that have the potential for causing injury to life or damage to property and the environment due to a hazardous materials spill or release. A hazards identification includes information about:

- Chemical identities:
- The location of facilities that use, produce, process, or store hazardous materials:
- The type and design of chemical container or vessel:
- The quantity of material that could be involved in an airborne release: and
- The nature of the hazard (e.g., airborne toxic vapors or mists which are the primary focus of this guide; also other hazards such as fire, explosion, large quantities stored or processed, handling conditions) most likely to accompany hazardous materials spills or releases.

B. Vulnerability analysis identifies areas in the community that may be affected or exposed, individuals in the community who may be subject to injury or death from certain specific hazardous materials, and what facilities, property, or environment may be susceptible to damage should a hazardous materials release occur. A comprehensive vulnerability analysis provides information on:

- The extent of the vulnerable zones (i.e., an estimation of the area that may be affected in a significant way as a result of a spill or release of a known quantity of a specific chemical under defined conditions) ;
- The population, in terms of numbers, density, and types of individuals (e.g., facility employees: neighborhood residents: people in hospitals, schools, nursing homes, prisons, day care centers) that could be within a vulnerable zone:
- The private and public property (e.g., critical facilities, homes, schools, hospitals, businesses, offices) that may be damaged, including essential support systems (e.g., water, food, power, communication, medical) and transportation facilities and corridors; and
- The environment that may be affected, and the impact of a release on sensitive natural areas and endangered species.

Chapter 2 discusses vulnerability analysis with a special emphasis on human populations.

C. Risk analysis is an assessment by the community of the likelihood (probability) of an accidental release of a hazardous material and the actual consequences that might occur, based on the estimated vulnerable zones. The risk analysis is a judgement of probability and severity of consequences based on the history of previous incidents, local experience, and the best available current technological information. It provides an estimation of:

- The likelihood (probability) of an accidental release based on the history of current conditions and controls at the facility, consideration of any unusual environmental conditions (e.g., areas in flood plains), or the possibility of simultaneous emergency incidents (e.g., flooding or fire hazards resulting in the release of hazardous materials);
- Severity of consequences of human injury that may occur (acute, delayed, and/or chronic health effects), the number of possible injuries and deaths, and the associated high-risk groups:
- Severity of consequences on critical facilities (e.g., hospitals, fire stations, police departments, communication centers);
- Severity of consequences of damage to property (temporary, repairable, permanent); and
- Severity of consequences of damage to the environment (recoverable, permanent) .

To have an accurate view of the potential problems in a district, the LEPC would need to address all of the steps in hazards analysis outlined above. Each of the three steps should be followed even if extensive information is not available for each site. The process anticipates that local judgement will be necessary.

1.5 Background

This section briefly describes EPA's original Chemical Emergency Preparedness Program (CEPP), other recent public and private sector programs, and EPCRA.

1.5.1 EPA's Chemical Emergency Preparedness Program

For the past several years, EPA has pursued an active voluntary program to enhance preparedness and response capabilities for incidents involving the airborne release of EHSs. In June 1985, EPA announced a two-part National Strategy for Toxic Air Pollutants. The first part, established under Section 112 of the Clean Air Act, deals with routine releases of hazardous air pollutants. The second part was the development of the CEPP, designed to address, on a voluntary basis, accidental airborne releases of acutely toxic chemicals. Since its inception, CEPP has had two goals: to increase community awareness of chemical hazards and to enhance State and local emergency planning for dealing with chemical accidents. These goals and initial activities influenced the legislative action that led to the enactment of Title III of SARA, where many CEPP objectives are addressed (see Section 1.5.3).

1.5.2 Other Public and Private Sector Programs

Awareness of the 1984 Bhopal, India tragedy and less catastrophic incidents in the United States has led many State and local governments to improve their preparedness and response capabilities for chemical emergencies. They developed emergency plans for chemical accidents, enacted right-to-know legislation to provide citizens access to information about chemicals in their community, and organized hazardous materials planning councils and response teams.

In the private sector, the Chemical Manufacturers Association (CMA) has developed and implemented the Community Awareness and Emergency Response (CAER) program. The CAER program encourages chemical plant managers to contact community leaders and assist them in preparing for possible incidents involving hazardous materials, including those involving airborne toxics. CAER industry participants can provide information about chemicals and chemical processes that exist within the community (an important source for the "hazards identification" phase of a hazards analysis); professional expertise to help communities develop emergency plans; equipment and personnel to assist local officials during emergency notification and response operations: and specific assistance in training responders and exercising emergency plans.

1.5.3 Emergency Planning and Community Right-to-Know Act of 1986 (Title Ill of SARA)

On October 17, 1986, SARA became law. Title Ill of SARA contains numerous requirements for Federal, State, and local governments as well as private industry in the areas of emergency planning, community right-to-know, hazardous emissions reporting, and emergency notification. These requirements build upon the original CEPP (elements of which are now mandatory), numerous existing State and local programs aimed at community right-to-know and preparedness, and the CMA CAER program.

The objectives of Title Ill are to improve local chemical emergency response capabilities (primarily through improved emergency planning and notification) and to provide citizens and local governments access to information about chemicals in their localities.

Title Ill addresses planning by: (1) identifying the EHSs that trigger the planning process: (2) requiring facilities to identify themselves if they have quantities of EHSs exceeding the TPQs; (3) requiring the establishment of a State and local planning structure and process (including specifics on committee membership); (4) requiring facilities to make information available to local planners: and (5) specifying the minimum contents of local emergency plans. This guidance includes information about all of these topics. (See NRT-1 for an additional discussion of plan contents and guidance for planning). Exhibit 1-2 summarizes the types of information that will be available as a result of compliance with Title Ill, and indicates how local planners can use the information. Planners should not only be aware of Federal, but also of State and local requirements that apply to emergency planning.

A. Identifying the Extremely Hazardous Substances that Trigger the Planning Process.

Title Ill required EPA to publish a list of EHSs and TPQs for each of those substances. EPA fulfilled this requirement in a rule published on April 22, 1987 (Federal Register, Vol. 52, No. 77, pp. 13378-13410). The list of EHSs included the 402 chemicals found in the CEPP Interim Guidance List of Acutely Toxic Chemicals[2] and four additional chemicals added as a result of new information. Four chemicals have been removed from the list and 36 others are proposed for delisting as they do not meet the acute lethality criteria. (See Appendix C for the list of EHSs and Appendix B for an explanation of the criteria used in identifying these chemicals.)

B. Planning Structure and Process.

Sections 301-303 of Title Ill include the following required steps:

i. State Governors appointed SERCs by April 17, 1987. SERCs identified local emergency planning districts (LEPDs) by July 17, 1987 and appointed members of the LEPC by August 17, 1987. SERCs are to coordinate and supervise the work of the LEPCs, and review all emergency plans to ensure that all the local plans for any one State are coordinated.

ii. Facilities had to notify SERCs by May 17, 1987 if they have any listed EHS(s) that exceed the designated TPQ. The TPQ is a specific quantity assigned to each of the EHSs. If a facility has present at any time an EHS in an amount greater than the TPQ, the facility must identify itself to the SERC. The SERC notifies the LEPC to include the facility, if appropriate, in its comprehensive emergency plan. SERCs can specify other facilities to be included in the emergency plan.

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2 Title II1 of SARA replaces the term "acutely toxic chemical" with "extremely hazardous substance".

-Exhibit 1-2

TITLE III INFORMATION FROM FACILITIES PROVIDED IN SUPPORT OF PLAN DEVELOPMENT

Information Generated by Title Ill Compliance	Title Ill Authority	How LEPC Can Use the Information
Facilities subject to Title Ill planning requirements (including those designated by the Governor or SERC)	Section 302; Notice from Governor/SERC	Hazards analysis -- Hazards identification
Additional facilities near subject facilities (such as hospitals, natural gas facilities, etc.)	Sections 302 (b) (2) ; 303 (c) (1)	Hazards analysis -- Vulnerability analysis
Transportation routes	Sections 303(c) (1) ; 303(d) (3)	Hazards analysis -- Hazards identification
Major chemical hazards (chemical name, properties, location, and quantity)	Section 303 (d) (3) for extremely hazardous substances used, produced, stored Section 311 MSDSs for chemicals manufactured or imported Section 312 inventories for chemicals manufactured or imported	Hazards analysis -- Hazards identification
Facility and community response methods, procedures, and personnel	Sections 303(c) (2); 303(d) (3)	Response functions (see pp. 49ff of NRT Planning Guide)
Facility and community emergency coordinators	Sections 303 (c) (3) ; 303 (d) (1)	Assistance in preparing and implementing the plan (see p. 11 of NRT Planning Guide)
Release detection and notification procedures	Sections 303(c) (4) ; 303 (d) (3)	Initial notification; Warning systems (see pp. 50, 53 respectively of NRT Planning Guide)
Methods for determining release occurence and population affected	Sections 303 (c) (5) ; 303 (d) (3)	Hazards analysis -- Vulnerability analysis and risk analysis
Facility equipment and emergency facilities; persons responsible for such equipment and facilities	Sections 303 (c) (6) ; 303 (d) (3)	Resource management
Evacuation plans	Sections 303(c) (7) ; 303(d) (3)	Evacuation planning
Training programs	Sections 303 (c) (8) ; 303(d) (3)	Resource management
Exercise methods and schedules	Sections 303(c) (9); 303(d) (3)	Testing and updating

iii. Facilities must provide the following information to the LEPC: the name of a facility representative (by September 17, 1987) to serve as facility emergency coordinator and assist the LEPC in the planning process; information requested by the LEPC that is necessary for developing and implementing the emergency plan (see Section 303(d) (3) of Title Ill of SARA); and any changes at the facility that could affect emergency planning. (Facility compliance with this SARA requirement will make available much information that should prove helpful for hazards analysis and annual plan revisions.)

iv. LEPCs must prepare comprehensive emergency plans for all facilities subject to the regulations by October 17, **1988.**

v. Transporters of EHSs do not have to notify SERCs under Section 302. Section 327 of Title Ill of SARA states that Title Ill does not apply to any substance or chemical being transported, including transportation by pipeline, except as provided in Section 304. Section 304 requires notification of releases of EHSs and Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) hazardous substances from facilities, pipelines, motor vehicles, rolling stock and aircraft. Barges and other vessels are exempted from Section 304 reporting.

The Title III planning structure for receiving information and formulating plans is displayed in Exhibit 1-3.

C. Other Title III Information for Planners.

This guide does not include a detailed description of Sections 304, 311, 312, and 313 of Title Ill. Details of these sections may be found in Appendix A of NRT-1. What is important for users of this guide to know is that facilities complying with these sections of Title Ill will provide information to LEPCs that may prove useful for hazards analysis and emergency plan development and revision.

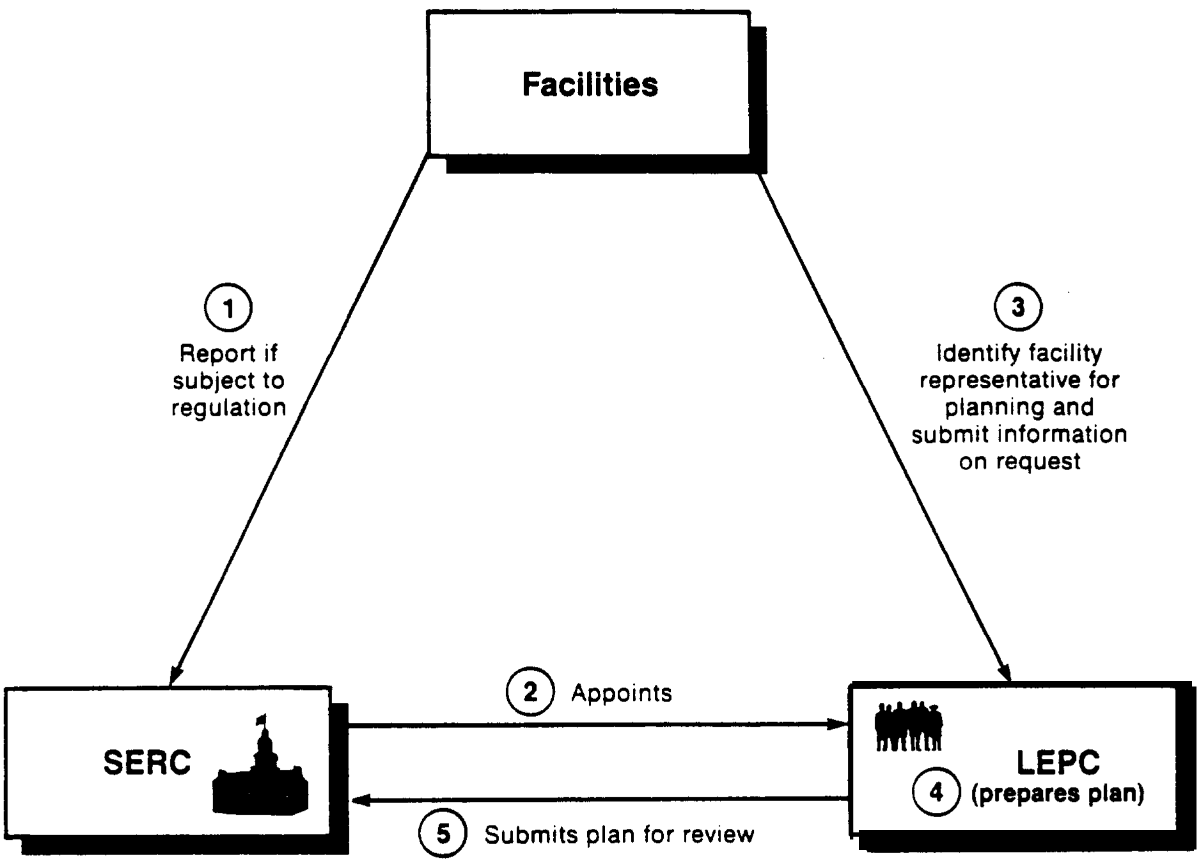
1.6 Contents of this Guide

The components of a hazards analysis are discussed in more detail in the next chapter of this guide. The discussion in Chapter 2 is as simplified and direct as possible, given the complexity of hazards analysis. Additional technical material is in the appendices. Chapter 3 provides a detailed step-by-step procedure for hazards analysis of the EHSs at the local level. Guidance for incorporating results of a hazards analysis into the overall planning process is found in Chapter 4.

Several appendices have been included in this guide. Appendix A contains a list of abbreviations and acronyms and a glossary of technical terms. (Users of this guide should regularly consult Appendix A for help in understanding the terms used). Appendix B describes EPA's criteria for identifying EHSs. Appendix C contains the list of EHSs designated by Title Ill of SARA both alphabetically and by Chemical Abstract Service (CAS) number. This appendix also provides information on important physical properties of each substance and the levels of concern (LOC) which are required to estimate vulnerable zones. Appendix D provides information and calculations concerning exposure levels of EHSs and the basis for the LOC. Appendix E is a sample chemical profile of one of the EHSs (acrolein). Appendix F contains descriptions of fire and reactivity hazards. Appendix G contains more technical information for estimating and reevaluating vulnerable zones. As a warning to planners to avoid automatically establishing evacuation distances from the estimated vulnerable zones, Appendix H includes a discussion of issues to be considered for evacuation. Appendix I supplements Chapters 3 and 4 with a procedure for gathering important information to evaluate sites for contingency planning. Appendix J details other methods for evaluating hazards and supplements Chapters 2 and 3.

Exhibit I-3

Title III Planning Steps



SERC = State emergency response commission

LEPC = Local emergency planning committee

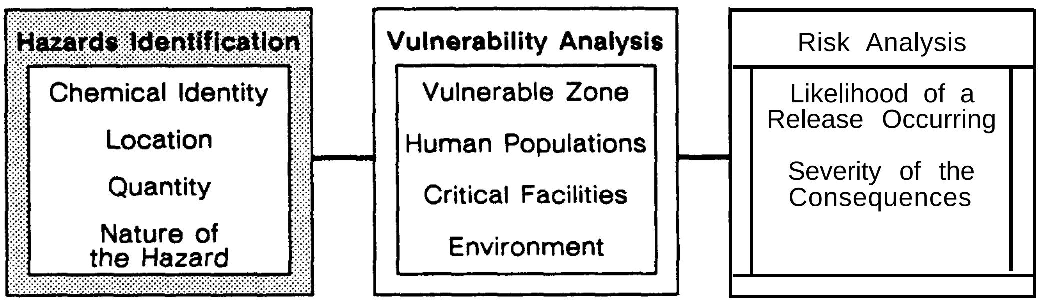
Appendix K provides an evaluation guide for the use of computerized systems that could be of assistance in emergency response planning. Appendix L is an annotated bibliography of pertinent references. Appendix M lists the EPA Regional preparedness contacts and coordinators as well as FEMA Regional contacts.

2. Hazards Analysis: An Overview

This chapter provides an overview of hazards analysis as it relates to emergency planning for extremely hazardous substances (EHSs) under Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). The approch to hazards analysis presented here is not mandatory but it will assist localities in meeting the planning requirements of SARA Title Ill. As in Chapter 1 this chapter follows the same general format and supports the principles presented in NRT-1. It represents a relatively simple yet effective means of evaluating potential hazards resulting from the accidental release of an EHS. The three basic components in the hazards analysis discussed here are (1) hazards identification, (2) vulnerability analysis, and (3) risk analysis.

The step-by-step process planners should follow in conducting a hazards analysis is outlined in Exhibit 2-1 1 (pp. 2-26 and 2-27) and described in detail in Chapter 3. The overview in this chapter should be carefully read and understood before attempting an actual hazards analysis as outlined in Chapter 3. The information in Appendices I and J should also be reviewed.

2.1 Hazards Identification



Hazards identification, the first step in hazards analysis, is the process of collecting information on:

- The types and quantities of hazardous materials in a community;
- The location of facilities that use, produce, process, or store hazardous materials;
- Conditions of manufacture, storage, processing, and use:
- Transportation routes used for transporting hazardous materials: and
- Potential hazards associated with spills or releases.

This information can be used by emergency planners, as well as by fire/rescue services, police departments, and environmental protection departments as they prepare for, respond to, and recover from emergencies involving hazardous materials. Section 2.1 .1 discusses the types of hazards that chemicals may pose to the community. Section 2.1.2 discusses sources of data for hazards identification and procedures that planners may use in gathering data. Information derived from hazards identification will subsequently be used in vulnerability analysis (described in Section 2.2) and risk analysis (described in Section *2.3).*

2.1.1 Identification of Hazardous Chemicals

Hazards are situations that have the potential for causing injury to life and/or damage to property and the environment. Chemicals may be potentially hazardous because of their toxicity or physical/chemical properties such as flammability and reactivity. Comprehensive planning for hazardous materials emergencies should encompass all hazards capable of causing loss of life, injury or damage to health, or damage to property or the environment. The guidance in this document focuses on the single hazard of acute toxicity, specifically acute lethality to individuals as a result of airborne releases of EHSs.

Extremely Hazardous Substances

Chemicals with high acute lethality have the potential for causing death in unprotected populations after relatively short exposure periods at low doses. On the basis of toxicity criteria (discussed in Appendix B), EPA identified a list of chemicals with high acute toxicity (listed in Appendix C) from the more than 60,000 chemicals in commerce. This is the list of EHSs required by Title Ill of SARA. Because airborne releases of acutely lethal substances, while infrequent, can be catastrophic, Title Ill requires consideration of these EHSs in emergency plans.

Although all of the listed substances are extremely toxic, the hazards presented by a spill will also vary depending on the physical and chemical properties of the substance spilled and the conditions under which the substance is handled (e.g., elevated temperatures and pressures) . Some substances are highly volatile and thus likely to become airborne, while others are non-powdered solids that are unlikely to become airborne. The potential to become airborne was considered in the determination of the threshold planning quantity (TPQ) for ‘EHSs.

A summary of publicly available information on the listed substances is presented in the EPA Chemical Profiles issued in December 1985 as part of the Chemical Emergency Preparedness Program (CEPP) Interim Guidance. The profile for each chemical includes synonyms as well as information on recommended exposure limits, physical/chemical characteristics, fire and explosion hazards and fire fighting procedures, reactivity, health hazards, use, and precautions. Profiles for each EHS are available. The profiles are currently being updated and supplemented with additional information, including emergency medical treatment guidance and information about personal protective equipment which should be used by emergency response teams. The revised profiles should be available by spring 1988. See Appendix E for a revised sample chemical profile.

Other Hazards

In addition to acute lethality, substances may cause other types of toxic effects in people exposed to them (e.g., long-term or short-term illness, damage to skin or eyes). Criteria for the identification of chemicals (other than those that are acutely lethal) that cause serious health effects from short-term exposures are being developed on a priority basis. When such criteria are established, they will be used in expanding the list of EHSs. At that time, guidance will be provided to address planning for chemicals that cause these other toxic effects. It should be noted that even substances that are relatively less toxic may pose a hazard if they become airborne in large quantities.

Hazards other than toxicity (e.g., fire, explosion, and reactivity) that may be associated with both EHSs and other substances should be considered in emergency preparedness and response planning and are discussed briefly in Appendix F. In many cases, emergency response agencies such as fire departments may have already addressed these types of hazards. Hazards other than toxicity will be considered in future revisions to the list of EHSs.

2.1.2 Procedures for Hazards Identification

Hazards identification begins with the identification of the facilities that have EHSs in the community. Mandatory reporting by facilities, under Title Ill, will now identify those facilities that possess one or more of the EHSs in excess of its TPQ. In addition, because considerable information on the properties, amounts, and conditions of use of EHSs is needed to prepare reliable emergency plans, Title Ill specifically states: “the owner or operator of the facility shall promptly provide information to such committees necessary for developing and implementing the emergency plan” (Section 303 (d) (3)). Supplemental information on the quantity and location of hazardous chemicals will become available in March of 1988, fulfilling requirements under Sections 311 and 312, Title Ill of SARA. Facility inspections will remain important information-gathering activities for local planners, as well as for safety and emergency response personnel who must establish accident prevention programs and pre-emergency plans. Other information available from the site may include facility hazard assessments, facility safety audits, spill prevention and control countermeasures (SPCC), and probability-based risk assessments (PRAs) . Although hazards identification should also include identification of transportation routes through the community for EHSs, this information will not be reported under Title Ill of SARA.

This section will discuss how to obtain information on EHSs and the types of facilities that are engaged in manufacturing , processing, storing, handling, selling, and transporting EHSs. This section also briefly discusses sources of information on other hazardous substances.

Extremely Hazardous Substances

EHSs present in quantities above their TPQ will be identified for the Local Emergency Planning Committee (LEPC) by the reporting facilities. However, EHSs in quantities below the TPQ could also present a hazard to the community under certain circumstances and the LEPCs may wish to include them in their hazards analysis. As noted in Section 1.5.3, Title Ill of SARA includes the following provisions concerning EHSs:

- If a facility has one or more chemicals from the current list of EHSs in quantities exceeding its TPQ, it must report this fact to the State emergency response commission (SERC).
- The committee can obtain from the facility information on what chemicals are present and in what amounts. The facility emergency coordinator will be the primary source of information. The specific chemical identity of an EHS may sometimes be withheld as a trade secret. Even when the chemical identity is held confidential, however, certain information on the specific chemical is important for subsequent steps in hazards analysis and will be provided by the facility.

The following points should be discussed with facility representatives to obtain information for hazards identification:

- Chemical identity, including chemical name and Chemical Abstract Service (CAS) number for substances not claimed as trade secret;
- Quantities of EHSs normally present, including:
  (1) Total quantity of each EHS at the facility. The quantity of chemical can vary from day to day depending on operations. Planners should determine the amount that is typically on hand on any given day. This information is necessary to assess the potential impact should an accident involving this quantity occur.
  (2) Maximum quantity that could be present in each storage or processing location. Facilities may use the same chemical in many different locations and have the capacity to store more than what is typically on hand. Planners need to determine the maximum quantity, even though the facility may rarely have this much on-site. Hazards associated with the maximum quantity may be much different than the hazards associated with the typical quantity. These differences need to be addressed by planners.
  (3) Configuration of storage, including the maximum potential quantity in a single storage or processing vessel. Some facilities handle. quantities of chemicals in isolated storage vessels while others may have two or more interconnected vessels to allow greater flexibility in the use of storage capacity. It is possible that an accident involving one vessel will involve the inventory in another if they are interconnected. The maximum potential quantity in a single vessel or group of interconnected vessels must be known to estimate the impact of an accidental release (see "vulnerability analysis" in Section 2.2).

- If the chemical identity is held confidential, information about certain properties of the substance will be provided by the facility to allow a hazards analysis to proceed, including:
  (1) Physical state. At ambient conditions (room temperature and atmospheric pressure) is the chemical a gas, liquid, or solid? If solid, is it powdered (with less than 100 micron particle size), in solution, or molten?
  (2) Approximate vapor pressure (in millimeters of mercury or atmospheres), if the substance is a liquid or is a solid handled in molten form. For the liquid, the vapor pressure at handling temperature should be obtained, while the vapor pressure at the melting point should be obtained for the molten solid.
  (3) Approximate level of concern (LOC) (the concentration of EHS in air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time). The approximate concentration in air that equals the LOC in grams per cubic meter is needed in the vulnerable zone analysis (see Appendices C and D) .

  The approximate values provided should be sufficiently close so as not to significantly alter the size of the estimated zones (see Section 2.2).
- Conditions under which the chemicals are processed, handled, or stored, including:
  (1) Temperature. Facilities may keep certain substances at temperatures other than ambient depending on their use.
  (2) Pressure. Some substances must be stored under pressure (e.g., liquefied gases).
  (3) Other unique features of the handling systems employed to manufacture, process, store, use or otherwise handle the substance at the facility. This information is useful for the risk analysis portion of the hazards analysis. See Appendix J for more information. Note that some of this information might be held as trade secret by the facility. Planners should work closely with facility representatives to obtain information necessary for emergency plan development.

Exhibit 2-1 presents several chemicals from the list of EHSs and some types of facilities other than chemical plants where these chemicals might be present in quantities exceeding the TPQ. Some of the EHSs in the exhibit might be found in other types of facilities in smaller quantities (e.g., chemicals in laboratories).

Hazardous materials, including EHSs, are also transported through, by, or over communities by highway vehicles, rail cars, watercraft, and aircraft virtually 24 hours a day. Shipments may range from less than a pound to thousands of pounds of material. Because transporters are not required to report under SARA Sections 302 and 303, identification of routes through a community over which EHSs are transported will be more difficult than the identification of fixed facilities. Nevertheless, transportation routes and transported chemicals should be identified if possible.

The experience gained through Department of Transportation (DOT) pilot planning projects demonstrates that identification of transportation hazards for emergency planning can be done by gathering information directly at the community level (see Hazardous Materials Transoortation: A Synthesis of Lessons Learned from the DOT Demonstration Project) . Usefull information may be collected with assistance from representatives of trucking. rail, air freight, and shipping industries. Facility representatives may be able to provide data on the shipping and transfer of EHSs, although this approach will identify only those transported materials destined for local facilities. The following points could be discussed with facility representatives:

- Frequency of shipments (daily, weekly, irregular schedule) ;
- Form of shipment (tank truck, tank car, drums, boxes, carboys in trucks or vans, pipelines, barges) ;

Exhibit 2-l

Types of Faclities where Certian Extremely Hazardous Substances Might be Found in Quantities Greater than their TPQs

Type of Facility	Etremely Hazardous Substance (TPQs in parentheses) Ammonia (100 lbs)	Chlorine (100 lbs)	Sulfuric Acid (500 lbs)	Phosgene (10 lbs)	Aldicarb (100 lbs/ 10,000 lbs)
Blueprinting Facilities	X		X		
Bulk Storage Facilities	X		X		
Farms	X				X
Frozen Food Processing Facilities	X				
Pesticide Distributors					X
Processing Plants/ Formulators	X	X	X	X	
Plumbing, Heating, and Air Conditioning Companies	X				
Pulp and Paper Plants		X	X		
Retail Stores	X				
Swimming Pools		X			
Warehouses	X		X		X
Water Treatment Facilities		X	X		

**TPQ for Aldicarb is 100 pounds for fine powders or solutions, 10.000 pounds otherwise.*

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- Quantity of shipments (tons; gallons; number of drums, tanks, vats or carboys); and
- Transportation routes through the community (highways, railroads, pipelines).

The Hazardous Materials Transportation Act (HMTA) establishes DOT as the responsible agency for guidance on routing controls. Proposed Changes in routes should be made in accordance with the Guidelines for Applying Criteria to Designate Routes for Transporting Harzardous Materials, DOT FHWA 1980.

Other Hazardous Materials

Planners can apply the toxicity criteria used by EPA for the list of EHSs (see Appendix B) to determine whether other chemicals at facilities in the area qualify as EHSs even though they are not listed as such under the Federal regulations. Planners may also want to obtain information on transportation of other hazardous materials, as described above for EHSs. The discussion points listed in the previous section on EHSs could also be raised with facility representatives and transportation industry representatives with reference to other hazardous substances.

Hazardous materials can be found throughout most communities in several types of sites and facilities. Besides obvious sites and facilities (e.g., flammable liquid storage tanks, gasoline stations, chemical supply companies), hazardous materials are likely to be found at other places, see Exhibit 2-1 (e.g., dry cleaners, auto body shops, hospitals, and construction sites).

Information on hazards other than toxicity associated with the chemicals on the list of EHSs may be obtained from the EPA Chemical Profiles. Flammability and reactivity data on many other chemicals are available in the Fire Protection Guide on Hazardous Materials developed by the National Fire Protection Association (NFPA) . The Hazardous Materials Table (49 CFR 172), developed by DOT, classifies hazardous materials in transportation by the type of hazards they present. (See also the DOT Hazardous Materials Table in the Proposed Rule of November 6, 1987, Federal Register, Vol. 52, No. 215, pp. 42787-42931.) Planners might Want to use those chemicals listed by the NFPA with the highest flammability and reactivity ratings, and those listed by DOT in certain hazard classes, as a starting point for identification of these types of hazards in the community. The United Nations publication, Recommendations on the Transport of Dangerous Goods, is also a useful source of information. Another source of information on many chemicals is the Coast Guard's Chemical Hazards Response Information System (CHRIS) hazardous chemical data base.

2.1.3 Summary of Useful Information Resulting from Hazards Identification

At the conclusion of the hazards identification step of hazards analysis, planners should have the following information:

- A list of EHSs present at facilities in the district in quantities exceeding the TPQ; the properties of these EHSs: and where, in what quantity, and under what conditions they are used, produced, processed, or stored. Mixtures of chemicals will be reported if the portion of EHSs in the mixture is equal to or greater than one percent and more than the TPQ.
- Information on chemicals claimed as trade secret, including physical state, approximate vapor pressure of liquids and molten solids, and approximate LOC as defined in this guidance.
- Routes used for transportation of EHSs through the planning district.

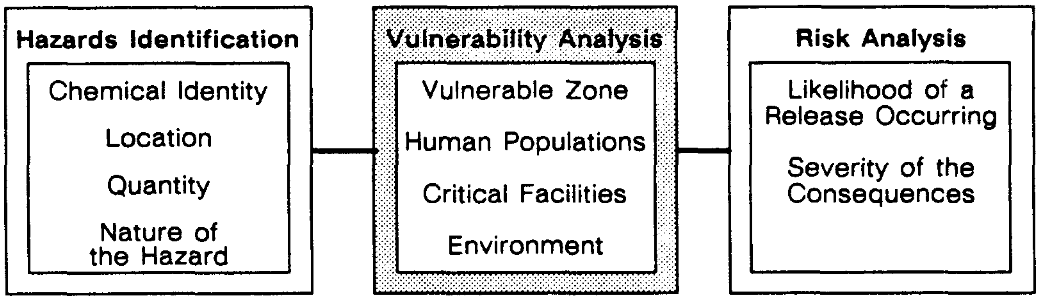
In addition, although it is not presently required to meet the statutory requirements for emergency plan development under Title Ill of SARA, planners may obtain the following information during hazards identification if necessary for developing and implementing an emergency plan:

- A list of EHSs present in quantities less than the TPQ and where, in what quantity, and under what conditions they are used, produced, processed, or stored.
- Hazards besides airborne toxicity posed by the EHSs in the community.
- Chemicals other than those listed that meet the acute lethality criteria.

- A list of other hazardous chemicals and where, in what quantity, and under what conditions they are used, produced, processed, or stored; and the type of hazard they pose.
- Routes used for transportation of other hazardous materials through the community.

Exhibit 2-2 summarizes the types and sources of information obtained during hazards identification.

2.2 Vulnerability Analysis for Airborne Hazardous Substances



Vulnerability analysis is the second part of the three-part hazards analysis. This section outlines a process that can be used in performing a vulnerability analysis for facilities that have chemicals on the Section 302 list of extremely hazardous substances (EHSs) and transportation routes used for transporting these substances to and from the fixed facilities or through the communities. (The facilities and transportation routes should be identified as described in Section 2.1).

The vulnerability analysis will provide information that will be helpful in fulfilling planning requirements under Title Ill of SARA. This information includes:

An estimation of the vulnerable zone for each EHS reported and the conditions and assumptions that were used to estimate each vulnerable zone:

- The population, in terms of numbers and types (e.g., neighborhood residents: high density transient populations such as workers and spectators in auditoriums or stadiums; sensitive populations in hospitals, schools, nursing homes, and day care centers) that could be expected to be within the vulnerable zones: and
- Essential service facilities such as hospitals, police and fire stations, emergency response centers, and communication facilities,

Although this guide is primarily concerned with the impact of EHSs on the surrounding human population, planners may also choose to consider as part of their vulnerability analysis the private and public property (e.g., homes, schools, hospitals, businesses, offices) that may be affected, including essential support systems (e.g. water, food, power, medical), as well as sensitive environments (e.g., drinking water supplies, food crops, or animal habitats). Consideration of property and sensitive environments may be particularly important for chemical releases that pose hazards other than those associated with acute toxicity. Planners can refer to community emergency services (e.g., fire departments, police departments, hospitals) for assistance in obtaining information about the population and essential services within the vulnerable zone.

2.2.1 General Description of Estimation of Vulnerable Zones

For purposes of this guidance, a vulnerable zone is an estimated geographical area that may be subject to concentrations of an airborne EHS at

Exhibit 2-2

INFORMATION FROM HAZARDS IDENTIFICATION

Essential Information	Source of Information
• Facilities in community with EHSs in quantities exceeding the TPQ	Facilities must report to SERC information will be made available to LEPC's
• identity of EHSs in community	Facility emergency coordinator
• Quantity of EHSs present	Facility emergency coordinator
• Transportation routes for EHSs	Facility emergency coordinator, representative of transportation industries
Other Useful information	
• identity and location of other acutely toxic chemicals	Information to be provided now under Section 303 (d) (3) and in the future under Sections 311, 312, and 313 of SARA: facility emergency coordinators
• Information on hazards other than toxicity of EHSs	EPA Chemical Profiles; facility emergency coordinators
• Information on other hazardous substances, including: o Identity o Location o Quantity o Hazards	Information to be provided now under Section 303 (d) (3) and in the future under Sections 311, 312, and 313 of SARA: community sources
o Transportation routes	Representatives of transportation industries and facilities receiving shipments of chemicals

levels that could cause irreversible acute health effects or death to human populations within the area following an accidental release. Vulnerable zones are based on estimates of the quantity of an EHS released to air, the rate of release to air, airborne dispersion, and the airborne concentration that could cause irreversible health effects or death. Release and dispersion methodologies are not precise and provide only estimates of the actual distances and areas that may be affected by an accidental release. Many methods are available to evaluate both releases and airborne dispersion. They vary in their assumptions and therefore the results obtained may differ. The dispersion models selected for this guidance are described in Appendix G.

At the time of an accidental release, with the wind generally moving in one direction, the area affected by a release is the area downwind only. Because the wind direction at the time of an actual accidental release cannot be predicted, planners must consider all possible wind directions and subsequent plume paths. (A plume is the cloud formation of airborne chemical that results from a release (Exhibit 2-3).) Consequently, the estimated vulnerable zones are circles with the potential release site located at the center (Exhibit 2-4). Because it is not possible to predict the exact location of a transportation accident, the estimated vulnerable zone for potential releases associated with transportation of an EHS is a "moving circle" or corridor (Exhibit 2-5).

The size of an estimated vulnerable zone depends upon the distance the airborne chemical travels before it disperses and is diluted in the air to a concentration below a "level of concern" (see subsection D below) for acute health effects or death. This distance depends on several variable factors.

2.2.2 Variables in Estimating Size of Vulnerable Zones

Many of the variables are very complex and it is beyond the scope of this document to discuss them all in detail. In addition many do not have a significant impact on the size of estimated vulnerable zones given the imprecise nature of these assumptions. The major factors affecting the size of a vulnerable zone for emergency planning are described below.

A. Quantity and Rate of Release to Air

Not all of a released chemical will necessarily become airborne. The quantity that actually becomes airborne and the rate at which it becomes airborne depend upon:

- Total quantity released or spilled:
- Physical state (solid, liquid, gas); and
- Conditions (e.g., temperature, pressure) under which the chemical is stored or handled.

Gases typically become airborne more readily than liquids. Liquids or molten solids generally become airborne by evaporation. The rate at which they become airborne (rate of volatilization) depends on their vapor pressure, molecular weight, handling temperature, the surface area of the spill (pool size), and the wind speed at the time of the spill. A spilled liquid with a higher vapor pressure will become airborne (through evaporation) more rapidly than a spilled liquid with a low vapor pressure at the same temperature. Also, a liquid will evaporate faster if the surface area or pool size of the spill is increased, if the liquid has a higher than ambient temperature, and if it is exposed to greater wind speeds. Molten solids will volatilize much faster than those in solid state. Solids as powders are likely to become airborne only if propelled into the air by force (e.g., by an explosion or the loss of air filtration in a pneumatic conveying system). Solids that are not powdered are less likely to become airborne.

The size of an estimated vulnerable zone is proportional to the quantity and rate of release. Smaller release volumes based on similar assumptions will yield lower release rates which will reduce the size of the estimated vulnerable zone.

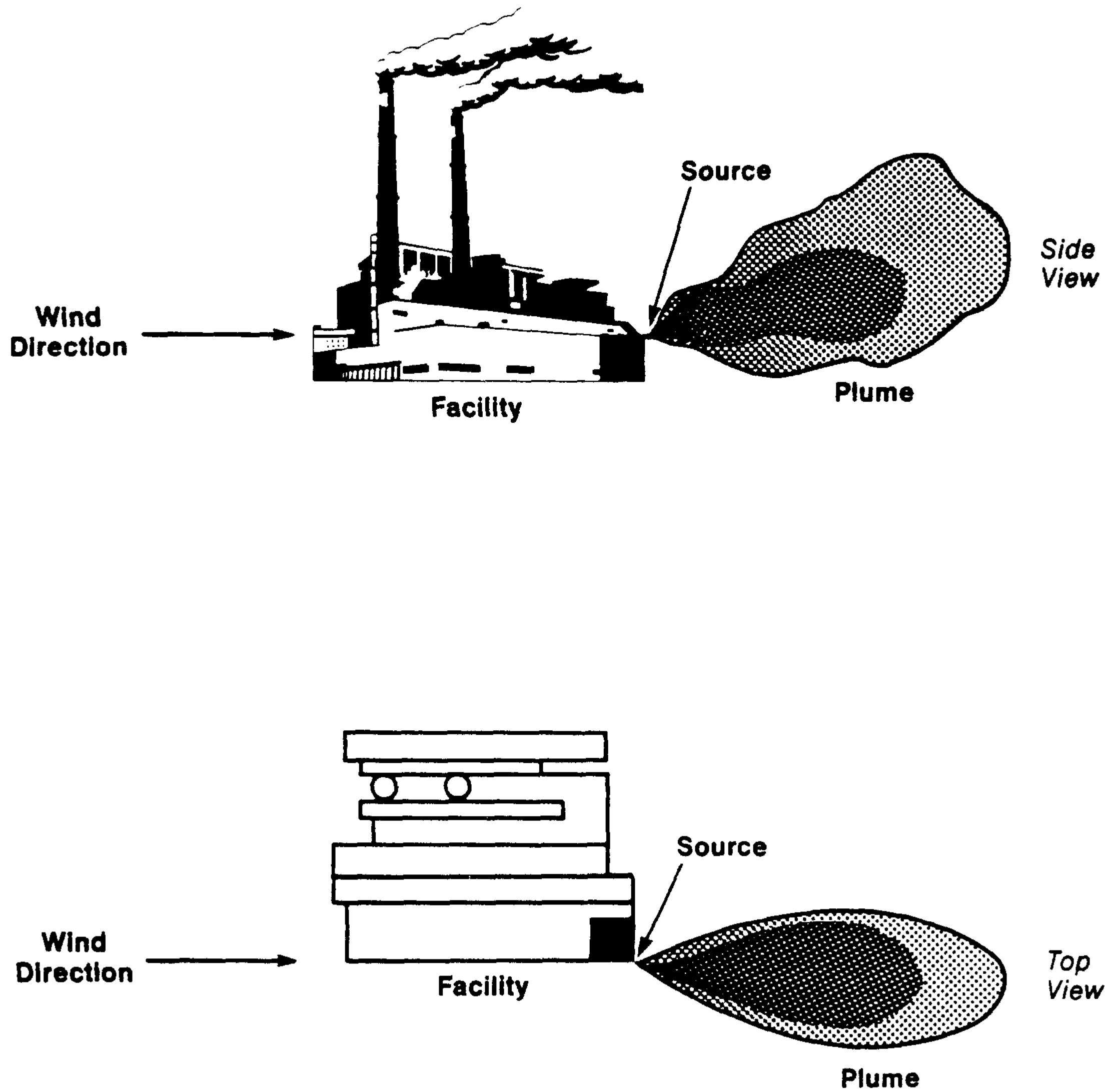
The application of these variables in the vulnerable zone estimate will be discussed later in this chapter and also in Chapter 3. For more information on the calculations and derivations related to these variables, see Appendix G.

B. Meteorological Conditions

Among the many meteorological factors, wind speed and atmospheric stability have the greatest effect on the size of estimated vulnerable zones.. Increased wind speed and the

Exhibit 2-3

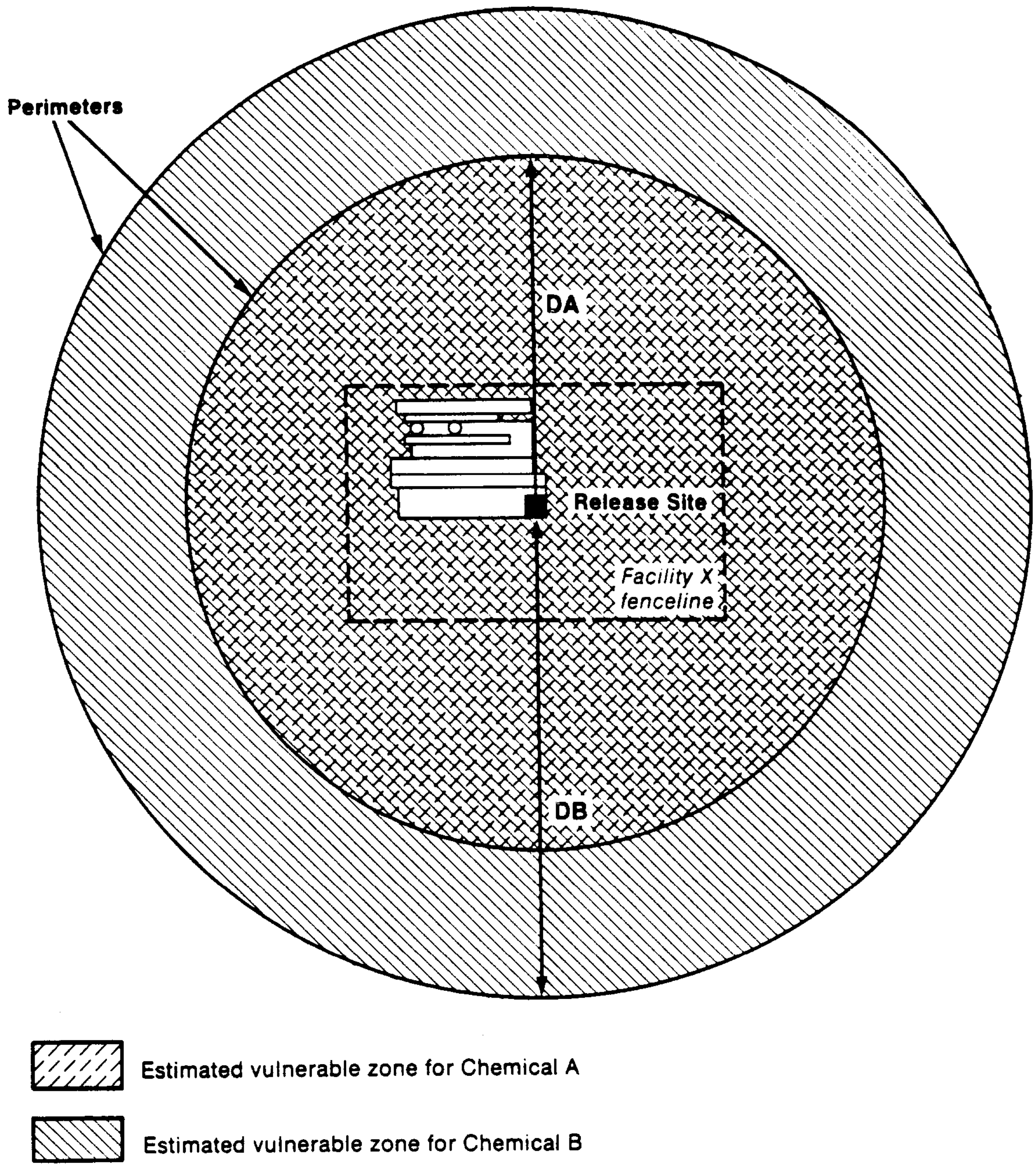
The Movement Downwind of a Plume of an Airborne Extremely Hazardous Substance Following an Accidental Release.



Note: Plume moves in the same direction as wind and tends to become longer and less concentrated as it moves downwind. This is due to the dispersion of the extremely hazardous substance in air.

Exhibit 2-4

Vulnerable Zones for Community Planning Resulting from Airborne Releases of Chemicals A and B



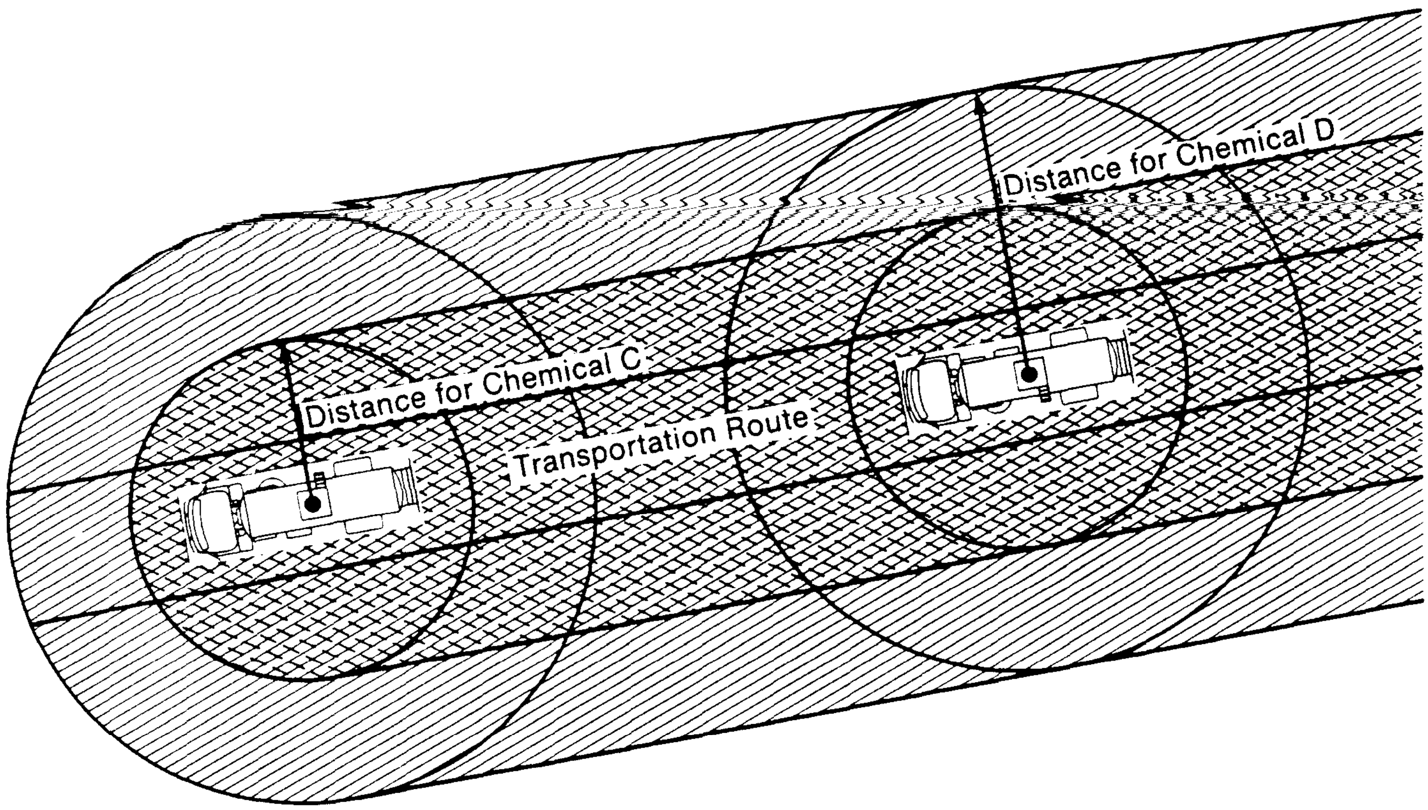
DA - Distance from release site to the point at which the airborne chemical concentration equals the level of concern for Chemical A

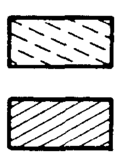
DB - Distance from release site to the point at which the airborne chemical concentration equals the level of concern for Chemical B

Note: Differences in the estimated vulnerable zones of Chemical A and Chemical B under identical meteorological conditions may be due to amount released, rate of release to air (volatilization rate), level of concern, or any combination of these variables.
For purposes of planning the vulnerable zone is expressed as a circle since the wind direction at the time of an actual release is not known. Under conditions of an accidental release, the area enveloped by a plume will represent only a portion of the circle.

Exhibit 2-5

Vulnerable Zones along a Transportation Route When Airborne Releases of Chemicals C and D Occur





Note: Transportation route would also be considered part of the estimated vulnerable zone.

accompanying decreased atmospheric stability will result in greater airborne dispersion (and dilution) of a chemical, and a resultant decrease in the size of the estimated vulnerable zone. Additional information on these meteorological variables is presented in Appendix G.

C. Surrounding Topography

The topography of the area surrounding a potential release site will affect the size of the estimated vulnerable zones.

The principal topographical factors are natural obstructions such as hills and mountains, and man-made structures such as high-rise buildings. Natural formations and surface conditions are always site-specific and therefore beyond the scope of this guidance. If significant natural barriers exist within estimated vulnerable zones, appropriate technical support should be solicited from local, State, or EPA Regional meteorologists or experts in the private sector including the facility. On the other hand, general methodologies do exist for describing the dispersion of chemical substances in urban areas containing high buildings and in flat, rural areas. The methodology for estimating vulnerable zones in urban and rural areas is discussed later in this chapter and is presented in Chapter 3.

D. Levels of Concern

A level of concern (LOC), for purposes of this document, is defined as the concentration of an EHS in air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

There is at present no precise measure of an LOC for the chemicals listed as EHSs. Various organizations over the past several years have been developing acute exposure guidelines for a limited number of hazardous chemicals; the methodology, however, is still under development. The preliminary guidelines and the progress to date are described in detail in Appendix D. Until more precise measures are developed, surrogate or estimated measures of the LOC have been identified for the listed EHSs. Local officials may choose values for the LOC different from those estimated in this guidance, depending upon their requirements, the specific characteristics of the planning district or site, and the level of protection deemed appropriate. Extreme caution and prudence should be exercised when choosing an LOC.

For the purposes of this guidance, an LOC has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" (IDLH) level published by the National Institute for Occupational Safety and Health (NIOSH) or one-tenth of an approximation of the IDLH from animal toxicity data. Other exposure guidelines that may be used to estimate LOC include the "Threshold Limit Value" (TLV) published by the American Conference of Governmental Industrial Hygienists (ACGIH), guidelines developed by the National Research Council (NRC) of the National Academy of Sciences (NAS), and Emergency Response Planning Guidelines (ERPGs) under development by a consortium of chemical companies. These values are discussed and listed in Appendix D. The use of LOC in the vulnerable zone estimate is discussed later in this chapter and in Chapter 3.

2.2.3 The Relationship of Estimated Vulnerable Zones to Actual Releases

The estimated vulnerable zones are shown as circles with different radii in Exhibits 2-6 and 2-7 to illustrate how changing conditions or assumptions can influence the vulnerable zone estimate. At the time of an accidental release, only some portion of the estimated vulnerable zone will actually be involved. The specific area covered by the plume will be determined principally by wind direction and the degree of dispersion of the plume. The area through which the plume moves is generally referred to as a plume "footprint." Exhibit 2-8 shows the plume footprint for the release of a sample chemical substance. Note that the actual concentration of the airborne chemical tends to decrease as it moves further downwind from the release site because of continual mixing and dilution (dispersion) of the chemical with air. Note also that the plume movement is affected by the speed of the wind.

Although a footprint represents the area enveloped by a plume, it is not possible to predict with any high degree of accuracy the wind direction and wind speed. Therefore the direction and shape which the plume may take at the time of an accidental release is not known in advance.

Exhibit 2-6

The Effect of Different Assumptions on the Calculation of the Radius of Estimated Vulnerable Zones

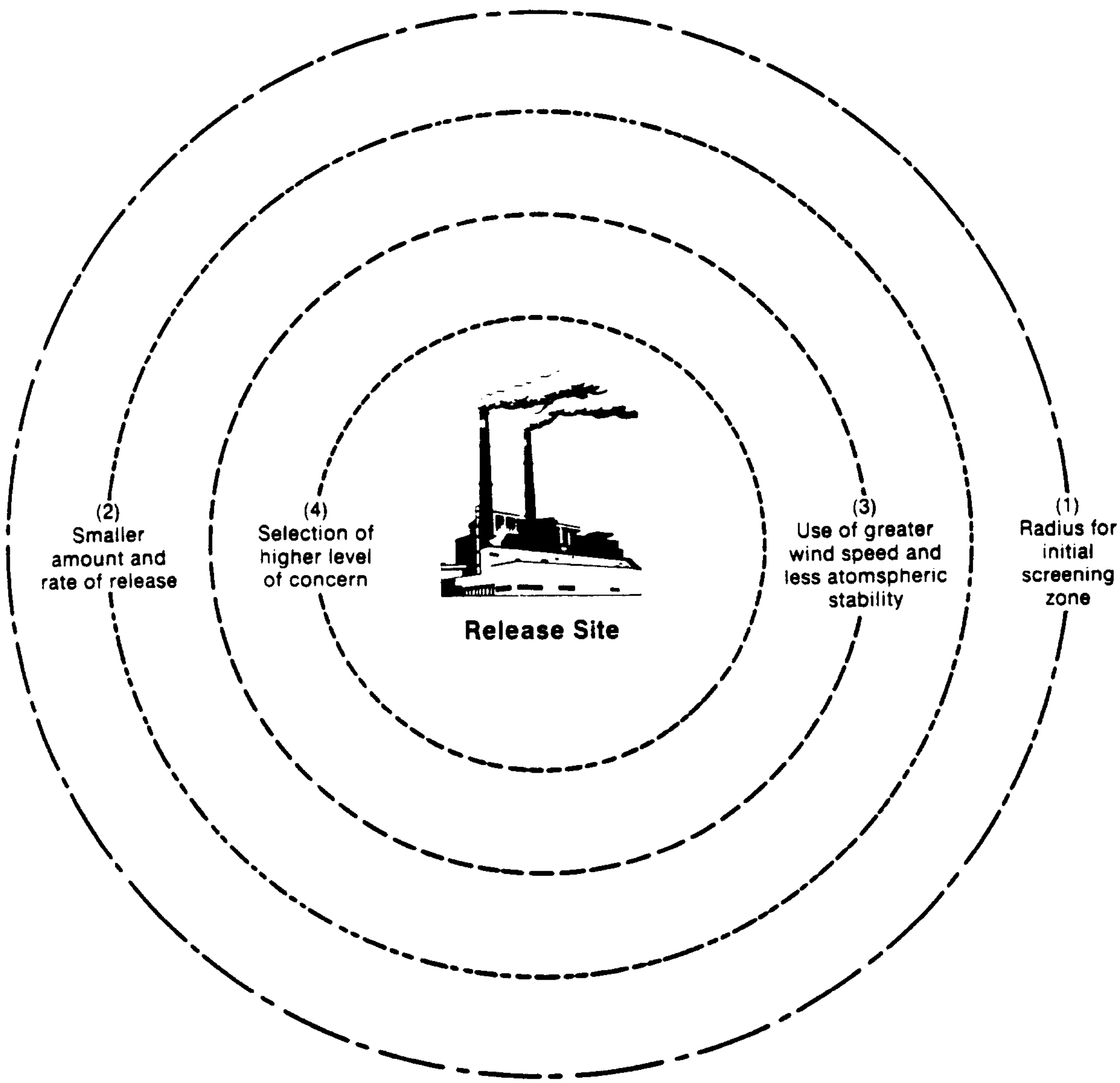


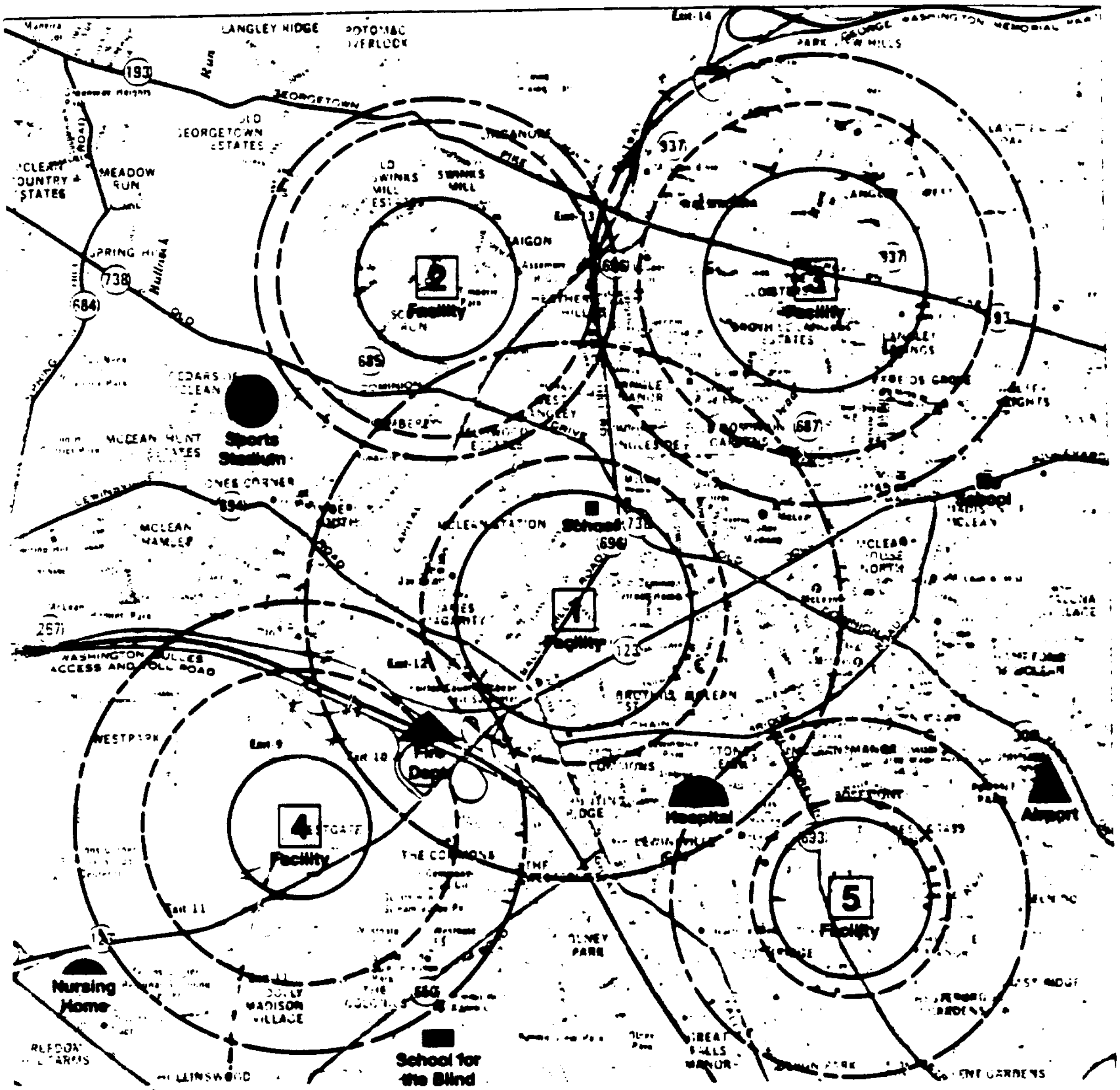
Diagram not drawn to scale.

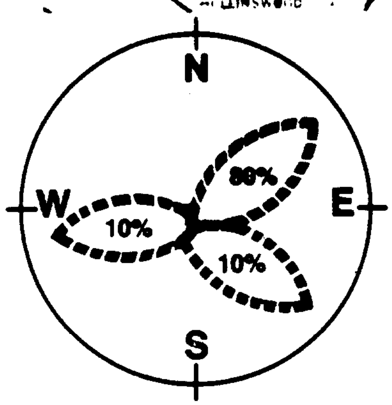
The effect of altering major assumptions on the downwind distance (radius) of the estimated vulnerable zone. Calculations made using (1) credible worst case assumptions for initial screening zone (2) reevaluation and adjustment of quantity released and/or rate of release of chemical (3) reevaluation and adjustment of wind speed (increase) and air stability (decrease) (4) selection of a higher level of concern. Note that adjustment of two or more variables can have an additive effect on reducing the size of the estimated vulnerable zone.

Note also that the relative sizes of the altered zones are not to scale (e.g., choosing a higher value for the level of concern does not always result in a smaller zone than the use of greater wind speed and less atmospheric stability.

Exhibit 2-7

Vulnerable Zones for Five Facilities in a Hypothetical Community





Wind rosette indicates % of time wind typically blows in that direction

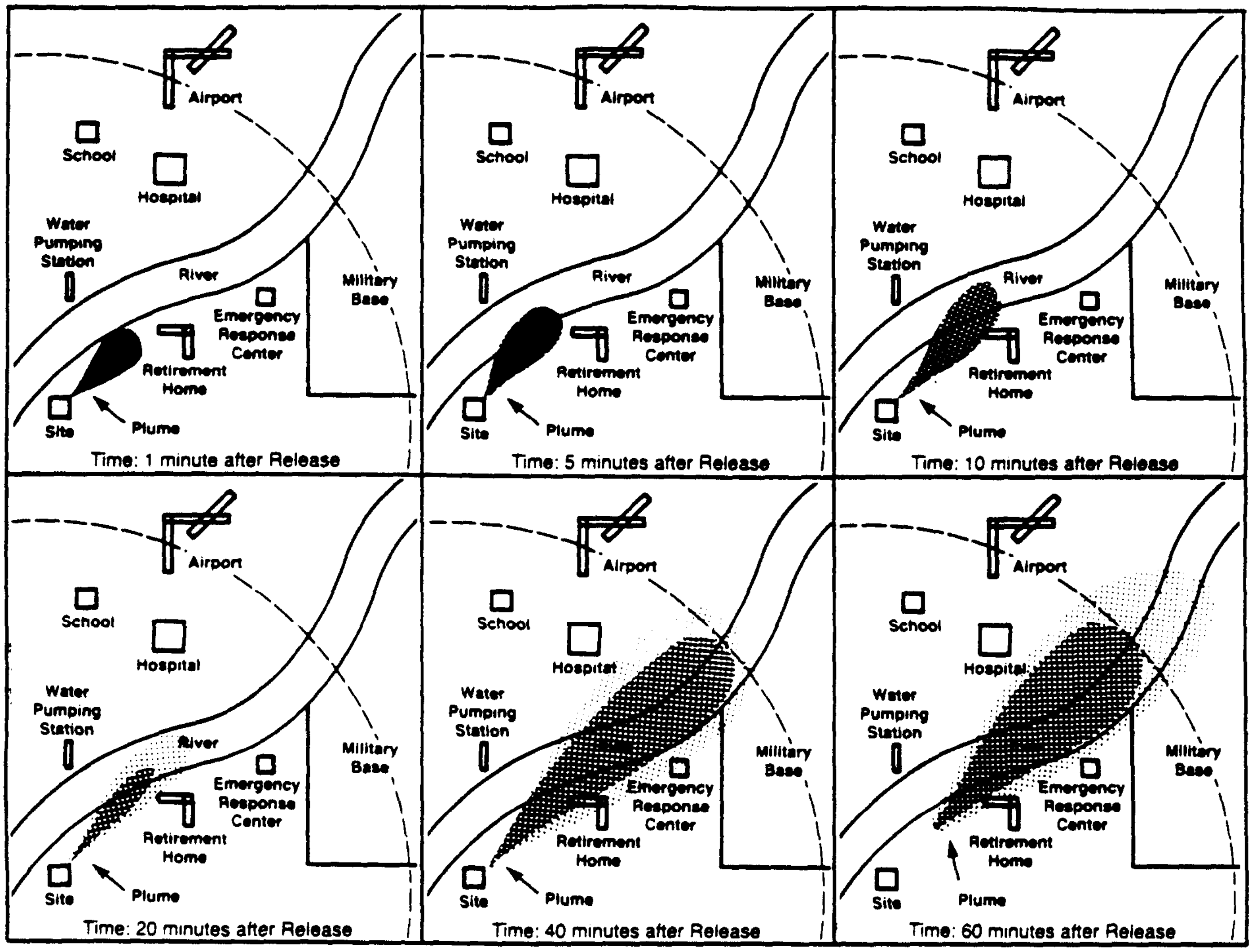
---- Estimated initial screening zones based on credible worst case assumptions

---- Changes in assumptions for meteorological conditions more characteristic of a specific community

—— Changes in other initial screening assumptions (variables) based on reevaluation of assumptions and conditions

Exhibit 2-8

Plume Development and Movement during a Hypothetical Accidental Release




perimeter of the estimated zone beyond which the airborne concentration of the chemical is below the level of concern

Note: As the plume dissipates, the gas becomes less concentrated. The shading of the plume indicates its concentration: the darker the plume, the more concentrated the gas is. This plume represents a neutrally buoyant gas with constant wind speed and direction. Release duration is 45 minutes.

Note also, that although the plume moves beyond the perimeter of the estimated vulnerable zone, the concentration of the chemical in the air is below the level of concern at that distance and beyond.

Further, both wind speed and direction may change during the course of the release. Because of this, it is suggested that planners use a circle for fixed sites or a corridor for transportation routes when estimating vulnerable zones.

2.2.4 Application of Estimated Vulnerable Zones to Hazards Analysis for Extremely Hazardous Substances

This section provides an overview of how vulnerable zones can be estimated as part of a hazards analysis. To estimate the zone, specific values must be assigned to each of the variables discussed in the previous sections. Values may be obtained from the reporting facilities, from techniques contained in this document, or other sources recommended in this guide. In several instances, this guide provides liquid factors which replace a series of calculations. These factors are intended to make the process of estimating the vulnerable zones much easier for local emergency planning committees (LEPCs) .

The step-by-step hazards analysis described in Chapter 3 of this guidance is divided into two major phases. The first phase involves a screening of all reporting facilities to set priorities among facilities so that more detailed hazards analysis can be conducted for those facilities that pose the greatest risk should a release occur. The first phase employs assumptions for a credible worst case scenario. The second phase involves the reevaluation of the facilities by priority. During this phase the LEPCs have the opportunity to reevaluate the assumptions used in the screening phase on a case by case basis using data that may be unique to a particular site.

Estimating Vulnerable Zones for Initial Screening

Because of time and resource limitations, local planners may not be able to evaluate all reporting facilities at the same time or to the same extent. Thus planners should set an order of priority among potential hazards for all facilities that have reported the presence of one or more EHSs in excess of the TPQ. One way to do this is to estimate a vulnerable zone radius using assumptions for a credible worst case scenario. Values that reflect these assumptions are assigned to all the variables discussed in Section 2.2.2. In this way, all facilities and substances are similarly evaluated to establish a relative measure of potential hazard for purposes of prioritization.

The initial estimated screening zones are based on the following credible worst case assumptions.

- Quantity released: maximum quantity that could be released from largest vessel or interconnected vessels.
- Rate of release to air: total quantity of gas, solid as a powder, or solid in solution is assumed to be released in 10 minutes; for liquids and molten solids, the rate is based on the rate of evaporation (rate of voltization). As explained in Appendix G this guidance simplifies the calculation of the rate of evaporation with a liquid factor which approximates. a series of calculations. This number is called liquid factor ambient (LFA), liquid factor boiling (LFB), or liquid factor molten (LFM) depending on the handling conditions of the EHS.
- Temperature: not applicable to gases or solids as powders or in solution; for liquids, dependent on whether they are used at ambient temperature or near their boiling points: for molten solids, at their melting point.
- Meteorological conditions: wind speed of 1.5 meters per second (3.4 miles per hour) ; F atmospheric stability.
- Topographic conditions: flat, level, unobstructed terrain: use of the dispersion model for rural areas.
- LOC: one-tenth of the (NIOSH) published (IDLH) value or one-tenth of its approximation. * (See Appendix D for a discussion of LOC.)

* Provided it is not exceeded by the ACGIH TLV. In this case, the TLV is used.

As a result, the only information necessary to estimate the vulnerable zone for initial screening is:

- Chemical identity:
- Maximum potential quantity in a single vessel or interconnected vessels (obtained from the facility);
- Location of vessel and facility (obtained from the facility);
- LOC (found in Appendix C); and
- In instances of confidentiality claims, the approximate LOC as defined in this guidance, physical state, and approximate vapor pressure of a liquid or molten solid (obtained from the facility).

Planners can use the estimated zone, together with an initial consideration of population and essential service facilities within this zone and any readily available information on the likelihood of a release to establish an order of priority among the facilities. The considerations of population and critical services are discussed in Section 2.3 of this chapter.

Reevaluation of the Estimated Zones

Once the prioritization of facilities is completed, the LEPCs should begin a systematic reevaluation of those facilities which initially appear to represent the greatest potential hazards. This will require careful review of the considerations presented in Chapters 2 and 3 and Appendices G and I in this document, consultation with facility officials, and perhaps the aid of experts in the appropriate technical areas. After careful evaluation of new data, planners may wish to alter certain values and assumptions such as:

- Quantity likely to be released (use information from facility);
- Likely rate of release to air (obtain information from facility or other sources);
- Meteorological conditions (obtain information from facility, local, State, or regional experts, or other sources);
- Topographical considerations (e.g., urban versus rural landscape); and
- Values used for the LOC.

Reevaluation of the screening zones based on "credible worst case" assumptions used for screening purposes should be performed with utmost care and prudence. Although some changes in estimated or assumed values may increase the size of the estimated vulnerable zone, in many instances the zone will be reduced by such changes. Exhibit 2-9 provides a summary table of how the principal variables affect the estimated zone. For example, discussions with a facility representative may indicate that in one particular operation, vessels are rarely filled to maximum capacity or that equipment is engineered or designed to minimize or contain accidental releases. Chemicals may be subjected to higher temperatures or pressures than was originally assumed. Meteorological data may show that the worst-case conditions prevail for only a small percentage of the time or that they prevail for a large percentage of the time. The use of one-tenth of the IDLH or an approximation of this value as the LOC may or may not be considered overly protective for local circumstances. Local planners may favor the use of another value as an appropriate guideline for an LOC.

Decisions to alter the values or assumptions that affect the size of the estimated vulnerable zone involve a consideration of acceptable risk and are a matter of judgement at the local level. There is no guidance available that can provide values that would ensure no risk or that can provide an acceptable balance between risk and the appropriate level of planning for each district. This decision rests with local officials.

It is possible that reevaluation of the screening zones may lead to the estimation of several vulnerable zones as shown in Exhibit 2-7. Planners must then carefully consider the populations and essential services at risk, both within and outside these zones and reach conclusions on the level and type of planning they believe is necessary. Section 2.3 provides information on analyzing the risk associated with releases of EHSs to populations and essential services facilities within the planning district.

2.2.5 Evacuation Considerations for Airborne Releases of Extremely Hazardous Substances

Decisions about whether or not to evacuate as well as about evacuation distances are incident-specific and must be made at the time of an ac-

EXHIBIT 2-9

FACTORS AFFECTING VULNERABLE ZONE ESTIMATIONS

IF	IT WILL CAUSE	RESULTING IN
the quantity on site that might be involved in an accident is reduced	a reduction in the total airborne quantity and the quantity released per minute	smaller estimated zones
the time period of release of a given quantity increases	a reduction in the airborne quantity released per minute	smaller estimated zones
the release source point is above ground level	an increase in dispersion (mixing and diluting of the chemical in air)	smaller estimated zones (possibly)
the terrain considered is rough (uneven and mountainous) instead of flat	an increase in dispersion (mixing and diluting of the chemical in the air)	smaller estimated zones
the area is urban, containing high buildings and other man-made structures	an increase in dispersion (mixing and diluting of the chemical in the air)	smaller estimated zones
a higher value for LOC is chosen	a reduction in the geographical area with airborne concentrations above the LOC	smaller estimated zones
a lower value for LOC is chosen	an increase in the geographical area with airborne concentrations above the LOC	larger estimated zones

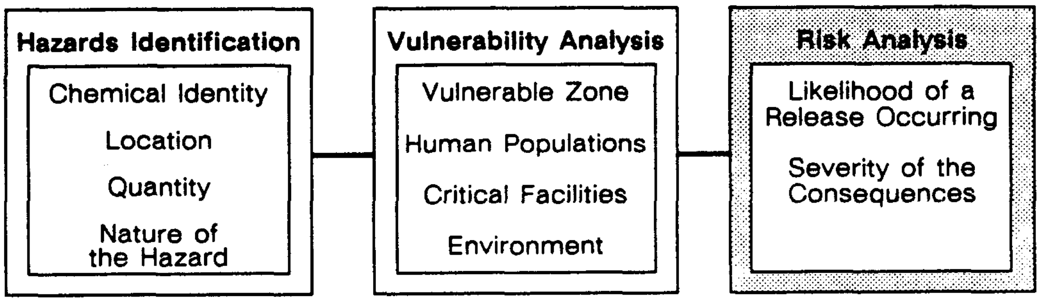
tual release. An estimated vulnerable zone should not automaticallv be used as the basis for evacuation during an incident response. For example, the following variable factors are always part of an evacuation decision: wind speed and direction, temperature, humidity, air dispersion conditions, and time of day. In addition, the vulnerable zone is described as a circle or a corridor surrounding the possible incident site and provides no information on the breadth of a potential plume. An evacuation zone is typically a pathway through which a plume might move from the point of release. The vulnerable zone is helpful because it identifies an area about which evacuation decisions might need to be made, but the evacuation zone will always depend on other factors.

Evacuation during incidents involving the airborne release of acutely toxic chemicals is sometimes, but by no means always, necessary. Release of airborne toxics can occur and move downwind so rapidly that there would be no time to evacuate residents. For short-term releases, the most prudent course of action for the protection of the nearby residents would often be to remain indoors with the doors and windows closed and the heating and air conditioning systems shut off. An airborne cloud will frequently move quickly past. Vulnerable populations, such as the elderly and sick, may suffer more injury by being evacuated than by staying inside and putting simple countermeasures into effect. If the releases occur over an hour or more, or if there is a fire that cannot be readily controlled within a short time, then evacuation may be a sensible alternative.

The disadvantages of evacuation in incidents involving airborne releases of EHSs are numerous. Two have already been alluded to, namely that events occur so rapidly that there may be no time to evacuate and that vulnerable populations would sustain fewer adverse effects by remaining inside until the toxic cloud has passed. Slight changes in wind velocity and direction could be very important if evacuation were begun during a release of airborne toxic chemicals: differences in temperature between air layers could also cause the toxic cloud to disperse in ways that would be hard to predict. It would be difficult to estimate how long a community would be exposed to a toxic cloud.

The estimated vulnerable zone for a potential airborne release of a specific quantity of EHS represents the area surrounding the potential release site within which vulnerable populations and facilities might be affected. It does not reflect the time frame of the impact of an accident. It also does not mean that just beyond the zone boundary residents are safe. The many assumptions made in the calculations for the vulnerable zones and the fact that no safe levels for any of the chemicals on the list of EHSs have been established for the general population, make it inappropriate to base evacuation solely on these estimates. If the estimated vulnerable zone is greater than planners can cope with, the community should work closely with the facility to discuss the possibility of reducing the risk of exposure. This could be achieved by reducing inventories, establishing controls or alarms to make sure no release occurs, and by installing early warning systems. A more detailed discussion of evacuation is given in Appendix H.

2.3 Risk Analysis



Risk analysis is the third part of the hazards analysis process. Risk analysis can provide a relative measure of the likelihood and severity of various possible hazardous events and enable the emergency plan to focus on the greatest potential risks. Risk analysis requires certain information collected during the first two steps of the hazards analysis (hazards identification and vulnerability analysis), as well as other information specific to the facility or the local area. The appropriate level of detail and scope of the risk analysis must be determined based on the local situation and the resources available. This guide is meant primarily to assist local emergency planning committees (LEPCs) in carrying out a relatively quick and inexpensive risk analysis. LEPCs with access to the necessary resources may wish to conduct a detailed quantitative risk analysis. However, **a** risk analysis of this type is beyond the scope of the guidance presented here and it is recommended that committees seek other guidance and expert advice for conducting quantitative risk assessments. A quantitative risk assessment is not deemed essential to performing a hazards analysis suitable for emergency response planning in most cases. The real value of risk analysis derives from the fact that it gives planners an ability to put each potential situation into perspective (in terms of the probability that it will occur and the resulting effects it will have) and results in emergency plans that will address the most likely and most severe potential hazards.

2.3.1 Overall Approach to Risk Analysis: Ranking of Hazards

Because available safeguards such as containment, controlled flow, and proper venting may greatly reduce the opportunity for, or extent of, exposure, the mere presence of a hazardous chemical is insufficient to identify the level of risk involved. Whenever a hazard exists, however, there is always some risk, however small it might be.

Risk analysis includes an estimate of the probability or likelihood that an event will occur. Risk can be characterized in qualitative terms as high, medium, or low, or in quantitative terms using numerical estimates and statistical calculations. For practical purposes, a risk analysis may be based on a subjective, common-sense evaluation. Few people live in daily fear of being struck by a meteorite. They know that, although the risk exists, it is very small because the probability is low. A busy street corner, known to be the site of frequent auto accidents, could be considered to present a high risk of accidents. Citizens know that the likelihood of being struck by an automobile is much greater and requires safeguards (e.g., looking both ways before crossing a street). In both of these situations, the evaluation of the probability of a future incident is based on knowledge of the frequency with which that incident has occurred in the past. Historical records of past events can, therefore, be put into practical use in risk analysis.

Both probability and consequences are extremely important in evaluating risk. A high risk situation can be the result of a high probability with severe consequences (e.g., irreversible health effects or death due to an airborne toxic chemical, a fire or explosion with injuries or fatalities) , whereas moderate risk situations can be a result of either high probability with mild consequences or low probability with more severe consequences. Diminishing the likelihood of an accident or minimizing the consequences will reduce risk overall.

A relative ranking of hazards for the purposes of community emergency planning does not require extensive mathematical evaluations, application of statistics, or extensive support from experts. Application of readily available information and common sense, when combined with site-specific evaluations such as the vulnerability analysis, will complete much of the risk analysis process. Because it is based on the knowledge, experience, local considerations, and the priorities of the people in the planning district or community involved, there is no universal right answer in risk analysis.

2.3.2 Types of Information Required for Risk Analysis

Much of the information concerning sources of hazard, populations, and essential services subject to damage should have been assembled during the screening portion of the hazards identification and vulnerability analysis. Risk analysis will also require information on facility and community plans and safeguards, existing local response capabilities in place, and an historical record of past incidents and their outcomes.

Planners who have used the screening methodology to estimate vulnerable zones as described in Section 2.2 of this chapter and in Chapter 3 will then need additional information about priority facilities for which they will develop plans first. The process described in this section is iterative: (1) Planners gather additional information about high priority facilities first; (2) Planners then reevaluate and rank the risks associated with highest priority sites (and make emergency plans accordingly); (3) Planners then return to the original list of facilities that were assigned a lower priority during the screening and repeat the process until all reporting facilities have been reevaluated. Following the reevaluation of all facilities, appropriate emergency plans should be developed.

Facility Information

Facilities are an important source of information about risk. They are required under Title Ill of SARA to provide both chemical inventory and release information to LEPCs. Information required under Section 304 about spills or releases that have occurred will be useful for this phase of hazards analysis. Certain State and local governments have additional community-right-to-know regulations and spill reporting requirements with which facilities must also comply. Thus industries can and should be approached with questions regarding the hazards and safeguards present at their facilities. Interaction with facilities should be based on cooperation, respect for trade secrets and other confidential business information, and recognition of the industry as a member of the community. Facilities should be aware of the importance of certain information (e.g., the results of a facility risk assessment) and should cooperate in providing as much pertinent information as possible. Specific types of information concerning extremely hazardous substances (EHSs) that LEPCs may want to request from facilities include:

- Anticipated adverse health effects of a substance and their degree of severity:
- Safeguards in place on-site:
- Recommendations made by facilities for community safeguards:
- Prevention approaches used for past events in which adverse health effects were prevented, and details of the events:
- Lessons learned from past events in which adverse health effects occurred, and details of the events:
- Hazards evaluations conducted by the facility (e.g., HAZOP; see Appendix J).

In addition to the information and recommendations which they will provide, facilities may be willing to contribute resources to assist in emergency response management including:

- Assistance in planning and response by facility technical experts:

- Copies of facility emergency response plans and spill prevention control and countermeasures (SPCC) plans (see Appendix I);
- Assistance in cleanup and recycling of spilled materials: and
- Training and safe handling instructions.

Community Plan and Safeguard Information

Many communities will already have in place one or more emergency response plans developed to address a variety of hazards. Such plans may require revision to include recent new regulations and perhaps may be incomplete in addressing acutely toxic airborne releases, but will provide a valuable starting point for additional planning. Specific types of plans which may already exist include:

- Local multi-hazard emergency operations plans (EOPs) (developed under Federal Emergency Management Agency (FEMA) guidance);
- Emergency plans for transportation-related hazards (developed under Department of Transportation (DOT) guidance);
- Community Awareness and Emergency Response (CAER) plans (developed by the Chemical Manufacturers Association (CMA)); and
- The SPCC plans of individual facilities.

Historical Accident Records

There are two benefits to the review of historical records of hazardous materials incidents in risk analysis. First, an analysis of the sites and materials involved in prior accidents will indicate hazards that may represent significant risks. Although no two accidents will be identical, certain situations, if unaltered, can precipitate other more severe incidents. A second benefit is the development of an ability to recognize and assess potential risks which would not be apparent to an untrained evaluator. The development of an appreciation for what could happen can be achieved through a review of what has happened in the past. To assist in increasing the overall awareness of the nature and complexity of hazardous incidents, Exhibit 2-10 includes brief summaries of some accidents that occurred during 1980 and 1981 throughout the world. The Acute Hazardous Events Data Base prepared for the EPA Office of Toxic Substances (December 1985) has information on the chemicals involved in accidents that posed high risks to human health. The historical record of local hazardous incidents may be more valuable in identifying possible hazards in each district. Facility compliance with Section 304 of Title Ill of SARA will provide this type of information in the future.

An historical record of local hazardous materials incidents should include information from the following organizations:

- Fire department and rescue squad:
- Police department:
- Public health department:
- Local hospitals and physicians:
- Local chemical cleanup and spill response companies;
- Universities (chemistry, chemical engineering, and science laboratory safety personnel);
- Local industry: and

News media (print and broadcast).

When accumulating records of past incidents, information concerning the responsible parties will not be essential to the risk analysis process. Many of the information sources listed above may be more willing to provide the needed data (e.g., date, time, location, material, extent of incident, injuries sustained, remedial actions taken, safeguards implemented) if they are assured that blame will not be assigned in the process.

Changing Factors Affecting Future Incidents

The historical record of incidents will contain valuable information. However, to properly apply such data to the risk analysis process requires that any changes which have occurred be taken into account. For example, the assembled historical record may contain several accidents involving the release of hazardous materials at a particular site. If the engineering controls, containment facilities or processes used are altered over time, the results of the risk analysis may be substantially different from what the historical record might predict. Any evaluation of past accidents must take into account any changes in the following:

Exhibit 2-10

SUMMARIES OF SOME ACCIDENTS THAT OCCURRED IN 1980-81

Location	Date	Incident	Consequences
1. Mexico	1980	Line rupture caused spill of liquid ammonia being pumped from a rail tank car to tank trucks at a loading rack.	3 bus passengers, 4 motorists and 2 pedestrians killed by vapor cloud.
2. California	1981	Pallets in a department store were tipped over and chlorine and ammonia became mixed.	10 persons attempting to clean up showed respiratory distress. 30 employees were evacuated, 6 required treatment.
3. Kentucky	1980	Fire in 6 of 10 derailed tank cars. The cars contained vinyl chloride, chlorine, acrylonitrile, and toluene. 3000 foot column of toxic smoke resulted.	Evacuation of 7500 residents.
4. Florida	1981	Vandalism at a swimming pool company resulted in a leak of chlorine and of muriatic acid.	Area was evacuated. 45 persons required hospital treatment.
5. Idaho	1980	Fire at a chemical plant resulted in airborne toxic fumes from pesticides and herbicides.	700 residents evacuated. 30 firefighters treated for fume inhalation.
6. Washington	1980	Nitric acid vapor released during transfer from a holding tank to a tank truck at an aircraft plant. Fumes drawn through plant via ventilation system.	800 employees evacuated.
7. Michigan	1981	Valve on vat of hot phenol formaldehyde/carbolic acid ruptured. An acid cloud covered one square mile of Detroit.	19 people treated for burns, eye and respiratory problems. Dead animals. Paint stripped from buildings and vehicles.

(Source: FEMA Interim SM-110. Analysis of Hazardous Materials Emergencies for Emergency Program Managers: Student Manual. January 1985.)

- Surrounding populations and critical facilities;
- Transportation routes: and
- Engineering control methods.

2.3.3 Limiting the Collection of Information

The preceding section contains some general guidance concerning the types of information required for a risk analysis and where to obtain such data. Appendix I contains suggestions for more detailed questions and concerns which may be raised during discussions to collect the needed information. These are all tools for use in determining what information to collect: none of them, however, will be wholly adequate for emergency planning needs. Community-specific checklists will have to be developed for use in collecting information since each locality and community has different needs, requirements, and points of emphasis.

The suggested approach for using the tools in this guide to aid in the development of such a community-specific checklist is to:

1) Review Appendix I for the types of information that appear to be needed.
2) Highlight and amend the suggestions in Appendix I to reflect the specific needs of your local.community or planning district.
3) Develop a detailed checklist of information needed based on the amended (tailored) version of Appendix I and the types of information outlined in the prior section of this guidance.
4) Set a priority for each item of information based on perceived need, effort involved, and available resources.
5) Request the needed information and assemble it. (This process will be described in the next section.)

It is very important to recognize when enough information has been collected. A cursory review of Appendix I, which is by no means a complete set of discussion points, will demonstrate the volume of information that can be collected for the risk analysis. Collection of data on all possible interactions of elements would be extremely time consuming. The complexity of the analysis and the effort required to perform it will depend directly on the volume of data collected. The focus of the information collection should be on developing a relative measure of the likelihood and severity of possible hazardous events. This goal does not demand an exhaustive collection of data. Reviewing data as they are collected will greatly assist in identifying information that is essential as opposed to that which is peripheral to the risk analysis process. If in doubt, base decisions on whether the information:

- Has the potential for altering the relative ranking of the hazard to the community: and
- Directly involves identification of a hazard, determination of likelihood of an incident, assessment of outcome of an accident, or identification of the safeguards needed or available to reduce the magnitude of the damage.

Anything outside these categories can be considered of secondary importance and should be collected only if resources allow. Such limitations, when properly applied to the entire information collection process (i.e., prioritization of the checklist before data is collected) can benefit the risk analysis by eliminating unnecessary types of information (e.g., details concerning damage from the least likely events) before effort is expended on its collection and analysis.

2.3.4 Assembly of the Information Obtained from the Hazards Analysis

Data that are systematically assembled as they become available during the three major steps of the hazards analysis can be easily evaluated as the risk analysis progresses and can be used to identify missing data as well as information that is complete. As has been discussed earlier in this chapter, a hazards analysis is first performed during the screening of reporting facilities using “credible worst case assumptions” for establishing priorities among facilities. The hazards analysis of each facility is then reevaluated according to priority based on a careful reassessment of the assumptions used in the screening process. A list of these steps is shown in Exhibit 2-11.

Information obtained during both the screening process and the reevaluation process can be stored in a hazards analysis matrix. The hazards

EXHIBIT 2-11

STEPS IN HAZARDS ANALYSIS

INITIAL SCREENING

1. HAZARDS IDENTIFICATION

A. List facilities that have reported EHSs in the community in excess of the threshold planning quantity TPQ

B. Contact each facility on the list for information on the EHSs present

i. Chemical identities

ii. Quantities and location of chemicals present

iii. Properties of the chemicals if identity is trade secret

iv. Conditions under which chemicals are used, produced, processed, or stored

C. Obtain information on transportation routes of EHSs, if possible

D. Obtain information on hazardous materials, facilities, and transportation routes (other than for those with EHSs above the TPQ) listed by SERCs (optional)

2. VULNERABILITY ANALYSIS

A. Estimate vulnerable zone for screening using credible worst case assumptions

i. Determine rate of release to air using information from the facility concerning quantity likely to be released from a vessel or interconnected vessels and fixed assumptions about time of release

ii. Use LOC from Appendix C

iii. Determine zone using Exhibit 3-l and fixed conditions

B. Identify characteristics of human population (e.g., number, concentration, general health) within estimated vulnerable zone

C. Identify critical facilities within estimated vulnerable zone

3. RISK ANALYSIS

A. Collect information obtained in hazards identification and vulnerability analysis

B. Make rough estimate of risks posed by each based on readily available information on the likelihood of a release and severity of consequences

C. Identify those facilities with higher priority due to the estimated risks they pose

PLANNING FOR FACILITIES BY PRIORITY

4. HAZARDS IDENTIFICATION

A. Contact each facility on the list and other expert sources for additional information on the EHSs present and what conditions might be present during a release

  i. Reevaluate estimate of quantity likely to be present

  ii. Reevaluate estimate of rate of release

  iii. Consider typical weather and wind conditions

B. Obtain additional information on typical transportation conditions, if possible

5. VULNERABILITY ANALYSIS

A. Reestimate vulnerable zone using reevaluated assumptions gathered from conversations with the facility and other expert sources

B. Identify characteristics of human population within estimated vulnerable zone

C. Identify critical facilities within estimated vulnerable zone

6. RISK ANALYSIS

A. Collect all information obtained in hazards identification and vulnerability analysis into a table

B. Obtain additional information on community and facility safeguards, response capabilities, and accident records

C. Make judgment of probability of release and severity of consequences

D. Organize all information (from A, B, and C) in a matrix format

E. Rank risks

F. Develop, or revise emergency plans for higher priority facilities

INTEGRATING HAZARDS ANALYSIS INTO THE PLAN.

See Exhibit 4-1 Emergency Planning Information Section.

Exhibit 2-12

EXAMPLE HAZARDS ANALYSIS MATRIX FOR A HYPOTHETICAL COMMUNITY

	Hazard A	*Hazard B*	*Hazard C*
INITIAL SCREENING			
1. HAZARDS IDENTIFICATION (Major Hazards)			
a. Chemical	Chlorine	Ammonia	Liquid methyl isocyanate (MIC)
b. Location	Water treatment plant	Tank truck on local interstate highway	Pesticide manufacturing plant in nearby semi-rural area
c. Quantity	800 lbs.	3000 lbs.	1000 lbs.
d. Properties	Poisonous; may be fatal if inhaled. Respiratory conditions aggravated by exposure. Contact may cause burns to skin and eyes. Corrosive. Effects may be delayed.	Poisonous; may be fatal if inhaled. Vapors cause irritation of eyes and respiratory tract. Liquid will burn skin and eyes. Contact with liquid may cause frostbite. Effects may be delayed. Although not flammable, will burn within certain vapor concentration limits and increase fire hazard in the presence of oil or combustible materials.	Causes death by respiratory distress after inhalation. Other effects would include permanent eye damage, respiratory distress, and disorientation. Explosive. Extremely flammable.
2. VULNERABILITY ANALYSIS			
a. Vulnerable zone*	A spill of 800 lbs. of chlorine from a storage tank could result in an area of radius greater than 10 miles where chlorine gas may exceed the level of concern (LOC). This would be a credible worst case scenario.	A spill of 3000 lbs. of ammonia resulting from a collision of a tank truck could result in an area of radius 7.6 miles where ammonia exceeds its LOC. This would be a credible worst case scenario.	A spill of 1000 lbs. of methyl isocyanate could affect an area of radius 7.6 miles with MIC vapors exceeding the LOC (assuming that the liquid is hot when spilled, the tank is not diked, and the MIC is at 100% concentration). This would be a credible worst case scenario.
b. Population within vulnerable zone	Approximately 600 residents of a nursing home; workers at a small factory; 29 workers at the water-treatment plant; urban area-400 persons/sq. mile; total population in vulnerable zone is more than125,000.	Up to 700 persons in residences, commercial establishments or vehicles near highway interchange; seasonal influx of visitors to forest preserve in the fall; rural area-75 persons/sq. mile; total population in vulnerable zone is 13,600.	Up to 200 workers at the plant and 1000 children in a school; rural area-85 persons/sq. mile; total population in vulnerable zone is 15,400.
c. Essential services within zone	2 fire stations and 1 hospital	1 volunteer fire station	None
3. RISK ANALYSIS (Initial Evaluation of Reporting Facilities--Relative Hazards)	Relative to potential hazards of other reporting facilities--high	Medium	High

	Hazard A	Hazard B	Hazard C
REEVALUATION	(Select facilities by priority based on initial screening)		
1. HAZARDS IDENTIFICATION			
a. Chemical	Chlorine	Ammonia	Liquid methyl isocyanate (MIC)
b. Location	No change	No change	No change
c. Maximum quantity that could be released	500 lbs. (decrease)	No change	1500 lbs. (increase) due to increased production
d. Properties	No change	No change	No change
2. VULNERABILITY ANALYSIS			
a. Vulnerable Zone	Zone decreases (new radius-1.0 miles) due to smaller quantity released and use of urban dispersion model.	No change	Zone increases (new radius-greater than 10 miles) due to larger quantity released.
b. Population within vulnerable zone	Decreases; total population in vulnerable zone is 1250.	No change	Increases; total population in vulnerable zone is 26,700 including 200 workers at the plant and 1000 children in school.
c. Essential services	None	No change	1 fire station and 1 police station
3. RISK ANALYSIS			
a. Likelihood of hazard occurrence	Low-because chlorine is stored in an area with leak detection equipment in 24 hour service with alarms. Protective equipment is kept outside storage room.	High-highway interchange has a history of accidents due to poor visibility of exits and entrances.	Low-facility has up to date containment facilities with leak detection equipment and an emergency plan for its employees. There are good security arrangements that would deter tampering or accidents resulting from civil uprisings.
b. Consequences if people are exposed	High levels of chlorine gas in the nursing home and factory could cause death and respiratory distress. Bed-ridden nursing home patients are especially susceptible. High severity of consequences. However, gas is unlikely to reach a nursing home under reevaluated release conditions.	Motorists' reactions to release vapors may cause traffic accidents. Injured and trapped motorists are subject to lethal vapors and possible incineration. Windblown vapors can cause respiratory distress for nearby residents and business patrons. High severity of consequences.	If accident occurs while school is in session, children could be killed, blinded and/or suffer chronic debilitating respiratory problems. Plant workers would be subject to similar effects at any time. High severity in school hours, medium severity at all other times.
c. Consequences for property	Possible superficial damage to facility equipment and structures from corrosive fumes (repairable).	Repairable damage to highway. Potential destruction of nearby vehicles due to fire or explosions.	Vapors may explode in a confined space causing property damage (repairable). Damage could result from fires (repairable).
d. Consequences of environmental exposure	Possible destruction of surrounding fauna and flora.	Potential for fire damage to adjacent forest preserve due to combustible material (recoverable in the long term).	Farm animals and other fauna could be killed or develop health effects necessitating their destruction or indirectly causing death.
e. Summary: likelihood/ severity of consequences	Low/High. The community would assess this on site and incident specific basis.	High/High. The community would assess this on site and incident specific basis.	Low/High to medium. The community would assess this on site and incident specific basis.

Exhibit 2-13

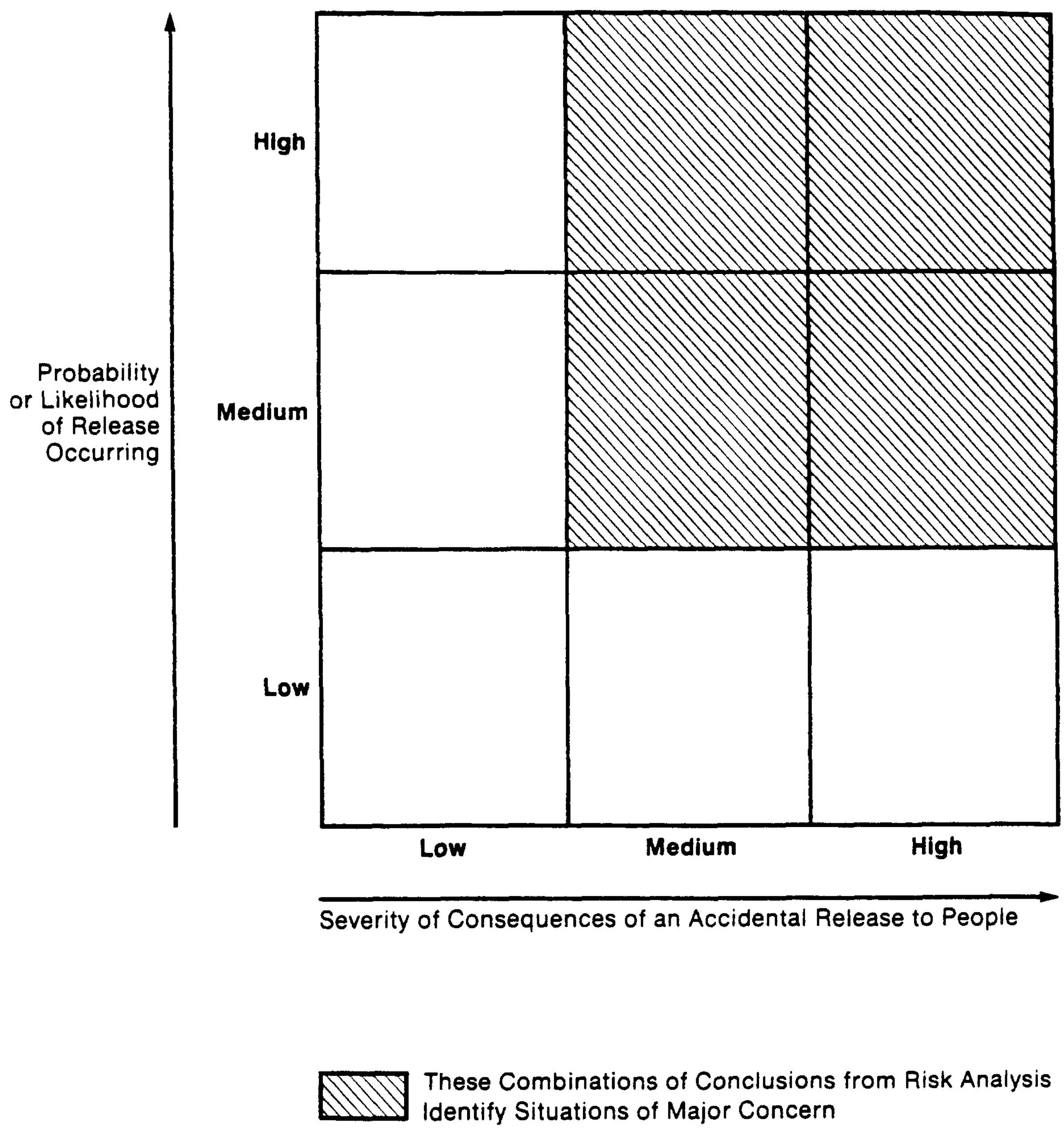
EXAMPLE QUALITATIVE DEFINITIONS OF PROBABILITY OF OCCURRENCE

I. Low:	Probability of occurrence considered **unlikely** during the expected lifetime of the facility assuming normal operation and maintenance.
II. Medium:	Probability of occurrence considered **possible** during the expected lifetime of the facility.
III. High:	Probability of occurrence considered sufficiently high to assume event **will occur** at least once during the expected lifetime of the facility.

EXAMPLE DEFINITIONS OF SEVERITY OF CONSEQUENCES TO PEOPLE

I. Low:	Chemical is expected to move into the surrounding environment in negligible concentrations. Injuries expected only for exposure over extended periods or when individual personal health conditions create complications.
II. Medium:	Chemical is expected to move into the surrounding environment in concentrations sufficient to cause serious injuries and/or deaths unless prompt and effective corrective action is taken. Death and/or injuries expected only for exposure over extended periods or when individual personal health conditions create complications.
III. High:	Chemical is expected to move into the surrounding environment in concentrations sufficient to cause serious injuries and/or deaths upon exposure. Large numbers of people expected to be affected.

Exhibit 2-14
Risk Analysis Matrix



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In general, the events with likelihood-consequence rankings of high-high, high-medium, medium-high, and medium-medium will require some additional attention and possible mitigating measures. However, other less likely scenarios may also have serious consequences and be of high concern to a particular community and would warrant the focus of emergency planning. This initial approach to ranking hazards can enable the best use of the available planning resources.

The planning and decision-making situations in which risk analysis information may prove valuable include:

- Development of a comprehensive local emergency plan;
- Updating of facility emergency response plans:
- Planning major transportation routes for hazardous chemicals (it should be emphasized that the Federal Highway Administration publication FHWA-IP-80-15, Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials, should be used. This document summarizes routing requirements at the Federal, State, and local levels consistent with the Hazardous Materials Transportation Act (HMTA) of 1975);
- Zoning;
- Providing a basis for requesting additional emergency response resources (e.g . , fire department vehicles equipped for hazardous materials incidents); and
- Developing new training materials or selecting available materials.

The application of the results of a risk analysis to the emergency planning process will be described in detail in Chapter 4.

The summary description of the components of hazards analysis presented in this chapter and Appendices I and J will provide a sound basis for understanding the next chapter of this guidance. Chapter 3 leads planners step by step through a hazards analysis, beginning with the initial screening of reporting facilities to establish priorities, and followed by a subsequent reevaluation of the estimated vulnerable zones and hazards analysis by priority of potential hazard.

3. Step-by-Step Procedures for Conducting a Hazards Analysis of Extremely Hazardous Substances

Introduction

Chapter 2 provided an overview of the underlying concepts and application of the three major steps in conducting a hazards analysis of extremely hazardous substances (EHSs) . These steps are hazards identification, vulnerability analysis, and risk assessment.

This chapter provides procedures that can be used in a stepwise fashion to actually conduct a hazards analysis for a specific EHS as reported by a facility under Title Ill of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This chapter contains only minimal information on the background and concepts of the hazards analysis. Effective use of these procedures requires that all information presented in Chapter 2 and Appendices I and J be reviewed and understood.

General Overview

Because of time and resource limitations, planners will likely not be able to analyze hazards and plan in detail for all facilities immediately. Resources should be concentrated first on those situations that present the greatest potential risk should an accident occur. To accomplish this, the hazards analysis is separated into two phases. The first phase is the initial screening of all facilities reporting EHSs on their premises in excess of their threshold planning quantities (TPQs). The initial screening is performed to establish priorities among reporting facilities using credible worst case assumptions. The second phase represents a reassessment by order of priority of the potential hazards posed by the reporting facilities. This is accomplished through the reevaluation of the assumptions used for the initial screening. Both the initial screening and the reevaluation phases utilize the three basic steps of a hazards analysis: hazards identification, vulnerability analysis, and risk analysis.

3.1 Initial Screening to Set Priorities Among Sites

3.1.1 Hazards Identification

The hazards identification for initial screening is based primarily on those facilities in the planning district that have reported EHSs in excess of the TPQs under Section 302, Title Ill of SARA. Identification of hazards from EHSs present in amounts lower than the TPQ and from other hazardous substances may be undertaken but is not mandatory under this Act.

Step 1. Prepare a list of all facilities in the planning district that have reported EHSs under Section 302 of Title Ill. Include any additional facilities specified by the State emergency response commission (SERC).

Step 2. Prepare a list of all EHSs at each facility that exceed the TPQs. Chemical identity should include chemical name and Chemical Abstract Service (CAS) registry number. Although it is not required under Title Ill of SARA, a list of EHSs below the TPQ could also be considered for hazards analysis. This information can be obtained from the facility representative.

Step 3. Using chemical name or CAS number, find ambient physical state of substance in Appendix C.

Step 4. Obtain from the facility representative information concerning the total quantity present, the average daily quantity, and maximum quantity in a single vessel or group of interconnected vessels for each EHS that exceeds the TPQ.

(If the EHS is a solid, these two steps (3 and 4) should establish the quantity of solid in each of the following forms: powdered (less than 100 microns particle diameter), molten (liquid), or in solution .)

Step 5. Obtain from the facility representative additional information on liquids, solids, and mixtures or solutions:

i. For liquids: temperature of liquid in each vessel and whether or not the vessel is located in a diked area. Information provided on temperature may be specific or may be stated generally as ambient or above/below ambient. For purposes of this guidance, liquids at ambient or below ambient temperature are evaluated at ambient, and those at temperatures greater than ambient are evaluated at their boiling temperature.

ii. For molten solids: whether or not each vessel is in a diked area. Solid materials other than those in powdered or molten form, or in solution, may be considered as low priority for hazards analysis.

iii. For mixtures, solutions, or solids as powders: concentration of each EHS in a mixture or solution, or fraction of a solid with particle size less than 100 microns, on a weight percent basis. The hazards analysis will be conducted using only the quantity of EHS present in the mixture or solution, or the quantity of solid with particle size less than 100 microns. (For example, 10,000 pounds of a solution of acrylamide in water at a concentration of 30 percent by weight represents 3,000 pounds of acrylamide for hazards analysis.)

(NOTE: for the purposes of this guidance, the state (solid, liquid, gas) of the EHS is assumed to be that for which it is listed at ambient conditions in Appendix C. The specific handling condition may place the EHS in a different state than listed, e.g., liquid handled as a gas. If the EHS is handled at other than ambient conditions, the calculations should reflect the ambient state, as explained in this guide.)

Step 6. If facilities make confidentiality claims for chemical identity, obtain from the facility representative close approximations of the level of concern (LOC) as defined in this guidance and close approximations of the following properties for each EHS:

i. Physical state at ambient conditions

ii. For liquids: the vapor pressure at ambient conditions and boiling point temperature

iii. For molten solids: the melting point temperature and vapor pressure at the melting point temperature

Approximation should be sufficiently close so as not to significantly affect the size of the estimated zones.

Step 7. If the local emergency planning committee (LEPC) deems it necessary, obtain information in steps 1 through 6 for other EHSs that are present in quantities that do not exceed the TPQ.

(NOTE: This step is not mandatory under Title Ill of SARA, but EHSs could pose a hazard to the community in quantities less than the TPQ.)

Step 8. Organize and record essential information and data. A discussion on the assembly of information is provided in Section 2.3.4.

3.1.2 Estimate Vulnerable Zones for Screening Purposes

For screening purposes, the vulnerable zone is an estimate of the area potentially affected by the release of an EHS using a set of fixed assumptions about the release and airborne dispersion of the substance.

Step 1. For each EHS, use the maximum quantity of material in a vessel or group of interconnected vessels.

For an EHS that is not in a mixture, solution, or partially powdered solid, this quantity is the maximum quantity that could be released (QS). Use this value and proceed to Step 3. To determine QS for an EHS in a mixture or solution, or as a powder, proceed to Step 2.

Step 2. For each EHS in a mixture, solution, or that is partially powdered or molten, determine the QS of EHS by multiplying the maximum quantity of mixture, solution, or solid in a single vessel or interconnected vessels by the concentration and/or portion that is molten or powdered as follows:

QS (lbs)

= Total Quantity of Mixture, Solution, or Solid (lbs) x Concentration and/or portion molten or powdered (wt%) /100

Example: A facility has 1000 pounds of a 50 percent by weight solution of ammonia in water. The quantity of ammonia that could be released is:

QS = 1000 pounds x 50/100
= 500 pounds

Step 3. Determine the rate (in pounds per minute) of release of the EHS to air. Note that the calculation of the rate at which a substance becomes airborne is dependent upon its physical state and the temperature of the liquid or molten solid at the time of release. If the physical state at ambient temperature is a gas, continue as described below in Section A. If the physical state is liquid, proceed to Section B. For soiids, refer to Section C. Once the rate of release (QR) is determined for each substance, proceed to step 4 to determine the vulnerable zone for each facility.

A. Gases

A-1. Determine the rate of release to air (QR) by dividing the maximum quantity of EHS that could be released from a vessel or group of interconnected vessels (QS) by 10:

QR (lbs/min) = QS (lbs)/lO minutes

Example: 2000 pounds (QS) of chlorine is stored in a single 1 ton container.

The rate of release to air (QR) is:

QR = 2000 lbs/lO minutes

QR = 200 lbs per minute.

B. Liquids

B-1. If the liquid is handled only at or below ambient conditions, use the Liquid Factor Ambient (LFA) from the list of EHSs in Appendix C (see Exhibit C-1 and C-2). If the liquid is handled at temperatures greater than ambient, use the Liquid Factor Boiling (LFB) from the list in Appendix C. If the chemical identity is claimed confidential and the facility representative has provided a close approximation of the vapor pressure and boiling point at the handling temperature for the confidential liquid, use Appendix G to calculate an LFA or LFB.

B-2. If the area surrounding the vessel(s) is not diked, go directly to B-6. If the area is diked, determine the area bounded by the dike in square feet (ft^2).

B-3. To determine if using the diked area is appropriate, estimate the area of the pool that might be formed by the spilled liquid if the area were not diked as follows:

Area of Pool (ft^2) = QS (lbs) x 0.49

B-4. Compare this area to the diked area. If the estimated area of the pool is smaller than the diked area, go to B-6 and do not use the diked area. If the diked area is smaller, continue to B-5.

Example: 10,000 pounds of acrolein is stored in a tank in a diked area of 1600 square feet. The pool area is derived as follows:

Area of Pool = 10,000 x 0.49
= 4900 ft^2

Since the diked area (1600 ft^2) is less than the calculated area of the pool (4900 ft^2), use the diked area for further calculations.

B-5. Determine the Rate of Release to air (QR) for a liquid spilled in a diked area using the following formula:

QR (lbs/min) = LFA or LFB x Diked Area (ft^2) x 2.8

(NOTE: the factors 2.8 and 1.4 in B-5 and B-6, respectively, take into account the low wind speed of 1.5 m/set (3.4 miles/hour); see Appendix G.)

Example: 50,000 pounds of pure, hot acrolein is spilled in a diked area of 1600 square feet. Using the liquid factor boiling (LFB) of 0.02, the rate of release to air (QR) is:

QR = 0.02 x 1600 ft^2 x 2.8

QR = 90 lbs/min

B-6. Determine the Rate of Release to air (QR) for a liquid spilled in an undiked area using this formula:

QR (lbs/min) = QS (lbs) x LFA or LFB x 1.4

Example: 50,000 pounds of pure, hot acrolein is spilled in an undiked area.

Using the liquid factor boiling (LFB) of 0.02, the rate of release to air (QR) is:

QR = 50,000 lbs x 0.02 x 1.4

QR = 1400 lbs/min

C. Solids

C-1. If the solid is powdered (particles less than 100 microns in diameter) or in solution, go to C-2.

If the solid is molten, go to C-3.

If the solid is not powdered, not in solution, nor molten, defer hazards analysis of this chemical and begin with another chemical at this facility, or proceed to another facility. Solids other than in powdered, molten, or dissolved form are less likely to become airborne.

C-2. It is assumed that the maximum quantity of a solid that might be released (QS) is the quantity finely powdered or in solution. The QR of a powder or solution of a solid is QS divided by 10 or:

QR (lbs/min) = QS (lbs)/lO minutes

C-3. For molten solids, find the Liquid Factor Molten (LFM) from the list of EHSs in Appendix C (see Exhibit C-1 or C-2). If no LFM is available on the list, consult with facility personnel to obtain the necessary data to calculate the LFM as described in Appendix G. For molten solids claimed confidential, obtain a close approximation of the vapor pressure and melting point temperature from the facility representative and calculate an LFM using the formulae in Appendix G.

C-4. If the area around the vessel(s) holding the molten solid is not diked, proceed to C-6. If the area around the vessel(s) is diked, determine if it is appropriate to use the diked area by comparing it to the liquid pool area as described in steps B-3 to B-5.

C-5. Determine the QR for a molten material in a diked area as follows:

QR (lb/min) = LFM x Diked Area (ft^2) x 2.8

C-6. Determine the QR for a molten material in an undiked area as follows:

QR (lb/min) = quantity actually molten (lbs) x LFM x 1.4

Step 4. Select the LOC for the chemical from the list of EHSs in Appendix C (see Exhibit C-1 or C-2). In instances of confidentiality claims, obtain this value or close approximation from the reporting facility.

Step 5. Estimate the distance (radius) of the screening zone using Exhibit 3-1 as follows:

i. Locate across the top of the table the LOC value that most closely approximates the LOC for the EHS in question. If the LOC value falls halfway between two values on the table, use the value on the table that is smaller (to the left).

ii. Locate the value in the left hand column that most closely approximates the calculated QR (lbs/min) . If the calculated OR is halfway between two values on the table, use the value which is larger (lower on the table).

iii Read across and down to the distance given in tenths of a mile. This value is the calculated radius of a circle encompassing the potential release site and represents the size (in tenths of a mile) of the estimated vulnerable zone for the initial screening of reporting facilities.

Example: The LOC for nitrobenzene is 0.10 grams per cubic meter and the estimated rate of release to air (QR) is 15 pounds per minute. The radius of the estimated vulnerable zone is 0.4 miles.

Step 6. Using a local map of appropriate scale, draw a circle to scale around the potential release site with the potential release site as the center and the estimated vulnerable zone distance as the radius. This represents the estimated vulnerable zone for initial screening of reporting facilities.

Step 7. Identify populations and essential service facilities that are located within the estimated vulnerable zone.

Step 8. Record essential data. A discussion of the assembly of information and an example format are provided in Section 2.3.4.

Worked Examples for Initial Screening

Example 1. Gas Release (Chlorine)

An 800 pound tank of chlorine, which is normally a gas, is stored at a water treatment plant. No other tanks are nearby and it is not interconnected to any other storage vessels containing chlorine. For screening purposes, it is assumed that the total quantity in the tank can be released, and the release will take place over a ten minute period. Therefore,

OR = QS/lO

QR = 800 pounds/l0 minutes = 80 pounds per minute.

The LOC for chlorine is 0.0073 grams per cubic meter (g/m^3) (from Exhibit C-1 or C-2 in Appendix C) .

Locate the LOC listed along the top row of Exhibit 3-1. The LOC of chlorine falls between two values on the table: the lower value is used (i.e., LOC = 0.005 g/m 3). Locate the OR (80 pounds per minute) in the left hand column. Read across from QR = 80 and down front LOC = 0.005 to the distance. The estimated vulnerable zone has a radius of greater than 10 miles from the chlorine storage tank.

Example 2. Gas Release (Ammonia)

A tank truck contains 3.000 pounds of ammonia. For screening purposes it is assumed that the entire 3,000 pounds is released during a ten-minute period following an accident: the airborne quantity released per minute (QR) is calculated as follows:

QR = 3,000 pounds110 minutes = 300 pounds per minute

The LOC for ammonia (from Exhibit C-1 or C-2 in Appendix C) is 0.035 g/m^3.

Locate the LOC in the top row of Exhibit 3-l. Locate the QR, 300 pounds per minute, in the left-hand column. Using Exhibit 3-1 and reading across from 300 pounds per minute and down from 0.035 g/m3 to the intersection of the row and column, the radius of the vulnerable zone or the distance over which the concentration of ammonia may reach the LOC is estimated to be 7.6 miles.

Example 3. Pure Liquid at Elevated Temperature, Undiked Area

Pure methyl isocyanate is handled in an undiked 1000 pound reactor in a pesticide plant. The chemical is handled at warm temperatures (39°C). The LFB from Exhibit C-1 is 0.02. The quantity released to air per minute is calculated as follows:

QR = QS (Ibs) x LFB x 1.4

QR = 1000 pounds x 0.02 x 1.4 = 28 pounds per minute

The LOC for methyl isocyanate is 0.0047 g/m^3 (see Exhibit C-1 or C-2 in Appendix C).

Using Exhibit 3-l the radius of the vulnerable zone is estimated. Locate the LOC in the top row. The LOC of methyl isocyanate falls between two values. Use the lower value, 0.0035 g/m^3 . Locate the QR, 28 pounds per minute, in the left hand column. The QR falls between two values. Use the higher value, 30 pounds per minute. Read across from the rate of release of 30 pounds per minute and down from the LOC of 0.0035 g/m^3 to find the distance. The vulnerable zone distance is estimated to be 7.6 miles.

(Note that for methyl isocyanate, there is a possibility that a runaway polymerization reaction could produce very high temperatures and pressures in the reactor. In this case, a large fraction of the chemical would become a solid and stay in the reactor while the remainder would be quickly released to the atmosphere as a gas.)

Example 4. Liquid at Ambient Temperature in Mixture or Solution in an Undiked Area

Acrolein in a 50 percent solution by weight, at ambient temperature, is stored in an undiked 50,000 pound tank. The LFA from Exhibit C-l is 0.007. The airborne quantity released per unit time to air is calculated as follows:

OS = 50,000 pounds x 50/100

QS = 25,000 pounds

QR = 25,000 pounds x 0.007 x 1.4

QR = 245 pounds per minute

The LOC for acrolein is 0.0011 g/m^3 (see Exhibit C-1 or C-2 in Appendix C) . The distance over which the concentration of acrolein in air may reach the LOC is estimated from Exhibit 3-1. Read across from 250 pounds per minute, and down from the LOC of 0.0007 to the distance. The vulnerable zone radius is estimated to be greater than 10 miles. (10 miles is the maximum radius that can be estimated by this method.)

Locate the LOC in the top row. The closest value lower than 0.0011 is 0.001. Locate the QR in the left hand column. The closest value higher than 245 pounds per minute is 250.

Example 5. Liquid in Diked Area

About 50,000 pounds of pure, hot acrolein is stored in a reactor. Since the liquid is hot, the LFB from Exhibit C-1, 0.02, is used in the calculation of the quantity released. The area around the reactor is diked and it is 40 feet square (1,600 ft^2).

Check this against the area of the pool generated by the reactor contents:

Area of pool = QS x 0.49 = 50,000 x 0.49 = 24,500 ft^2

Since the diked area is smaller the OR is:

QR (Ibslmin) = LFB x diked area (ft^2) x 2.8

QR = 0.02 x 1600 x 2.8 = 90 pounds per minute

Using Exhibit 3-1 locate the LOC of 0.0011 g/m^3 for acrolein in the top row. The closest value lower than 0.0011 is 0.001. Locate the release rate of 90 pounds per minute in the left hand column. Read across from 90 pounds per minute and down from 0.001 g/m^3 to find the distance. The distance over which the airborne concentration of acrolein could exceed the LOC (i.e., the radius of the estimated vulnerable zone) is estimated to be greater than 10 miles.

Example 6. Finely Powdered Solid

A site has 10,000 pounds of acrylamide stored in a large bin. About 20 percent of it has a particle size less than 100 microns. The maximum quantity that could be released (QS) is:

OS = 10,000 Ibs x 20/100 = 2,000 Ibs.

The rate of release to air is:

QR = OS/l0 minutes = 2,000/10 = 200 Ibs per minute

The LOC for acrylamide is 0.11 g/m^3 (see Exhibit C-1 or C-2 in Appendix C). Exhibit 3-1 is used to determine the distance over which the concentration of acrylamide in air may reach the LOC. Locate the LOC in the top row. The closest value lower than 0.11 is 0.1 g/m 3. Locate the QR in the left hand column. Reading across from the OR of 200 pounds per minute and down from the LQC of 0.1 g/m 3, the distance is estimated to be 2.1 miles.

3.1.3 Risk Analysis for Initial Screening of Reporting Facilities

For purposes of initial screening, the risk analysis is limited to a very rough estimate of the likelihood or probability of an incident and the severity of consequences to humans.

Step 1. Evaluate populations at risk in the estimated vulnerable zone. This should include estimated number of individuals, types of populations such as elderly, children, infirm, incarcerated, residents, and transients such as daily workers, audiences, and spectators.

Step 2. Evaluate critical facilities at risk in the estimated vulnerable zone. This should include hospitals or other health care facilities, fire and police stations, other emergency response facilities, and communications facilities.

Step 3. Establish a relative ranking system for the potential consequences posed by hazards from reporting facilities. This may be qualitative such as high, medium, or low, or may be a simple numerical system. For further information, see Section 2.3.1.

Step 4. If available, use known historical information about incidents in the area, estimate the likelihood of a release.

(NOTE: for most hazards, the probability of occurrence will be assumed to be the same.)

Step 5. Record the judgements made in steps 3 and 4.

3.2 Reevaluation; Planning for Facilities by Priority

The reevaluation process provides the opportunity to analyze further the potential hazards of reporting facilities by order of priority. This effort is characterized by the stepwise reevaluation of certain of the credible worst case assumptions used to estimate vulnerable zones during the initial screening process. It is important to emphasize that changes in assumptions resulting in a reduction in size of the zone should be considered with extreme care and prudence. Less conservative assumptions will decrease the estimated zone. In the event of a release under less favorable conditions, a greater area and perhaps a greater population may be affected.

3.2.1 Hazards Identification

Step 1. Review the priority list of reporting facilities developed during the initial screening process and, starting with the highest priority facilities, begin reevaluation of assumptions that were used to estimate the credible worst case vulnerable zones.

Step 2. List potential hazards other than those associated with acute lethality. (This step is not mandatory.)

3.2.2 Reevaluation of the Vulnerable Zones

step 1. Reevaluate the assumptions used to estimate the quantity of EHS likely to be released from a vessel or vessels. Planners should seek advice from appropriate experts including representatives of the facility. Estimates by the facility or other sources of the total quantity of EHS that could be released from a vessel and supporting rationale should be reviewed carefully. These may include revised estimates of the quantity of a liquid likely to be spilled based on actual quantities present or processed and the capabilities to mitigate a release.

step 2. Reevaluate the assumptions used to estimate the rate at which the EHS becomes have calculations or data on the actual amount of substance that could be released when solids are molten, in solution, in powdered form, or vaporized. If there is no way for powders or solutions to become airborne due to explosions or problems with pneumatic systems, release of the substance beyond the boundaries of the facility is not likely. This information should be included in the risk analysis (below). Similarly, molten solids may "freeze" upon contact with air at ambient temperatures and may not evaporate, or conditions may differ from those used to calculate the LFM. Obtain appropriate input from facility representatives and calculate a new LFM or use other data from the facility or other sources to estimate the rate at which the solid becomes airborne. As for liquids, the rate at which a molten solid evaporates from the pool depends upon the wind speed at the time of release. Consult Appendix G to calculate a factor to account for wind in the calculation of the rate of release to air of a molten solid.

Once more realistic site-specific information has been collected and reevaluated regarding the release rate to air of gases, liquids, and solids, be sure to record the new data and the justification for changes. Then proceed to the next step (Step 3) in the reevaluation of the vulnerable zones.

Step 3. Determine if the area around the facility is predominately rural or urban, as follows:

If more than 50% of the land within a mile (1.6 km) radius is used as:

1. Heavy industrial (large chemical, other manufacturing facilities, 3-5 story buildings, flat roofs, grass and trees extremely rare), or
2. Light to moderate industrial (rail yards, truck depots, warehouses, industrial parks, minor fabrication, l-3 story buildings, flat roofs, limited grass and trees), or
3. Commercial (office and apartments, hotels, 10 story heights, flat roofs, limited grass and trees), or
4. Compact residential (single and some multiple family dwellings closely spaced, 2 story or less, alleys, pitched or flat roofs, limited lawns and few old established shade trees, no driveways),

then the area should be classified as urban. Otherwise use rural conditions. Select appropriate tables for use under Step 4. Guidance may be sought from appropriate experts.

Step 4. Consider the principal meteorological conditions of wind speed and atmospheric stability. Consult local, State, or regional sources for information on frequency distributions of wind speed, direction, and atmospheric stability.

This guidance provides tables for four different conditions (NOTE: Exhibits for Chapter 3 are at the end of the Chapter):

a. The worst case conditions of rural topography, moderately stable atmospheric conditions (F stability) and low wind speed of 1.5 meters per second (3.4 mph) (Exhibit 3-1);

b. Urban area, low wind speed of 1.5 meters per second (3.4 mph), and moderately stable atmospheric conditions (F stability) predominate (Exhibit 3-2) ;

c. Rural area, moderate wind speed of 5.2 meters per second (about 12 mph), and less stable atmospheric conditions (D stability) (Exhibit 3-3); and

d. Urban area, moderate wind speed of 5.2 meters per second (about 12 mph), and less stable atmospheric conditions (D stability) (Exhibit 3-4).

Step 5. Evaluate the effect of varying wind speed and atmospheric stability on the estimated vulnerable zone by using Exhibits 3-3 and 3-4 (wind speed of 5.2 meters per second (12 mph) and D stability). For evaluation of other wind speeds and stabilities, refer to instructions in Appendix G. Decide to retain or change values for wind speed and stability and record final decision. If values for the assumptions used are not found in this guidance, consult experts including representatives of the facility.

Step 6. Consider the value of the LOC used to estimate the vulnerable zone during the initial screening process. The one-tenth of the National Institute for Occupational Safety and Health (NIOSH) Immediately Dangerous to Life or Health (IDLH) value or its approximation represents a credible worst case exposure level. Other exposure guidelines may be obtained from Appendix

D, from the facility in question, or from appropriate experts.

step 7. Evaluate the effect of changing the value of the LOC on the estimated zone and its impact on the risk analysis. After careful consideration of the impact on the risk analysis, retain or change the value of the LOC and record it.

Step 8. Using all revised data and assumptions, estimate new vulnerable zones and decide whether to utilize the reevaluated zones in the risk analysis process. This may be an iterative process.

3.2.3 Risk Analysis

The risk analysis performed during the reevaluation process includes an assessment of the likelihood as well as the severity of an accidental release. This relative risk analysis is qualitative in nature, although LEPCs have the option to develop a relative ranking on a numerical basis.

step 1. Based on information obtained from Chapter 2 and Appendices I and J of this guide, the facility representative, historical records, and appropriate experts, carefully evaluate the likelihood (probability) that an accidental release of a particular EHS will occur and not be contained or mitigated.

Step 2. Assign a high, medium, or low ranking for the probability in Step 1 and record the decision as discussed in Section 2.3.

Step 3. Using the reevaluated vulnerable zones, again evaluate populations at risk. This should include an estimated number of individuals, as well as types of populations such as elderly, children, infirm, and incarcerated. The evaluation should also consider transient populations (e.g., daily workers, audiences, and spectators),

Step 4. Evaluate critical facilities at risk within the reevaluated zone. This should include hospitals or other health care facilities, fire and police stations, other emergency response facilities, and communications facilities.

Step 5. Based on Steps 3 and 4, establish a relative ranking system, for the severity of consequences to humans associated with potential hazards posed by reporting facilities. This may be simply qualitative (high, medium, low) as discussed in Section 2.3, or it may be a simple numerical system.

Step 6. Using Steps 2 and 5, establish an overall relative risk for each facility, and record the relative rankings of facilities (see Section 2.3.1). This completes the hazards analysis as presented in this guidance document, This information can also be used for the development of site-specific release scenarios for training exercises and for refining response plans.

Exhibit 3-1
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

SCREENING - Rural, F Atmospheric Stability, Low Wind Speed (3.4 miles per hour), Distances are Given in Miles

For Quantities of Release up to 10,000 pounds/minute

QR Rate of Release (#/min)	Levels of Concern (grams per cubic meter) (For LOC less than this, assume 10 mile distance) 0.0001	0.0004	0.0007	0.001	0.002	0.0035	0.005	0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1.0	2.0	5.0	10.0
1	9.0	2.5	1.7	1.3	0.9	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**
2	*	4.5	2.8	2.1	1.3	0.9	0.8	0.6	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**
3	*	6.7	3.9	2.9	1.7	1.2	1.0	0.8	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
4	*	9.0	5.1	3.7	2.1	1.5	1.2	0.9	0.8	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
5	*	*	6.3	4.5	2.5	1.7	1.3	1.0	0.9	0.6	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**	**
8	*	*	*	7.1	3.7	2.4	1.8	1.4	1.2	0.8	0.5	0.4	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**
10	*	*	*	9.0	4.5	2.8	2.1	1.6	1.3	0.9	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**
15	*	*	*	*	6.7	3.9	2.9	2.1	1.7	1.1	0.8	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**
20	*	*	*	*	9.0	5.1	3.7	2.7	2.1	1.3	0.9	0.8	0.6	0.5	0.3	0.2	0.2	0.1	0.1	0.1	**
25	*	*	*	*	*	6.3	4.5	3.2	2.5	1.5	1.1	0.9	0.7	0.6	0.3	0.2	0.2	0.2	0.1	0.1	**
30	*	*	*	*	*	7.6	5.3	3.7	2.9	1.7	1.2	1.0	0.8	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1
35	*	*	*	*	*	9.0	6.2	4.2	3.3	2.0	1.3	1.1	0.8	0.7	0.4	0.3	0.2	0.2	0.1	0.1	0.1
40	*	*	*	*	*	*	7.1	4.8	3.7	2.1	1.5	1.2	0.9	0.8	0.4	0.3	0.2	0.2	0.1	0.1	0.1
45	*	*	*	*	*	*	8.0	5.3	4.1	2.3	1.6	1.2	1.0	0.8	0.5	0.3	0.3	0.2	0.2	0.1	0.1
50	*	*	*	*	*	*	9.0	5.9	4.5	2.5	1.7	1.3	1.0	0.9	0.5	0.3	0.3	0.2	0.2	0.1	0.1
60	*	*	*	*	*	*	*	7.1	5.3	2.9	1.9	1.5	1.2	1.0	0.6	0.4	0.3	0.3	0.2	0.1	0.1
70	*	*	*	*	*	*	*	8.4	6.2	3.3	2.1	1.7	1.3	1.1	0.6	0.4	0.3	0.3	0.2	0.1	0.1
80	*	*	*	*	*	*	*	9.7	7.1	3.7	2.4	1.8	1.4	1.2	0.7	0.4	0.4	0.3	0.2	0.1	0.1
90	*	*	*	*	*	*	*	*	8.0	4.1	2.6	2.0	1.5	1.2	0.7	0.5	0.4	0.3	0.2	0.1	0.1
100	*	*	*	*	*	*	*	*	9.0	4.5	2.8	2.1	1.6	1.3	0.8	0.5	0.4	0.3	0.2	0.1	0.1
120	*	*	*	*	*	*	*	*	*	5.3	3.3	2.5	1.8	1.5	0.8	0.6	0.4	0.4	0.3	0.2	0.1
140	*	*	*	*	*	*	*	*	*	6.2	3.7	2.8	2.0	1.7	0.9	0.6	0.5	0.4	0.3	0.2	0.1
160	*	*	*	*	*	*	*	*	*	7.1	4.2	3.1	2.3	1.8	1.0	0.7	0.5	0.4	0.3	0.2	0.1
180	*	*	*	*	*	*	*	*	*	8.0	4.6	3.4	2.5	2.0	1.1	0.7	0.6	0.5	0.3	0.2	0.1
200	*	*	*	*	*	*	*	*	*	9.0	5.1	3.7	2.7	2.1	1.2	0.8	0.6	0.5	0.3	0.2	0.1
250	*	*	*	*	*	*	*	*	*	*	6.3	4.5	3.2	2.5	1.3	0.9	0.7	0.6	0.4	0.2	0.2
300	*	*	*	*	*	*	*	*	*	*	7.6	5.3	3.7	2.9	1.5	1.0	0.8	0.6	0.4	0.3	0.2
350	*	*	*	*	*	*	*	*	*	*	9.0	6.2	4.2	3.3	1.7	1.1	0.8	0.7	0.5	0.3	0.2
400	*	*	*	*	*	*	*	*	*	*	*	7.1	4.8	3.7	1.8	1.2	0.9	0.8	0.5	0.3	0.2
450	*	*	*	*	*	*	*	*	*	*	*	8.0	5.3	4.1	2.0	1.2	1.0	0.8	0.5	0.3	0.2
500	*	*	*	*	*	*	*	*	*	*	*	9.0	5.9	4.5	2.1	1.3	1.0	0.9	0.6	0.3	0.2

SEE NEXT PAGE FOR HIGHER QUANTITIES OF RELEASE (QR).

Multiply miles by 1.6 to get kilometers (km).

To find distance: Find nearest LOC across top. Use the lower LOC value for in-between numbers. This is a conservative approach.
Find nearest QR on left column.
Read across and down to find distance in miles.

Notes: * - No distance estimated because method is not valid for distances greater than 10 miles.
** - No distance estimated because method is not valid for distances less than 0.1 mile.

Exhibit 3-1 (continued)
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

SCREENING - Rural, F Atmospheric Stability, Low Wind Speed (3.4 miles per hour), Distances are Given in Miles

For Quantities of Release up to 10,000 pounds/minute

QR Rate of Release (#/min)	Levels of Concern (grams per cubic meter) (For LOC less than this, assume 10 mile distance.) 0.0001	0.0004	0.0007	0.0010	0.0020	0.0035	0.005	0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1	2	5	10
500	*	*	*	*	*	*	*	*	*	*	*	9.0	5.9	4.5	2.1	1.3	1.0	0.9	0.6	0.3	0.2
600	*	*	*	*	*	*	*	*	*	*	*	*	7.1	5.3	2.5	1.5	1.2	1.0	0.6	0.4	0.3
700	*	*	*	*	*	*	*	*	*	*	*	*	8.4	6.2	2.8	1.7	1.3	1.1	0.7	0.4	0.3
800	*	*	*	*	*	*	*	*	*	*	*	*	9.7	7.1	3.1	1.8	1.4	1.2	0.8	0.4	0.3
900	*	*	*	*	*	*	*	*	*	*	*	*	*	8.0	3.4	2.0	1.5	1.2	0.8	0.5	0.3
1000	*	*	*	*	*	*	*	*	*	*	*	*	*	9.0	3.7	2.1	1.6	1.3	0.9	0.5	0.3
1250	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4.5	2.5	1.9	1.5	1.0	0.6	0.4
1500	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5.3	2.9	2.1	1.7	1.1	0.6	0.4
1750	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6.2	3.3	2.4	2.0	1.2	0.7	0.5
2000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	7.1	3.7	2.7	2.1	1.3	0.8	0.5
2500	*	*	*	*	*	*	*	*	*	*	*	*	*	*	9.0	4.5	3.2	2.5	1.5	0.9	0.6
3000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5.3	3.7	2.9	1.7	1.0	0.6
3500	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6.2	4.2	3.3	2.0	1.1	0.7
4000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	7.1	4.8	3.7	2.1	1.2	0.8
4500	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	8.0	5.3	4.1	2.3	1.2	0.8
5000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	9.0	5.9	4.5	2.5	1.3	0.9
6000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	7.1	5.3	2.9	1.5	1.0
7000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	8.4	6.2	3.3	1.7	1.1
8000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	9.7	7.1	3.7	1.8	1.2
9000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	8.0	4.1	2.0	1.2
10000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	9.0	4.5	2.1	1.3

FOR LOWER QUANTITIES OF RELEASE, SEE PREVIOUS PAGE.

Multiply miles by 1.6 to get kilometers (km).

To find distance: Find nearest LOC across top. Use the lower LOC value for in-between numbers. This is a conservative approach.
Find nearest QR on left column.
Read across and down to find distance in miles.

Notes: * - No distance estimated because method is not valid for distances greater than 10 miles.
** - No distance estimated because method is not valid for distances less than 0.1 mile.

Exhibit 3-2
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

Urban, F Atmospheric Stability, 3.4 Miles Per Hour Wind Speed, Distances are Given in Miles

For Quantities of Release up to 10,000 pounds/minute

QR Rate of Release (#/min)	Levels of Concern (grams per cubic meter) (For LOC less than this, assume 10 mile distance) 0.00001	0.00005	0.0001	0.0004	0.0007	0.001	0.002	0.0035	0.005	0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1.0	2.0	5.0	10.0
1	4.5	1.5	1.0	0.5	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**
2	7.6	2.4	1.5	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**
3	*	3.1	2.0	0.8	0.6	0.5	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**
4	*	3.8	2.4	1.0	0.7	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
5	*	4.5	2.8	1.1	0.8	0.7	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
8	*	6.4	3.8	1.5	1.1	0.9	0.6	0.4	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
10	*	7.6	4.5	1.8	1.2	1.0	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**
15	*	*	6.1	2.3	1.6	1.3	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**	**	**	**	**	**
20	*	*	7.6	2.8	1.9	1.5	1.0	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**
25	*	*	9.1	3.2	2.2	1.8	1.1	0.8	0.7	0.5	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**	**	**	**	**
30	*	*	*	3.6	2.5	2.0	1.3	0.9	0.7	0.6	0.5	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**	**	**	**
35	*	*	*	4.1	2.8	2.2	1.4	1.0	0.8	0.6	0.6	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
40	*	*	*	4.5	3.0	2.4	1.5	1.1	0.9	0.7	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
45	*	*	*	4.9	3.3	2.6	1.6	1.2	0.9	0.7	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
50	*	*	*	5.3	3.5	2.8	1.8	1.2	1.0	0.8	0.7	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
60	*	*	*	6.1	4.0	3.1	2.0	1.4	1.1	0.9	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**	**
70	*	*	*	6.8	4.5	3.5	2.2	1.5	1.2	1.0	0.8	0.6	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**
80	*	*	*	7.6	4.9	3.8	2.4	1.7	1.3	1.0	0.9	0.6	0.4	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**
90	*	*	*	8.3	5.4	4.1	2.6	1.8	1.4	1.1	0.9	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**
100	*	*	*	9.1	5.8	4.5	2.8	1.9	1.5	1.2	1.0	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**
120	*	*	*	*	6.7	5.1	3.1	2.1	1.7	1.3	1.1	0.7	0.5	0.4	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**
140	*	*	*	*	7.6	5.8	3.5	2.4	1.9	1.5	1.2	0.8	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**
160	*	*	*	*	8.5	6.4	3.8	2.6	2.0	1.6	1.3	0.9	0.6	0.5	0.4	0.4	0.2	0.2	0.1	0.1	0.1	**	**
180	*	*	*	*	9.3	7.0	4.1	2.8	2.2	1.7	1.4	0.9	0.7	0.6	0.4	0.4	0.2	0.2	0.1	0.1	0.1	0.1	**
200	*	*	*	*	*	7.6	4.5	3.0	2.4	1.8	1.5	1.0	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**
250	*	*	*	*	*	9.1	5.3	3.5	2.8	2.1	1.8	1.1	0.8	0.7	0.5	0.5	0.3	0.2	0.2	0.1	0.1	0.1	**
300	*	*	*	*	*	*	6.1	4.0	3.1	2.4	2.0	1.3	0.9	0.7	0.6	0.5	0.3	0.2	0.2	0.2	0.1	0.1	**
350	*	*	*	*	*	*	6.8	4.5	3.5	2.6	2.2	1.4	1.0	0.8	0.6	0.6	0.3	0.2	0.2	0.2	0.1	0.1	0.1
400	*	*	*	*	*	*	7.6	4.9	3.8	2.9	2.4	1.5	1.1	0.9	0.7	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1
450	*	*	*	*	*	*	8.3	5.4	4.1	3.1	2.6	1.6	1.2	0.9	0.7	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1
500	*	*	*	*	*	*	9.1	5.8	4.5	3.4	2.8	1.8	1.2	1.0	0.8	0.7	0.4	0.3	0.2	0.2	0.1	0.1	0.1

SEE NEXT PAGE FOR HIGHER QUANTITIES OF RELEASE (QR)

Multiply miles by 1.6 to get kilometers (km).

To find distance: Find nearest LOC across top. Use the lower LOC value for in-between numbers. This is a conservative approach.
Find nearest QR on left column.
Read across and down to find distance in miles.

Notes: * - No distance estimated because method is not valid for distances greater than 10 miles.
** - No distance estimated because method is not valid for distances less than 0.1 mile.

Exhibit 3-2 (continued)
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

Urban, F Atmospheric Stability, 3.4 Miles Per Hour Wind Speed, Distances are Given in Miles

For Quantities of Release up to 10,000 pounds/minute

QR Rate of Release (#/min)	Levels of Concern (grams per cubic meter) (For LOC less than this, assume 10 mile distance) 0.00001	0.00005	0.0001	0.0004	0.0007	0.001	0.002	0.0035	0.005	0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1.0	2.0	5.0	10.0
600	*	*	*	*	*	*	*	6.7	5.1	3.8	3.1	2.0	1.4	1.1	0.9	0.7	0.4	0.3	0.3	0.2	0.2	0.1	0.1
700	*	*	*	*	*	*	*	7.6	5.8	4.3	3.5	2.2	1.5	1.2	1.0	0.8	0.5	0.3	0.3	0.2	0.2	0.1	0.1
800	*	*	*	*	*	*	*	8.5	6.4	4.7	3.8	2.4	1.7	1.3	1.0	0.9	0.5	0.4	0.3	0.3	0.2	0.1	0.1
900	*	*	*	*	*	*	*	9.3	7.0	5.1	4.1	2.6	1.8	1.4	1.1	0.9	0.6	0.4	0.3	0.3	0.2	0.1	0.1
1000	*	*	*	*	*	*	*	*	7.6	5.5	4.5	2.8	1.9	1.5	1.2	1.0	0.6	0.4	0.3	0.3	0.2	0.1	0.1
1250	*	*	*	*	*	*	*	*	9.1	6.6	5.3	3.2	2.2	1.8	1.4	1.1	0.7	0.5	0.4	0.3	0.2	0.1	0.1
1500	*	*	*	*	*	*	*	*	*	7.6	6.1	3.6	2.5	2.0	1.5	1.3	0.7	0.5	0.4	0.3	0.2	0.2	0.1
1750	*	*	*	*	*	*	*	*	*	8.6	6.8	4.1	2.8	2.2	1.7	1.4	0.8	0.6	0.4	0.4	0.3	0.2	0.1
2000	*	*	*	*	*	*	*	*	*	9.6	7.6	4.5	3.0	2.4	1.8	1.5	0.9	0.6	0.5	0.4	0.3	0.2	0.1
2500	*	*	*	*	*	*	*	*	*	*	9.1	5.3	3.5	2.8	2.1	1.8	1.0	0.7	0.5	0.5	0.3	0.2	0.1
3000	*	*	*	*	*	*	*	*	*	*	*	6.1	4.0	3.1	2.4	2.0	1.1	0.7	0.6	0.5	0.3	0.2	0.2
3500	*	*	*	*	*	*	*	*	*	*	*	6.8	4.5	3.5	2.6	2.2	1.2	0.8	0.6	0.6	0.4	0.2	0.2
4000	*	*	*	*	*	*	*	*	*	*	*	7.6	4.9	3.8	2.9	2.4	1.3	0.9	0.7	0.6	0.4	0.3	0.2
4500	*	*	*	*	*	*	*	*	*	*	*	8.3	5.4	4.1	3.1	2.6	1.4	0.9	0.7	0.6	0.4	0.3	0.2
5000	*	*	*	*	*	*	*	*	*	*	*	9.1	5.8	4.5	3.4	2.8	1.5	1.0	0.8	0.7	0.5	0.3	0.2
6000	*	*	*	*	*	*	*	*	*	*	*	*	6.7	5.1	3.8	3.1	1.7	1.1	0.9	0.7	0.5	0.3	0.2
7000	*	*	*	*	*	*	*	*	*	*	*	*	7.6	5.8	4.3	3.5	1.9	1.2	1.0	0.8	0.6	0.3	0.2
8000	*	*	*	*	*	*	*	*	*	*	*	*	8.5	6.4	4.7	3.8	2.0	1.3	1.0	0.9	0.6	0.4	0.3
9000	*	*	*	*	*	*	*	*	*	*	*	*	9.3	7.0	5.1	4.1	2.2	1.4	1.1	0.9	0.6	0.4	0.3
10000	*	*	*	*	*	*	*	*	*	*	*	*	*	7.6	5.5	4.5	2.4	1.5	1.2	1.0	0.7	0.4	0.3

FOR LOWER QUANTITIES OF RELEASE, SEE PREVIOUS PAGE.

To find distance: Find nearest LOC across top. Use the lower LOC value for in-between numbers. This is a conservative approach.
Find nearest QR on left column.
Read across and down to find distance in miles.

Notes: * - No distance estimated because method is not valid for distances greater than 10 miles.
** - No distance estimated because method is not valid for distances less than 0.1 mile.

Exhibit 3-3
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

Rural, D Atmospheric Stability, 11.9 Miles Per Hour Wind Speed, Distances are given in Miles

For Quantities of Release up to 10,000 pounds/minute

QR Rates of Release (#/min)	Levels of Concern (grams per cubic meter) (For LOC less than this, assume 10 mile distance) 0.00001	0.00005	0.0001	0.0004	0.0007	0.001	0.002	0.0035	0.005	0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1.0	2.0	5.0	10.0
1	3.9	1.3	0.8	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**	**
2	6.5	2.0	1.3	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**
3	9.1	2.7	1.7	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**
4	*	3.3	2.0	0.8	0.6	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**
5	*	3.9	2.4	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**
8	*	5.5	3.3	1.3	0.9	0.7	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
10	*	6.5	3.9	1.5	1.0	0.8	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
15	*	9.1	5.2	1.9	1.3	1.1	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
20	*	*	6.5	2.4	1.6	1.3	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**
25	*	*	7.8	2.8	1.9	1.5	0.9	0.7	0.5	0.4	0.4	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**
30	*	*	9.1	3.1	2.1	1.7	1.1	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	**	**	**	**	**	**
35	*	*	*	3.5	2.4	1.8	1.2	0.8	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**
40	*	*	*	3.9	2.6	2.0	1.3	0.9	0.7	0.6	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**	**	**	**	**
45	*	*	*	4.2	2.8	2.2	1.4	1.0	0.8	0.6	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**	**	**	**	**
50	*	*	*	4.6	3.0	2.4	1.5	1.0	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**
60	*	*	*	5.2	3.5	2.7	1.7	1.2	0.9	0.7	0.6	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**	**	**	**
70	*	*	*	5.9	3.9	3.0	1.8	1.3	1.0	0.8	0.7	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
80	*	*	*	6.5	4.3	3.3	2.0	1.4	1.1	0.9	0.7	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
90	*	*	*	7.2	4.7	3.6	2.2	1.5	1.2	0.9	0.8	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
100	*	*	*	7.8	5.1	3.9	2.4	1.6	1.3	1.0	0.8	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**	**
120	*	*	*	9.1	5.8	4.4	2.7	1.8	1.4	1.1	0.9	0.6	0.4	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**	**
140	*	*	*	*	6.5	5.0	3.0	2.0	1.6	1.2	1.0	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**
160	*	*	*	*	7.3	5.5	3.3	2.2	1.7	1.3	1.1	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**
180	*	*	*	*	8.0	6.0	3.6	2.4	1.9	1.4	1.2	0.8	0.5	0.4	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**
200	*	*	*	*	8.7	6.5	3.9	2.6	2.0	1.5	1.3	0.8	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**
250	*	*	*	*	*	7.8	4.6	3.0	2.4	1.8	1.5	0.9	0.7	0.5	0.4	0.4	0.2	0.1	0.1	0.1	0.1	**	**
300	*	*	*	*	*	9.1	5.2	3.5	2.7	2.0	1.7	1.1	0.7	0.6	0.5	0.4	0.2	0.2	0.1	0.1	0.1	**	**
350	*	*	*	*	*	*	5.9	3.9	3.0	2.2	1.8	1.2	0.8	0.7	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**
400	*	*	*	*	*	*	6.5	4.3	3.3	2.5	2.0	1.3	0.9	0.7	0.6	0.5	0.3	0.2	0.2	0.1	0.1	0.1	**
450	*	*	*	*	*	*	7.2	4.7	3.6	2.7	2.2	1.4	1.0	0.8	0.6	0.5	0.3	0.2	0.2	0.1	0.1	0.1	**
500	*	*	*	*	*	*	7.8	5.1	3.9	2.9	2.4	1.5	1.0	0.8	0.6	0.5	0.3	0.2	0.2	0.1	0.1	0.1	**

SEE NEXT PAGE FOR HIGHER QUANTITIES OF RELEASE (QR)

Multiply miles by 1.6 to get kilometers (km).

To find distance: Find nearest LOC across top. Use the lower LOC value for in-between numbers. This is a conservative approach.
Find nearest QR on left column.
Read across and down to find distance in miles.

Notes: * - No distance estimated because method is not valid for distances greater than 10 miles.
** - No distance estimated because method is not valid for distances less than 0.1 mile.

Exhibit 3-3 (continued)
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

Rural, D Atmospheric Stability, 11.9 Miles Per Hour Wind Speed, Distances are given in Miles

For Quantities of Release up to 10,000 pounds/minute

QR Rate of Release (#/min)	Levels of Concern (grams per cubic meter) (For LOC less than this, assume 10 mile distance) 0.00001	0.00005	0.0001	0.0004	0.0007	0.001	0.002	0.0035	0.005	0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1.0	2.0	5.0	10.0
600	*	*	*	*	*	*	9.1	5.8	4.4	3.3	2.7	1.7	1.2	0.9	0.7	0.6	0.4	0.2	0.2	0.2	0.1	0.1	**
700	*	*	*	*	*	*	*	6.5	5.0	3.7	3.0	1.8	1.3	1.0	0.8	0.7	0.4	0.3	0.2	0.2	0.1	0.1	0.1
800	*	*	*	*	*	*	*	7.3	5.5	4.1	3.3	2.0	1.4	1.1	0.9	0.7	0.4	0.3	0.2	0.2	0.1	0.1	0.1
900	*	*	*	*	*	*	*	8.0	6.0	4.4	3.6	2.2	1.5	1.2	0.9	0.8	0.4	0.3	0.2	0.2	0.1	0.1	0.1
1000	*	*	*	*	*	*	*	8.7	6.5	4.8	3.9	2.4	1.6	1.3	1.0	0.8	0.5	0.3	0.3	0.2	0.1	0.1	0.1
1250	*	*	*	*	*	*	*	*	7.8	5.7	4.6	2.8	1.9	1.5	1.1	0.9	0.5	0.4	0.3	0.2	0.2	0.1	0.1
1500	*	*	*	*	*	*	*	*	9.1	6.5	5.2	3.1	2.1	1.7	1.3	1.1	0.6	0.4	0.3	0.3	0.2	0.1	0.1
1750	*	*	*	*	*	*	*	*	*	7.4	5.9	3.5	2.4	1.8	1.4	1.2	0.7	0.4	0.3	0.3	0.2	0.1	0.1
2000	*	*	*	*	*	*	*	*	*	8.2	6.5	3.9	2.6	2.0	1.5	1.3	0.7	0.5	0.4	0.3	0.2	0.1	0.1
2500	*	*	*	*	*	*	*	*	*	9.9	7.8	4.6	3.0	2.4	1.8	1.5	0.8	0.5	0.4	0.4	0.2	0.1	0.1
3000	*	*	*	*	*	*	*	*	*	*	9.1	5.2	3.5	2.7	2.0	1.7	0.9	0.6	0.5	0.4	0.3	0.2	0.1
3500	*	*	*	*	*	*	*	*	*	*	*	5.9	3.9	3.0	2.2	1.8	1.0	0.7	0.5	0.4	0.3	0.2	0.1
4000	*	*	*	*	*	*	*	*	*	*	*	6.5	4.3	3.3	2.5	2.0	1.1	0.7	0.6	0.5	0.3	0.2	0.1
4500	*	*	*	*	*	*	*	*	*	*	*	7.2	4.7	3.6	2.7	2.2	1.2	0.8	0.6	0.5	0.3	0.2	0.1
5000	*	*	*	*	*	*	*	*	*	*	*	7.8	5.1	3.9	2.9	2.4	1.3	0.8	0.6	0.5	0.4	0.2	0.1
6000	*	*	*	*	*	*	*	*	*	*	*	9.1	5.8	4.4	3.3	2.7	1.4	0.9	0.7	0.6	0.4	0.2	0.2
7000	*	*	*	*	*	*	*	*	*	*	*	*	6.5	5.0	3.7	3.0	1.6	1.0	0.8	0.7	0.4	0.3	0.2
8000	*	*	*	*	*	*	*	*	*	*	*	*	7.3	5.5	4.1	3.3	1.7	1.1	0.9	0.7	0.5	0.3	0.2
9000	*	*	*	*	*	*	*	*	*	*	*	*	8.0	6.0	4.4	3.6	1.9	1.2	0.9	0.8	0.5	0.3	0.2
10000	*	*	*	*	*	*	*	*	*	*	*	*	8.7	6.5	4.8	3.9	2.0	1.3	1.0	0.8	0.5	0.3	0.2

FOR LOWER QUANTITIES OF RELEASE, SEE PREVIOUS PAGE.

Multiply miles by 1.6 to get kilometers (km).

To find distance: Find nearest LOC across top. Use the lower LOC value for in-between numbers. This is a conservative approach.
Find nearest QR on left column.
Read across and down to find distance in miles.

Notes: * - No distance estimated because method is not valid for distances greater than 10 miles.
** - No distance estimated because method is not valid for distances less than 0.1 mile.

Exhibit 3-4
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

Urban, D Atmospheric Stability, 11.9 Miles Per Hour Wind Speed, Distances are Given in Miles

For Quantities of Release up to 10,000 pounds/minute

Levels of Concern (grams per cubic meter)

(For LOC less than this, assume 10 mile distance)

QR e of ease min)	0.00001	0.00005	0.0001	0.0004	0.0007	0.001	0.002	0.0035	0.005	0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1.0	2.0	5.0	10.0
1	1.2	0.5	0.3	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
2	1.9	0.7	0.5	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**	**	**	**
3	2.5	0.9	0.6	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**	**	**
4	3.1	1.0	0.7	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**	**
5	3.7	1.2	0.8	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**	**
8	5.3	1.6	1.0	0.5	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**
10	6.4	1.9	1.2	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**	**
15	9.2	2.5	1.5	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**	**
20	*	3.1	1.9	0.8	0.6	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**	**
25	*	3.7	2.2	0.9	0.6	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**
30	*	4.2	2.5	1.0	0.7	0.6	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**	**
35	*	4.8	2.8	1.1	0.8	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
40	*	5.3	3.1	1.2	0.8	0.7	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
45	*	5.9	3.4	1.3	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
50	*	6.4	3.7	1.4	1.0	0.8	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
60	*	7.5	4.2	1.5	1.1	0.9	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
70	*	8.6	4.8	1.7	1.2	0.9	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**	**
80	*	9.7	5.3	1.9	1.3	1.0	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**
90	*	*	5.9	2.0	1.4	1.1	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	**	**	**	**	**	**
100	*	*	6.4	2.2	1.5	1.2	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**
120	*	*	7.5	2.5	1.7	1.3	0.9	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**	**
140	*	*	8.6	2.8	1.9	1.5	0.9	0.7	0.5	0.4	0.4	0.3	0.2	0.2	0.1	0.1	0.1	**	**	**	**	**	**
160	*	*	9.7	3.1	2.1	1.6	1.0	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**
180	*	*	*	3.4	2.2	1.7	1.1	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**	**
200	*	*	*	3.7	2.4	1.9	1.2	0.8	0.7	0.5	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**	**	**	**	**
250	*	*	*	4.4	2.8	2.2	1.4	1.0	0.8	0.6	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**	**
300	*	*	*	5.0	3.2	2.5	1.5	1.1	0.9	0.7	0.6	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	**	**	**	**
350	*	*	*	5.7	3.7	2.8	1.7	1.2	0.9	0.7	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
400	*	*	*	6.4	4.1	3.1	1.9	1.3	1.0	0.8	0.7	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
450	*	*	*	7.1	4.5	3.4	2.0	1.4	1.1	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**
500	*	*	*	7.8	4.9	3.7	2.2	1.5	1.2	0.9	0.8	0.5	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	**	**	**

SEE NEXT PAGE FOR HIGHER QUANTITIES OF RELEASE (QR)

Multiply miles by 1.6 to get kilometers (km).

To find distance: Find nearest LOC across top. Use the lower LOC value for in-between numbers. This is a conservative approach.
Find nearest QR on left column.
Read across and down to find distance in miles.

Notes: * - No distance estimated because method is not valid for distances greater than 10 miles.
** - No distance estimated because method is not valid for distances less than 0.1 mile.

Exhibit 3-4 (continued)
VULNERABLE ZONE DISTANCES FOR RATES OF RELEASE AND LEVEL OF CONCERN

Urban, D Atmospheric Stability, 11.9 Miles Per Hour Wind Speed, Distances are Given in Miles

For Quantities of Release up to 10,000 pounds/minute

R tity eased in)	Levels of Concern (grams per cubic meter) (For LOC less than this, assume 10 mile distance) 0.00001	0.00005	0.0001	0.0004	0.0007	0.001	0.002	0.0035	0.005	0.0075	0.01	0.02	0.035	0.05	0.075	0.1	0.25	0.5	0.75	1.0	2.0	5.0	10.0
600	*	*	*	9.2	5.6	4.2	2.5	1.7	1.3	1.0	0.9	0.6	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**	**
700	*	*	*	*	6.4	4.8	2.8	1.9	1.5	1.1	0.9	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**
800	*	*	*	*	7.2	5.3	3.1	2.1	1.6	1.2	1.0	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**
900	*	*	*	*	8.0	5.9	3.4	2.2	1.7	1.3	1.1	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	**	**
1000	*	*	*	*	8.8	6.4	3.7	2.4	1.9	1.4	1.2	0.8	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**
1250	*	*	*	*	*	7.8	4.4	2.8	2.2	1.7	1.4	0.9	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**	**
1500	*	*	*	*	*	9.2	5.0	3.2	2.5	1.9	1.5	1.0	0.7	0.6	0.5	0.4	0.2	0.2	0.1	0.1	0.1	**	**
1750	*	*	*	*	*	*	5.7	3.7	2.8	2.1	1.7	1.1	0.8	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	**
2000	*	*	*	*	*	*	6.4	4.1	3.1	2.3	1.9	1.2	0.8	0.7	0.5	0.5	0.3	0.2	0.2	0.1	0.1	0.1	**
2500	*	*	*	*	*	*	7.8	4.9	3.7	2.7	2.2	1.4	1.0	0.8	0.6	0.5	0.3	0.2	0.2	0.1	0.1	0.1	**
3000	*	*	*	*	*	*	9.2	5.6	4.2	3.1	2.5	1.5	1.1	0.9	0.7	0.6	0.3	0.2	0.2	0.2	0.1	0.1	**
3500	*	*	*	*	*	*	*	6.4	4.8	3.5	2.8	1.7	1.2	0.9	0.7	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1
4000	*	*	*	*	*	*	*	7.2	5.3	3.8	3.1	1.9	1.3	1.0	0.8	0.7	0.4	0.3	0.2	0.2	0.1	0.1	0.1
4500	*	*	*	*	*	*	*	8.0	5.9	4.2	3.4	2.0	1.4	1.1	0.9	0.7	0.4	0.3	0.2	0.2	0.1	0.1	0.1
5000	*	*	*	*	*	*	*	8.8	6.4	4.6	3.7	2.2	1.5	1.2	0.9	0.8	0.5	0.3	0.2	0.2	0.1	0.1	0.1
6000	*	*	*	*	*	*	*	*	7.5	5.3	4.2	2.5	1.7	1.3	1.0	0.9	0.5	0.3	0.3	0.2	0.2	0.1	0.1
7000	*	*	*	*	*	*	*	*	8.6	6.1	4.8	2.8	1.9	1.5	1.1	0.9	0.5	0.4	0.3	0.3	0.2	0.1	0.1
8000	*	*	*	*	*	*	*	*	9.7	6.8	5.3	3.1	2.1	1.6	1.2	1.0	0.6	0.4	0.3	0.3	0.2	0.1	0.1
9000	*	*	*	*	*	*	*	*	*	7.5	5.9	3.4	2.2	1.7	1.3	1.1	0.6	0.4	0.3	0.3	0.2	0.1	0.1
10000	*	*	*	*	*	*	*	*	*	8.2	6.4	3.7	2.4	1.9	1.4	1.2	0.7	0.5	0.4	0.3	0.2	0.1	0.1

FOR LOWER QUANTITIES OF RELEASE, SEE PREVIOUS PAGE.

Multiply miles by 1.6 to get kilometers (km).

To find distance: Find nearest LOC across top. Use the lower LOC value for in-between numbers. This is a conservative approach.
Find nearest QR on left column.
Read across and down to find distance in miles.

Notes: * - No distance estimated because method is not valid for distances greater than 10 miles.
** - No distance estimated because method is not valid for distances less than 0.1 mile

4. Using the Results of a Hazards Analysis

As noted in Chapter 1, hazards analysis is a necessary first step in developing a comprehensive emergency plan; it is a decision-making process that helps planners screen and decide which facilities to plan for. After local planners have completed a hazards identification, vulnerability analysis, and risk analysis, they should develop appropriate response procedures and organize all this material into an emergency response plan. This information can also be used for the development of site-specific release scenarios for training exercises and for refining response plans. This chapter summarizes the plan contents required by Title Ill of the Superfund Amendments and Reauthorization Act (SARA), lists the information provided by by a hazards analysis, briefly discusses three case studies for planning purposes, and describes how computers can be helpful to the planning process. Planners should use the National Response Team's Hazardous Materials Energency Planning Guide (NRT-1) guidance document and the information generated by using this guidance to develop emergency plans for their district.

4.1 What the Plan Must Contain

Title Ill of SARA requires each emergency plan to include at least each of the following:

(1) Identification of facilities within the local emergency planning district (LEPD) subject to the Title Ill requirements: identification of routes likely to be used for the transportation of substances on the list of extremely hazardous substances (EHSs) ; and identification of additional facilities contributing or subjected to additional risk due to their proximity to facilities subject to Title Ill of SARA, such as hospitals or natural gas facilities.

(2) Methods and procedures to be followed by facility owners and operators and local emergency and medical personnel to respond to any releases of EHSs.

(3) Designation of a community emergency coordinator and facility emergency coordinators, who shall make determinations necessary to implement the plan.

(4) Procedures providing reliable, effective, and timely notification by the emergency coordinators and the community emergency coordinator to persons designated in the emergency plan, and to the public, that a release has occurred.

(5) Methods for determining the occurrence of a release, and the area or population likely to be affected by such release.

(6) A description of facilities in the community subject to Title Ill requirements and emergency equipment at each facility in the community.

(7) Evacuation plans, including provisions for a precautionary evacuation and alternative traffic routes.

(8) Training programs, including schedules for training of local emergency response and medical personnel.

(9) Methods and schedules for exercising the emergency plan.

The information gathered in the hazards analysis will be useful in fulfilling several of these requirements, in particular (l), (4), (5) and (6). NRT-1 (page 38, Planning Element G) discusses the integration of the hazards analysis into emergency planning, and should be used as a complement to this guide. NRT-1 discusses approaches to the planning process, whether a community chooses to develop a multi-hazard emergency operations plan (EOP) or incorporate hazardous materials planning into an existing EOP, or to develop or revise a single-hazard hazardous materials plan. Sample formats for emergency plans are outlined and planning elements are discussed in detail.

4.2 Planning Information Provided by the Hazards Analysis

As a result of the hazards analysis, the following types of information concerning EHSs should be available during the initial stages of the planning process :

- Location

(1) What facilities have EHSs

(2) What transportation routes have EHSs

- Quantity

(1) The maximum quantity likely to be released at a facility

(2) The maximum quantity likely to be transported at one time per transportation vehicle

- Potential risks

(1) Likelihood of release

(2) Consequences of release

- Other hazards to consider

(1) Whether the material is flammable

(2) Whether water can be used on it

(3) Reactivity with other materials present to form other hazardous substances and/or to release heat

(4) Likelihood of damage to property

(5) Likelihood of damage to the environment

- Emergency response information

(1) Size of the vulnerable zone in case of a release

(2) How many people are likely to be within the vulnerable zones

(3) Sensitive populations within the vulnerable zones

(4) Essential service facilities within the vulnerable zones

(5) What emergency medical procedures should be followed

(6) What specialized equipment emergency medical response personnel or local hospitals need to treat victims of exposure and whether they have such equipment

(7) Type of protective gear (clothing and equipment) needed by emergency response personnel

- Is it available at the facility?

- Is it available to emergency responders?

(8) What sampling and monitoring devices can be used to determine concentration levels

- Are such devices available?

(9) Containment/cleanup procedures

(10) What materials are needed for containment, neutralization, and cleanup

- Are these materials available?

4.3 Case Studies from Hazards Analysis

To illustrate the planning process, and the use of hazards analysis in this process, the same hypothetical releases of chlorine, ammonia, and methyl isocyanate as described in Chapter 2 (Exhibit 2-12) and Chapter 3 are used as examples. Exhibit 4-1 presents relevant data on the three example chemicals and considerations that the planning committee needs to address. This information can be used in the planning process to ensure that all needs can be accommodated should an emergency arise.

In each of the case studies, a release of a hazardous substance is possible and both the responsible party and local government must be prepared to handle the resulting hazards and associated problems. In order to respond in an effective and safe manner, local emergency responders (and private sector managers in the cases of fixed facilities such as the water treatment plant and the pesticide manufacturing plant portrayed in these case studies) must work together to create a comprehensive hazardous materials emergency plan. In order to be effective, the plan must be tested and updated at least annually and more often as needed if conditions change after establishment of the plan.

In each of the case studies, planners must first consider the safety of people within the estimated vulnerable zones. Not only must planners address evacuation but also in-place sheltering, as vapor clouds may move into populated areas too quickly to allow for a safe evacuation. Adequate warning systems must be in place to notify the public of a release. Persons who will require protection from hazardous releases include: a) people located in 'the immediate area of the release (plant employees in the case studies involving chlorine and methyl isocyanate, and motorists in the case of an anhydrous ammonia tank truck accident), b) people in areas threatened by hazards resulting from the released materials, and c) emergency responders. (Appendix H presents a detailed discussion on evacuation and in-place sheltering, including decision-making, planning, conducting an evacuation, sheltering of evacuees, and re-entry.)

A second planning consideration is hazard control and containment operations. Procedures for controlling and containing a hazardous release must be established and identified within the plan and exercised regularly. In each of the case studies, the hazardous material has multiple hazards associated with it. (Chlorine is poisonous, corrosive, and can act as an oxidizer; anhydrous ammonia is corrosive and can be fatal if inhaled: and methyl isocyanate is poisonous and extremely flammable.) Multiple hazards require special expertise in control and containment procedures. Regarding incidents where local government and private industry are both involved in remedial actions (such as the cases of the water treatment plant and the pesticide plant), planners must set forth provisions for cooperation between the two groups to ensure that response actions are coordinated and that direction and control are centralized.

Another key planning consideration is that of emergency medical care. Provisions must be made for on-scene emergency medical care (establishment of a triage area may be necessary) , transport of victims to hospitals, and emergency room treatment. In order for this emergency care system to function properly, the hazardous materials plan should establish procedures coordinating the activities of the local emergency medical services (e.g., fire/rescue department, rescue squad, ambulance service) and local hospital(s) to ensure that victims are treated quickly and effectively.

Specialized medical supplies to treat exposures to certain chemicals should be identified during the planning process so that adequate and current supplies will be available.

Planners must address several other areas of community response as well. These include incident command; communications: search and rescue: detection, monitoring, sampling and analysis: damage assessment: cleanup: decontamination: and cost recovery. The hazardous

Exhibit 4-1

EXAMPLE HAZARDS MATRIX FOR PLANNING COMMUNITY

REEVALUATED RESULTS OF HAZARDS ANALYSIS

	Hazard A	*Hazard B*	*Hazard C*
1. RESULTS OF HAZARDS IDENTIFICATION			
a. Chemical	Chlorine	Ammonia	Liquid methyl isocyanate (MIC)
b. Location	Water treatment plant	Tank truck on local interstate highway	Pesticide manufacturing plant in semi-rural area
c. Quantity	500 lbs.	3000 lbs.	1000 lbs.
d. Properties	Health Effects: May be fatal if inhaled. Contact may cause burns to skin and eyes. Respiratory conditions may be aggravated.	Health Effects: May be fatal if inhaled. Contact may cause burns and blistering to skin and eyes. Vapors are irritating to eyes and respiratory tract.	Health Effects: May be fatal if inhaled. Skin irritant. Can cause permanent eye damage. Attacks the respiratory system and can injure lungs and bronchial airways.
	Other Hazards: Corrosive to metal (may damage structures, equipment, and vehicles). Oxidizing agent. May affect water supply (treatment plant is primary supplier). Vapors will hang close to ground level.	Other Hazards: Corrosive. Will burn under certain conditions. Vapors will initially hug the ground before rising.	Other Hazards: Extremely flammable. Odorless (in low concentrations) and colorless. Reacts violently with water. Vapors will hang close to ground level.
2. RESULTS OF VULNERABILITY ANALYSIS			
a. Vulnerable zone*	A spill of 500 lbs. of chlorine from a storage tank could result in an area of radius 1.0 miles where chlorine gas may exceed the level of concern (LOC). This is for an urban area.	A spill of 3000 lbs. of ammonia resulting from a collision of a tank truck could result in an area of radius 7.6 miles where ammonia exceeds its LOC. This is for a rural area.	A spill of 1500 lbs. of methyl isocyanate could affect an area of radius greater than 10 miles with MIC vapors exceeding the LOC. This is for a rural area assuming the liquid is hot, not diked, and at 100% concentration.
b. Population within Vulnerable zone	Total population within vulnerable zone is approximately 1250.	A total of 13,600 people in the vulnerable zone including up to 700 persons in commercial establishments or vehicles near highway interchange and seasonal influx of visitors to forest preserve in the fall.	A total of 26,700 people in the vulnerable zone including 200 workers at the plant and 1000 children in school.
c. Essential services Within zone	None	1 volunteer fire station	1 fire station and 1 police station

*The distances here may not correspond with those in NRT-1 as the assumptions used in the calculation are different.

Exhibit 4-1 (Continued)

	Hazard A	**Hazard B**	**Hazard C**
3. RESULTS OF RISK ANALYSIS			
a. Likelihood of hazard occurrence	Low-because chlorine is stored in an area with leak detection equipment in 24 hour service with alarms. Protective equipment is kept outside storage room.	High-highway interchange has a history of accidents due to poor visibility of exits and entrances.	Low-facility has up to date containment facilities with leak detection equipment and an emergency plan for its employees. There are good security arrangements that would deter tampering or accidents resulting from civil uprisings.
b. Consequences if people are exposed	High levels of chlorine gas in the nursing home and factory could cause death and respiratory distress. Bedridden nursing home patients are especially susceptible. High severity of consequences. However, gas is unlikely to reach a nursing home under reevaluated release conditions.	Motorists' reactions to release vapors may cause traffic accidents. Injured and trapped motorists are subject to lethal vapors and possible incineration. Windblown vapors can cause respiratory distress for nearby residents and business patrons. High severity of consequences.	If accident occurs while school is in session, children could be killed, blinded and/or suffer chronic debilitating respiratory problems. Plant workers would be subject to similar effects at any time. High severity in school hours, medium severity at all other times.
c. Consequences for property	Possible superficial damage to facility equipment and structures from corrosive fumes (repairable).	Repairable damage to highway. Potential destruction of nearby vehicles due to fire or explosions.	Vapors may explode in a confined space causing property damage (repairable). Damage could result from fires (repairable).
d. Consequences of environmental exposure	Possible destruction of surrounding fauna and flora.	Potential for fire damage to adjacent forest preserve due to combustible material (recoverable in the long term).	Farm animals and other fauna could be killed or develop health effects necessitating their destruction or indirectly causing death.
e. Summary: likelihood/severity of consequences	Low/High. The community would assess this on site and incident specific basis.	High/High. The community would assess this on site and incident specific basis.	Low/High to medium. The community would assess this on site and incident specific basis.

EXAMPLES OF EMERGENCY PLANNING INFORMATION RESULTING FROM HAZARDS ANALYSIS

	Hazard A	*Hazard B*	*Hazard C*
Protective Equipment Needed	• Chemical-resistant clothing with full body coverage • Positive pressure, self-contained breathing apparatus	• Chemical-resistant clothing with full body coverage • Positive pressure self-contained breathing apparatus	• Chemical-resistant clothing with full body coverage • Thermal protection (in case of fire) • Positive pressure self-contained breathing apparatus
Other Equipment Needed	• Equipment to repair leaks ("Chlorine B kit") • Sampling and monitoring devices: ° Gas tube samplers and/or photoionization detectors for air ° Colorimetric kits for water • Neutralizing materials: ° Fly ash ° Cement powder ° Activated carbon ° Soda ash ° Caustic soda	• Equipment to repair leaks if possible (plugging and/or patching devices) • Sampling and monitoring devices: ° Gas tube samplers ° Photoionization detectors • Neutralizing materials: ° Fly ash ° Cement powder • Vinegar and other dilute acids	• Equipment to repair leaks if possible (plugging and/or patching devices) • Sampling and monitoring devices • Alcohol foam and dry chemical agent in case of fire • Equipment for building dikes for containment: ° Heavy equipment
Cleanup of Residual Contamination	• Equipment for containing runoff (if water spray is used to knock down vapors): ° Heavy equipment (bulldozers, backhoes, dump trucks) ° Soil, sandbags, foamed polyurethane, or foamed concrete for dikes • Heavy equipment for removal of contaminated soil, pavement, containment material	• Equipment for containing runoff (if water spray is used to knock down vapors): ° Heavy equipment (bulldozers, backhoes, dump trucks) ° Soil, sandbags, foamed polyurethane, or foamed concrete for dikes	• Heavy equipment for removal of contaminated soil and pavement

SUMMARY: Information resulting from hazards analysis may identify other needs associated with warning systems; public notification; health and medical services; law enforcement; public works; and procedures for exercising the plan (see NRT-1, Chapters 4 and 5).

materials plan must address each of these areas of community response by delegating specific responsibilities to appropriate agencies of the local government. The plan also should include assistance available from regional, State, and Federal agencies as well as private industry and volunteer organizations.

In addition to addressing emergency procedures, the hazardous materials plan must also address what equipment is needed to contain and control hazardous materials spills and fires. The plan must identify the equipment, its location, how to get it to the incident scene, and how to use it safely and effectively. The most important specialized equipment that will be needed is protective gear for the emergency responders. This includes fully encapsulated chemical protective suits, thermal protection, and positive pressure self-contained breathing apparatus. In terms of equipment needed to stop a leak, specialized plugging and/or patching devices are likely to be needed, unless the opening in the damaged tank is too large to seal off. In order to keep track of hazardous material concentration levels, specialized monitoring devices will be needed. Monitoring is extremely important in the case of methyl isocyanate due to its vapors being odorless (but still highly dangerous) in low concentrations. Specialized cleanup and neutralizing materials (e.g., soda ash, caustic soda, activated carbon, diatomaceous earth) likely will be needed as well. Containment equipment also must be available at the accident scene. Materials (e.g., soil, sand) and heavy equipment (e.g., bulldozers, back hoes, dump trucks) likely will be used to construct dikes to contain spilled material or contaminated runoff from vapor knockdown and fire suppression operations. The heavy equipment also will be needed following the incident to remove contaminated soils and pavement. Lack of information concerning these specialized resources could make response efforts for a hazardous materials release unnecessarily difficult.

4.4 Plan Reviews in the Context of Local Resource Needs

Title Ill requires each planning committee “to evaluate the resources necessary to develop, implement and exercise the emergency plan” and to “make recommendations with respect to additional resources that may be required and the means for providing such additional resources.”

The NRT believes that it would be very useful to have these resource evaluations and recommendations available for the Regional Response Teams (RRTs) at the time of the plan reviews. Many of the suggested plan changes may be rather modest and are not likely to require the expenditure of significant local emergency planning committee (LEPC) resources. Other changes may be more difficult to accomplish and may require substantially more resources than are available to the LEPC. RRT comments may be more useful if the RRTs can formulate them in a way that takes into consideration the LEPC’s resource base. RRTs may wish to identify those suggestions for improvement that could be made with available resources and those that might require additional resources.

LEPCs may include their resource requirements in a separate section of their plans, provide information in a separate report or present requirements in a formal request for additional resources submitted to the cognizant State emergency response commission (SERC) . Regardless of the method used, RRTs would be interested in information on:

- the personnel resources required by the LEPC in the preparation of the plan, including man-months of effort, and technical expertise provided and the additional resources that the LEPC would like to have available to revise and strengthen this plan:
- the financial resources required to develop the plan and the financial resources that the LEPC would like to have available in the future:
- the personnel and financial resources that would be required to exercise the plan, as proposed by the LEPC in the section on exercises: and

- the means by which the LEPC generated the resources necessary to develop the plan and the means by which the LEPC believes that the necessary additional resources could be secured.

4.5 Use of Computerized Systems in Planning

Computerized systems have many applications that would be useful to the LEPC as it incorporates hazards analysis information into a comprehensive emergency plan. They could be used for:

- Listing the facilities and the major transportation routes that handle or carry hazardous substances through the planning district and for storing and reporting chemical and hazards analysis information. This could facilitate data management associated with hazards identification.
- Modelling the release of chemicals and estimating vulnerable zones (vulnerability analysis). The system's capabilities could be restricted to the simplified methods outlined in Chapters 2 and 3 or could include a more sophisticated analysis. A further level of sophistication which considers meteorological, topographical, and other site-specific release scenario variables could also be developed according to the level of detail the local planning committee considers appropriate.
- Identifying the regulatory requirements of Title III as they relate to chemical emergency preparedness.

In addition, computerized systems could be used to provide emergency management and response information. Appendix K provides an evaluation guide in the form of a checklist for hazardous chemical inventory, planning, and response computerized systems. This checklist was developed to assist local emergency planning groups in evaluating and selecting computer systems and software that will have capabilities relevant to their environmental management and planning needs.

APPENDIX A

ACRONYMS AND GLOSSARY OF TERMS

ACRONYMS

AAR/BOE	Association of American Railroads/Bureau of Explosives
ACGIH	American Conference of Governmental Industrial Hygienists
AIChE	American Institute of Chemical Engineers
AIHA	American Industrial Hygiene Association
ATSDR	Agency for Toxic Substances and Disease Registry
BLEVE	Boiling Liquid Expanding Vapor Explosion
CAER	Community Awareness and Emergency Response (a CMA program)
CAS	Chemical Abstract Service
CEPP	Chemical Emergency Preparedness Program (EPA)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("Superfund")
CHLOREP	Chlorine Emergency Plan (developed by the Chlorine Institute)
CHRIS	Chemical Hazard Response Information System
CMA	Chemical Manufacturers Association
DOD	Department of Defense
DOT	Department of Transportation
EEC	European Economic Community
EEG	Emergency Exposure Guideline (developed by Dow Chemical)
EEGL	Emergency Exposure Guidance Level (developed by the NRC)
EHS	Extremely Hazardous Substance
EOP	Emergency Operation Plan
EPA	Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes, Effects, and Criticality Analysis
FTA	Fault Tree Analysis
HAZOP	Hazard and Operability Study

HMTA	Hazardous Materials Transportation Act
IDLH	Immediately Dangerous to Life or Health
LC50	Median Lethal Concentration
LCLO	Lethal Concentration Low
LD50	Median Lethal Dose
LDLO	Lethal Dose Low
LEPC	Local Emergency Planning Committee
LEPD	Local Emergency Planning District
LFA	Liquid Factor Ambient
LFB	Liquid Factor Boiling
LFM	Liquid Factor Molten
LOC	Level of Concern
MSDS	Material Safety Data Sheet
NAS	National Academy of Sciences
NCP	National Oil and Hazardous Substances Contingency Plan
NFPA	National Fire Protection Association
NRC	National Response Center or National Research Council
NRT	National Response Team
NRT-1	Hazardous Materials Emergency Planning Guide, prepared by the National Response Team
NIOSH	National Institute for Occupational Safety and Health
OPP	Office of Pesticide Programs (EPA)
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response (EPA)
PEL	Permissible Exposure Limit
PMN	Premanufacture Notice
PRA	Probabilistic Risk Assessment
QR	Rate of Release of EHS to Air
QS	Maximum Quantity of Chemical that Could Be Released
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limits
RQ	Reportable Quantity
RSPA	Research and Special Programs Administration (DOT)

RRT	Regional Response Team
RTECS	Registry of Toxic Effects of Chemical Substances
SARA	Superfund Amendments and Reauthorization Act of 1986
SERC	State Emergency Response Commission
SPCC	Spill Prevention Control and Countermeasures (Plan)
SPEGL	Short-term Public Exposure Guidance Level (developed by the NRC)
Title III	Emergency Planning and Community Right-to-Know Act of 1986 (Part of the Superfund Amendments and Reauthorization Act of 1986)
TLVs*	Threshold Limit Value
TWA	Time Weighted Average
TPQ	Threshold Planning Quantity
TSCA	Toxic Substances Control Act
USCG	United States Coast Guard
USGS	United States Geological Survey
VP	Vapor Pressure
VSD	Virtually Safe Dose
Vz	Vulnerable Zone
WB	World Bank

*TLVs is a registered trademark

GLOSSARY OF TERMS

Accident Site
The location of an unexpected occurrence, failure, or loss, either at a facility or along a transportation route, resulting in a release of hazardous materials: an incident site.

Acute
Severe but of short duration. Acute health effects are those that occur immediately after exposure to hazardous chemicals.

Acutely Toxic Chemicals
Chemicals that can cause severe short- and long-term health effects after a single, brief exposure (short duration). These chemicals (when ingested, inhaled, or absorbed through the skin) can cause damage to living tissue, impairment of the central nervous system, severe illness, or, in extreme cases, death.

Airborne Release
Release of any chemical into the air.

Ambient
Surrounding. Ambient temperatures are temperatures of the surrounding area (e.g., air or water).

By-Product
Material, other than the principal product, that is produced or generated as a consequence of an industrial process.

Chemical Process
A particular method of manufacturing or making a chemical, usually involving a number of steps or operations.

Chronic
Of long duration or having frequent recurrence. Chronic health effects are those that become apparent or continue for some time after exposure to hazardous chemicals.

Combustion Product
Material produced or generated during the burning or oxidation of a material,

Command Post
Facility located at a safe distance upwind from an accident site, where the on-scene coordinator, responders, and technical representatives can make response decisions, deploy manpower and equipment, maintain liaison with media, and handle communications.

Community Awareness and Emergency Response (CAER) Program
Program developed by the Chemical Manufacturers Association (CMA), to assist chemical plant managers in taking the initiative in cooperating with local communities to develop integrated (community/industry) plans for responding to releases of hazardous materials.

Contingency Plan
A document to identify and catalog the elements required to respond to an emergency, to define responsibilities and specific tasks, and to serve as a response guide.

Critical Facilities
Facilities essential to emergency response, such as fire stations, police stations, hospitals, and communication centers.

Decomposition Product
Material produced or generated as a result of the physical or chemical degradation of a parent material.

Dike

A barrier such as a low wall or embankment designed to prevent a spill from spreading or flooding.

Disposal

The removal of waste material to a site or facility that is specifically designed and permitted to receive such wastes.

Emergency

A situation created by an accidental release or spill of hazardous chemicals which poses a threat to the safety of workers, residents, the environment, or property.

Evacuation

Removal of residents and other persons from an area of danger.

Exercise

A simulated accident or release set up to test emergency response methods and for use as a training tool.

Extremely Hazardous Substances (EHSs)

A list of chemicals identified by EPA on the basis of toxicity, and listed under Title Ill of SARA. These chemicals are listed in Appendix C. The list is subject to revision.

Facility

Defined for Section 302 of Title Ill of SARA as all buildings, equipment, structures, and other stationary items which are located on a single site or on contiguous or adjacent sites and which are owned or operated by the same person (or by any person which controls, is controlled by, or under common control with, such person). For purposes of emergency release notification, the term includes motor vehicles, rolling stock, and aircraft.

Facility Emergency Coordinator

Facility representative for each facility with an extremely hazardous substance (EHS) in a quantity exceeding its threshold planning quantity (TPQ), who participates in the emergency planning process.

Fenceline

Outermost perimeter of a facility property.

Hazard

Any situation that has the potential for causing damage to life, property, and/or the environment.

Hazardous Chemical

Any chemical which is a physical hazard or a health hazard as defined under OSHA 29 CFR 1910.1201.

Hazardous Material

Any substance or material in a quantity or form which may be harmful to humans, animals, crops, water systems, or other elements of the environment if accidentally released. Hazardous materials include: explosives, gases (compressed, liquefied, or dissolved), flammable and combustible liquids, flammable solids or substances, oxidizing substances, poisonous and infectious substances, radioactive materials, and corrosives.

Hazardous Substances (Superfund)

Substances designated as hazardous under CERCLA (also known as Superfund); CERCLA incorporates substances listed under the Clean Water Act, the Clean Air Act, RCRA, and TSCA Section 7.

Hazards Analysis

The procedure for identifying potential sources of a hazardous materials release, determining the vulnerability of an area to a hazardous materials release, and comparing hazards to determine risks to a community.

Hazards Identification

Provides information on which facilities have extremely hazardous substances (EHSs), what those chemicals are, and how much there is at each facility. Also provides information on how the chemicals are stored and whether they are used at high temperatures, Mandatory facility reporting under Title Ill will provide most of the information needed for a hazards identification,

Immediately Dangerous to Life and Health (IDLH)

The maximum level to which a healthy worker can be exposed for 30 minutes and escape without suffering irreversible health effects or escape-impairing symptoms,

Lethal

Causing or capable of causing death.

Lethal Concentration Low (LCLO)

The lowest concentration of a chemical at which some test animals died following inhalation exposure.

Lethal Dose Low (LDLO)

The lowest dose of chemical at which some test animals died following exposure.

Level of Concern (LOC)

The concentration of an extremely hazardous substance (EHS) in the air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

Local Emergency Planning Committee (LEPC)

A committee appointed by the State emergency response commission (SERC), as required by Title Ill of SARA, to formulate a comprehensive emergency plan for its district.

Material Safety Data Sheet (MSDS)

A compilation of information required under the OSHA Hazard Communication Standard on the identity of hazardous chemicals, health and physical hazards, exposure limits, and precautions. Section 311 of Title Ill of SARA requires facilities to submit MSDSs under certain conditions.

Median Lethal Concentration (LC50)

Concentration level **at** which 50 percent of the test animals died when exposed by inhalation for a specified time period.

Median Lethal Dose (LDSO)

Dose at which 50 percent of test animals died following exposure. Dose is usually given in milligrams per kilogram of body weight of the test animal.

Morbidity

Ability to cause illness or disease.

National Response Center

A communications center for activities related to response actions: it is located at Coast Gaurd headquarters in Washington, DC. The National Response Center receives and relays notices of discharges or releases to the appropriate On-Scene Coordinator, disseminates On-Scene Coordinator and Regional Response Team (RRT) reports to the National Response Team (NRT) when appropriate, and provides facilities for the NRT to use in coordinating a national response action when required. The toll-free number (800-424-8802, or 202-426-2675 or 202-267-2675 in the Washington, DC area) can be reached 24 hours a day for reporting actual or potential pollution incidents.

On-Scene Coordinator
The pre-designated local, State, or Federal official responsible for the coordination of a hazardous materials response action, as outlined in the pertinent Emergency Response Plan.

Plume
Effluent cloud resulting from a continuous source release.

Radius of the Vulnerable Zone
The maximum distance from the point of release of a hazardous substance at which the airborne concentration could reach the level of concern (LOC) under specified weather conditions.

Reportable Quantity (RQ)
The quantity of a hazardous substance that triggers reporting under CERCLA; if a substance is released in a quantity that exceeds its RQ, the release must be reported to the National Response Center (NRC), as well as to the State emergency response commission (SERC) and the community emergency coordinator for areas likely to be affected by the release.

Response
The efforts to minimize the risks created in an emergency by protecting the people, the environment, and property, and the efforts to return the scene to normal pre-emergency conditions.

Risk
A measure of the probability that damage to life, property, and/or the environment will occur if a hazard manifests itself: this measure includes the severity of anticipated consequences to people.

Risk Analysis
Assessment of the probable damage that may be caused to the community by a hazardous substance release.

Special Populations
Groups of people that may be more susceptible than the general population (due to preexisting health conditions (e.g., asthmatics) or age (e.g., infants and the elderly)) to the toxic effects of an accidental release.

Spill Prevention Control and Countermeasures (SPCC) Plan
Plan covering the release of hazardous substances as defined under authority of the Clean Water Act.

Stability Classes, Atmospheric
Pasquill stability classes (ranging from “A” to “F”) are meteorological categories of atmospheric conditions. Pasquill stability class A represents unstable conditions under which there are strong sunlight, clear skies, and high levels of turbulence in the atmosphere, conditions that promote rapid mixing and dispersal of airborne contaminants. At the other extreme, class F represents light, steady winds, fairly clear nighttime skies, and low levels of turbulence. Airborne contaminants mix and disperse far more slowly with air under these conditions, and may travel further downwind at hazardous concentrations than in other cases. Stability class D, midway between A and F, is used for neutral conditions, applicable to heavy overcast, daytime or nighttime.

State Emergency Response Commission (SERC)
Commission appointed by each State governor according to the requirements of Title Ill of SARA: duties of the commission include designating emergency planning districts, appointing local emergency planning committees (LEPCs), supervising and coordinating the activities of planning committees, reviewing emergency plans, receiving chemical release notifications, and establishing procedures for receiving and processing requests from the public for information.

Storage

Methods of keeping raw materials, finished goods, or products while awaiting use, shipment, or consumption.

Threshold Planning Quantity (TPQ)

A quantity designated for each chemical on the list of extremely hazardous substances (EHSs) that triggers notification by facilities of the State emergency response commission (SERC) that such facilities are subject to emergency planning under Title Ill of SARA.

Toxic Chemical Release Form

Information form required to be submitted by facilities that manufacture, process, or use (in quantities above a specified amount) chemicals listed in Section 313 of Title Ill of SARA.

Toxic Cloud

Airborne mass of gases, vapors, fumes, or aerosols of toxic materials.

Toxicity

The ability of a substance to cause damage to living tissue, impairment of the central nervous system, severe illness, or death when ingested, inhaled, or absorbed by the skin.

Toxicology

The study of the adverse effects of chemical agents on biological systems.

Transfer

Loading and unloading of chemicals between transport vehicles and storage vessels, and sending chemicals via pipes between storage vessels and process reactors.

Transport Mode

Method of transportation: highway: rail (trains); water (ships/barges); pipelines: air (planes).

Vapor Dispersion

The movement of vapor clouds or plumes in air due to wind, gravity spreading, and mixing.

Vulnerability Analysis

Assessment of elements in the community that are subject to damage should a hazardous materials release occur; includes gathering information on the extent of the vulnerable zone, conditions that influence the zone, size and type of the population within the zone, private and public property that might be damaged, and the environment that might be affected.

Vulnerable Zone

An area over which the airborne concentration of a chemical involved in an accidental release could reach the level of concern (LOC).

APPENDIX B

THE CRITERIA USED TO IDENTIFY EXTREMELY HAZARDOUS SUBSTANCES

B.1 BASIS FOR THE CRITERIA

Introduction. In an effort to direct community planning efforts to those chemicals that, because of their inherent toxicity, are most likely to cause severe toxic effects in humans who are exposed to them due to an accidental release, EPA has specified toxicity criteria that can be used to screen chemical information sources and to identify acutely toxic chemicals. These criteria were used to identify the chemicals on the list of extremely hazardous substances (EHSs) required by Title Ill. While the criteria focus on animal lethality data, EPA is also concerned about a wide array of human toxic or clinical effects other than death (e.g., lung edema, liver or kidney damage, reproductive and developmental toxicity, neurological disorders, cardiac effects, dermal irritation and corrosion, and ocular damage). Such effects may be considered if suitable data are available when the list of EHSs is revised.

Use of Animal Data. In defining criteria, EPA had to identify the health effects of concern and the data to be used. EPA elected to use animal acute toxicity data derived from controlled experiments to infer potential for acute toxic effects in humans. EPA has assumed that humans and animals (mammals) are similar, on the average, in intrinsic susceptibility to toxic chemicals and that animal data can be used as surrogates for human data. This assumption is one of the basic premises of modern toxicology and is an important component in the regulation of toxic chemicals. An additional benefit of using animal data is that there exists a large data base that is accessible to the public and government agencies such as EPA. Because human populations are diverse (e.g., individuals differ in age, health, and genetic background) and individuals are expected to vary considerably in their sensitivity to chemical substances, EPA assumed that humans are at least as sensitive to each toxic chemical as the most sensitive animal species tested.

Type of Toxicity Data Used. Complete toxicological information on all potential concerns about the consequences of an acute chemical exposure is not available on all chemicals. EPA initially focused on lethality, not only because EPA wishes to avoid accidents resulting in human death, but also because lethality data are the most available and commonly reported information provided from animal toxicity testing. EPA determined that the most appropriate animal test data to use as surrogates for human acute toxicity are those data from animal acute toxicity tests expressed as the median lethal concentration (LC50) when the substance has been administered by inhalation (via the lungs), or the median lethal dose (LD50) when the substance has been administered orally (via the mouth) or dermally (via the skin). These data represent dose levels or concentrations of a chemical that are expected to result in the death of 50 percent of the test animals. Exposure to EHSs released during an accident is expected primarily to involve chemicals that are airborne. Thus, the inhalation route of human exposure is of primary concern during or following an accident. However, it should be borne in mind that humans could be exposed to an EHS by any or all of these routes after its accidental release. In using data on oral and dermal acute lethality, EPA was not specifically concerned with these routes of exposure in humans, but rather with identifying compounds with inherent high potential for acute toxicity.

Use of LDLO and LCLO Data. Even with the amount of animal data that is available, there exist chemicals for which there are no standard acute toxicity test data. In those cases where toxicity testing has not determined an LD50 or LC50 value, EPA selected an alternative measure of acute toxicity: the lowest dose or concentration at which some animals died following exposure (LDLO or LCLO). EPA used LDLO or LCLO values in those instances where there are no median toxicity values available for a chemical. Data from these tests may be more Variable than those provided from median lethality tests, but for the purposes of screening large numbers of chemicals it was deemed necessary to provide a second level screening tool in preference to missing potentially toxic chemicals not adequately tested. However, it is expected that there are chemicals that may be acutely toxic, but for which there are no toxicity test data available in the public literature. It is expected that planners may obtain data that are not available in the open literature from firms manufacturing chemicals. By knowing whether chemical firms and other facilities have any chemicals that are on the list of EHSs or that meet the criteria, planners should be able to identify all potentially acute toxicants used in their community,

B.2 THE CRITERIA

Criteria Values Adopted. EPA adopted the criteria shown in Exhibit B-l to identify EHSs that may present severe health hazards to humans exposed to them during an accident or other emergency. The specific values chosen are consistent with toxicity values judged by the scientific community as indicative of potential for acute toxicity. The values shown in Exhibit B-l are lower than those for highly toxic chemicals in the health hazard definitions mandated by OSHA in its Hazard Communication Standard (FR Vol. 48, No. 248, p. 53346).

A chemical was identified as an EHS if animal test data with a value less than or equal to that stated for the LD50 or LC50 criteria for any one of three exposure routes were found. A chemical without LD50 or LC50 test data was evaluated using the alternate LDLO or LCLO criteria. EPA has prepared a list of chemicals that meet these criteria: these chemicals are included on the list of EHSs under Title Ill of SARA.

EPA **Criteria Compared with European Economic Community/World Bank Criteria.** The screening criteria selected by EPA were consistent with internationally accepted criteria used by both the European Economic Community (EEC) and the World Bank (WB). EPA's criteria recognized precedents set by these two organizations; however, in a conservative effort to avoid missing or excluding any potentially toxic chemicals, EPA modified the basic toxic substances criteria used by these organizations in three ways:

1. Lethality data are not limited to data on rats, but include data on the most sensitive mammalian species tested:
2. Data from tests with inhalation exposure time up to 8 hours is accepted instead of data from 4-hour exposure tests only: and
3. LDLO and LCLO data are used when LD50 or LC50 data are not available.

The criteria were designed to take maximum advantage of the kinds of animal data available for screening and to limit the potential for overlooking chemicals that may be potentially acutely toxic. The criteria should maximize the potential for planners to identify toxic chemicals.

8.3 APPLICATION OF THE CRITERIA

RTECS Data Base. The screening criteria can be applied to any experimental data or data base on chemical substances that includes acute animal toxicity data. EPA applied the criteria to a specific toxicity data repository, Registry of Toxic Effects of Chemical Substances (RTECS), maintained by the National Institute for Occupational Safety and Health (NIOSH). The RTECS data base was used as the source of toxicity data for identifying acutely toxic chemicals because it has the largest computerized set of acute toxicity information available, with information on more than 79,000 chemicals. RTECS is designed to be a single-source document for basic toxicity information and other data. It is widely accepted and used as a toxicity data source, as indicated by the fact that some organizations (e.g., health agencies and chemical companies) include RTECS numbers as a toxicity reference on the lists of chemicals in their files. While RTECS is not formally peer reviewed, the data presented are from scientific literature that has been edited by the scientific community before publication. In addition, the RTECS Editorial Review Board is responsible for reviewing a limited number of citations to remove ambiguities or errors. Them are limitations associated with the use of the RTECS data base, but for the purposes of screening acute

Exhibit B-I

Criteria to Identify Extremely Hazardous Substances that May Present Severe Health Hazards to Humans Exposed During a Chemical Accident or Other Emergency

Route of Exposure [a]	Acute Toxicity Measure [b]	Value
Inhalation	Median Lethal Concentration in Air (LC50)	Less than or equal to 0.5 milligrams per liter of air for exposure time of 8 hours or less
Dermal	Median Lethal Dose (LD50)	Less than or equal to 50 milligrams per kilogram of body weight
Oral	Median Lethal Dose (LD50)	Less than or equal to 25 milligrams per kilogram of body weight

[a] The route by which the test animals absorbed the chemical, i.e., by breathing it in air (inhalation), by absorbing it through the skin (dermal), or by ingestion (oral).

[b] LC50: The concentration of the chemical in air at which 50 percent of the test animals died. LD50: The dose that killed 50 percent of the test animals. In the absence of LC50 or LD50 data, LCLO or LDLO data should be used. LCLO: Lethal Concentration Low, the lowest concentration in air at which any test animals died. LDLO: Lethal Dose Low, the lowest dose at which any test animals died.

toxicity data, RTECS provides a large and easily searchable data file. It is important to emphasize that the purpose of the criteria was to provide a screening tool for the initial identification of chemicals that may be acutely toxic to humans. Additional information on the toxicity of specific chemicals may be available from the facility emergency coordinator.

TSCA Inventory, Active Pesticide Ingredients, and PMN Chemicals. EPA selected only those chemical substances in current production by referring to the 1977 Toxic Substances Control Act (TSCA) Inventory and the current EPA list of active pesticide ingredients. The TSCA Inventory is a list of chemical substances in production at the time the Inventory was compiled. Chemical substances entering commerce since 1977 through the Premanufacturing Notice (PMN) review process under Section 5 of TSCA were screened for acute toxicity data and compared to the criteria for possible inclusion on the list.

Radioactive materials, chemical substances in research and development stages, and those manufactured, processed, or distributed in commerce for use as food, food additives, drugs, or cosmetics are not listed in the TSCA Inventory and, hence, were not considered. If research chemicals that meet the criteria are produced for commercial use under TSCA or for pesticide use under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA will identify such chemicals through its PMN review program and pesticide registration program and list them under future rulemakings.

8.4 OTHER EXTREMELY HAZARDOUS SUBSTANCES

Chemicals that do not meet the criteria for acute toxicity discussed in the previous section are not necessarily safe. In fact, some are toxic to humans and may pose threats to the community if accidents occur. EPA identified and included on the list of EHSs some of these chemicals using criteria based on the following factors: large volume production, acute lethality values, and known risk, as indicated by the fact that some of the chemicals have caused death and injury in accidents.

Candidates for listing were identified from the high-production capacity chemicals listed in the SRI International publication, 1985 Directory of Chemical Producers, United States of America, pp. 388-389, or from the World Bank List Group B: Other Toxic Substances. The toxicity criteria shown in Exhibit B-2 were used to aid in deciding which chemicals to list. In addition to high-production chemicals meeting these criteria, several other slightly less toxic chemicals were listed because of their known hazards: for example, several of them have caused death or injury in accidents. Exhibit B-3 lists these other chemicals included on the list of EHSs.

Exhibit B-2

Criteria to Identify Other Hazardous Substances Produced in Large Quantities that May Present Severe Health Hazards to Humans Exposed During a Chemical Accident or Other Emergency

Route of Exposure [a]	Acute Toxicity Measure [b]	Value
Inhalation	Median Lethal Concentration in Air (LC50)	Less than or equal to 2 milli-grams per liter of air for exposure time of 8 hours or less
Dermal	Median Lethal Dose (LD50)	Less than or equal to 400 milligrams per kilogram of body weight
Oral	Median Lethal Dose (LD50)	Less than or equal to 200 milligrams per kilogram of body weight

[a]The route by which the test animals absorbed the chemical, i.e., by breathing it in air (inhalation), by absorbing it through the skin (dermal), or by ingestion (oral).

[b] LC50: The concentration of the chemical in air at which 50 percent of the test animals died. LD50: The dose that killed 50 percent of the test animals. In the absence of LEO or LD50 data, LCLO or LDLO data should be used. LCLO: Lethal Concentration Low, the lowest concentration in air at which any test animals died. LDLO: Lethal Dose Low, the lowest dose at which any test animals died.

Exhibit B-3

Other Extremely Hazardous Substances

Chemicals on the following list were judged to be extremely hazardous substances (EHSs) on the basis of high production capacity and the criteria summarized in Exhibit B-2 or known hazards (see Section 8.4).

Name	CAS Number
Acrylamide	79-06-1
Acrylonitrile	107-13-1
Adiponitrile	111-69-3
Ammonia	7664-41-7
Aniline	62-53-3
Bromine	7726-95-6
Carbon disulfide	75-15-0
Chloroform	67-66-3
Cyclohexylamine	108-91-8
Epichlorohydrin	106-89-8
Ethylene oxide	75-21-8
Formaldehyde	50-00-0
Hydrogen chloride (gas only)	7647-01-0
* Hydrogen peroxide	7722-84-1
Hydrogen sulfide	7783-06-4
Hydroquinone	123-31-9
Methyl bromide	74-83-9
Nitrobenzene	98-95-3
Phosgene	75-44-5
Propylene oxide	75-56-9
Sulfur dioxide	7446-09-5
Tetramethyl lead	75-74-1
Vinyl acetate monomer	108-05-4

* *Concentration greater than 52 percent.*

APPENDIX C

THE LIST OF EXTREMELY HAZARDOUS SUBSTANCES

EPA identified chemicals that meet the criteria for extremely hazardous substances (EHSs) discussed in Section B.2. In addition, other chemicals were identified as EHSs as described in Section B.4. The chemicals are listed by their common names and also by their Chemical Abstract Service (CAS) numbers. While a chemical may be known by several different names, the CAS number provides a unique and unambiguous identification. The list of EHSs is presented in the following forms:

- Exhibit C-1 : List of common names, in alphabetical order, with CAS number, ambient physical state, molecular weight, boiling point, vapor pressure, level of concern (LOC), and liquid factors,
- Exhibit C-2: Same list as that in Exhibit C-1, in CAS number order.

Note that the value for the LOC given in these Exhibits is one tenth the Immediately Dangerous to Life and Health (IDLH) level or an estimation of that level for chemicals which do not have a specific IDLH assigned to them. Refer to Appendix D for a more detailed discussion of the LOC and other values that planners may wish to use.

Exhibit C-1
List of Extremely Hazardous Substances and Data for Hazards Analysis
(Alphabetical Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
75-86-5	Acetone Cyanohydrin	Liquid	85	200	0.50	0.012	0.00002	0.02	
1752-30-3	Acetone Thiosemicarbazide	Solid	131		0.00001	0.1			
107-02-8	Acrolein	Liquid	56	52.5	220.0	0.0011	0.007	0.02	
79-06-1	Acrylamide	Solid	71	250	0.007	0.11			0.00004
107-13-1	Acrylonitrile	Liquid	54	77.3	115.0	0.11	0.004	0.02	
814-68-6	Acrylyl Chloride	Liquid	91	75	300.0	0.0009	0.01	0.03	
111-69-3	Adiponitrile	Liquid	108	295	0.001	0.017	0.00000005	0.02	
116-06-3	Aldicarb	Solid	190	287	0.50	0.0003			0.00004
309-00-2	Aldrin	Solid	365	145	0.000006	0.01			0.02
107-18-6	Allyl Alcohol	Liquid	58	97	23.8	0.036	0.0008	0.02	
107-11-9	Allylamine	Liquid	57	55	500.0	0.0032	0.02	0.02	
20859-73-8	Aluminum Phosphide	Solid	58	320	0.00001	0.02			
54-62-6	Aminopterin	Solid	440		0.00001	0.025			
78-53-5	Amiton	Liquid	269	330	0.000001	0.0033	0.00000000009	0.03	
3734-97-2	Amiton Oxalate	Solid	359		0.00001	0.003			
7664-41-7	Ammonia	Gas	17	-33.4		0.035			
*16919-58-7	Ammonium Chloroplatinate	Solid	444		0.00001	0.00044			
300-62-9	Amphetamine	Liquid	135	200	0.90	0.02	0.00005	0.03	
62-53-3	Aniline	Liquid	93	184	0.67	0.038	0.00003	0.02	
88-05-1	Aniline, 2,4,6-Trimethyl-	Liquid	135	232	0.10	0.0029	0.000006	0.03	
7783-70-2	Antimony Pentafluoride	Liquid	217	141	7.0	0.0027	0.0006	0.04	
1397-94-0	Antimycin A	Solid	549		0.00001	0.0018			
86-88-4	ANTU	Solid	202	400	0.000001	0.01			0.00009
1303-28-2	Arsenic Pentoxide	Solid	230		0.00001	0.008			
1327-53-3	Arsenous Oxide	Solid	198	465	0.0000001	0.0014			0.001
7784-34-1	Arsenous Trichloride	Liquid	181	130.21	10.0	0.01	0.0007	0.04	
7784-42-1	Arsine	Gas	78	-62		0.0019			
2642-71-9	Azinphos-Ethyl	Solid	345	400	0.0000002	0.0039			0.00000000003
86-50-0	Azinphos-Methyl	Solid	317	400	0.0000001	0.0007			0.000000003
98-87-3	Benzal Chloride	Liquid	161	205	1.0	0.0023	0.00007	0.03	
98-16-8	Benzenamine, 3-(Trifluoromethyl)-	Liquid	161	187.5	1.0	0.0044	0.00007	0.03	
100-14-1	Benzene, 1-(Chloromethyl)-4-Nitro-	Solid	172	230	0.05	0.028			0.00008
98-05-5	Benzenearsonic Acid	Solid	202		0.00001	0.00027			
*98-09-9	Benzenesulfonyl Chloride	Liquid	177	251	0.03	0.2	0.000002	0.03	
3615-21-2	Benzimidazole, 4,5-Dichloro-2-(Trifluoromethyl)-	Solid	255			0.013			
98-07-7	Benzotrichloride	Liquid	195	220.8	1.0	0.0007	0.00007	0.03	
100-44-7	Benzyl Chloride	Liquid	127	179	1.0	0.0052	0.00006	0.03	
140-29-4	Benzyl Cyanide	Liquid	117	233.5	1.0	0.0043	0.00005	0.02	
15271-41-7	Bicyclo[2.2.1]Heptane-2-Carbonitrile, 5-Chloro-6-((((Methylamino)Carbonyl) Oxy)Imino)-, (1S-(1-alpha,2-beta, 4-alpha,5-alpha,6E))-	Solid	242		0.00001	0.019			
534-07-6	Bis(Chloromethyl) Ketone	Solid	127	173	1.0	0.00027			0.0002
4044-65-9	Bitoscanate	Solid	192	290	0.0001	0.02			0.0002
10294-34-5	Boron Trichloride	Gas	117	13		0.01			
7637-07-2	Boron Trifluoride	Gas	68	-127		0.028			
353-42-4	Boron Trifluoride Compound with Methyl Ether (1:1)	Liquid	114	126	20.0	0.023	0.001	0.03	
28772-56-7	Bromadiolone	Solid	527		0.00001	0.001			
7726-95-6	Bromine	Liquid	160	60	172.0	0.0065	0.01	0.04	
*106-99-0	Butadiene	Gas	54	-4.4		4.43			

Exhibit C-1
List of Extremely Hazardous Substances and Data for Hazards Analysis
(Alphabetical Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
*109-19-3	Butyl Isovalerate	Liquid	158	175.5	0.45	8.2	0.00003	0.03	
*111-34-2	Butyl Vinyl Ether	Liquid	100	94	50	0.62	0.002	0.03	
1306-19-0	Cadmium Oxide	Solid	128	1559 S	0.00001	0.004			0.000004
2223-93-0	Cadmium Stearate	Solid	681		0.00001	0.0013			
7778-44-1	Calcium Arsenate	Solid	398		0.00001	0.01			
8001-35-2	Camphechlor	Solid	414	D	0.4	0.02			0.003
56-25-7	Cantharidin	Solid	196	110 S	0.02	0.0043			0.02
51-83-2	Carbachol Chloride	Solid	183		0.00001	0.015			
26419-73-8	Carbamic Acid, Methyl-, O-(((2,4-Dimethyl-1,3-Dithiolan-2-Yl) Methylene)Amino)-	Solid	234	400	0.0000006	0.001			0.000004
1563-66-2	Carbofuran	Solid	221	360	0.00001	0.00043			0.00005
75-15-0	Carbon Disulfide	Liquid	76	46.5	360.0	0.16	0.01	0.03	
786-19-6	Carbophenothion	Liquid	343	350	0.0000003	0.0068	0.00000000003	0.04	
*2244-16-8	Carvone	Liquid	150	230	0.04	0.0037	0.000002	0.03	
57-74-9	Chlordane	Liquid	410	400	0.00001	0.05	0.000000001	0.04	
470-90-6	Chlorfenvinfos	Liquid	360	390	0.000004	0.01	0.0000000004	0.04	
7782-50-5	Chlorine	Gas	71	-34.6		0.0073			
24934-91-6	Chlormephos	Liquid	235	295	0.0056	0.007	0.0000005	0.03	
999-81-5	Chlormequat Chloride	Solid	158		0.00001	0.007			
*107-20-0	Chloroacetaldehyde	Liquid	78.5	85	100	0.069	0.004	0.03	
79-11-8	Chloroacetic Acid	Solid	95	189	0.5	0.0018			0.0002
107-07-3	Chloroethanol	Liquid	81	128	5.0	0.0033	0.0002	0.02	
627-11-2	Chloroethyl Chloroformate	Liquid	143	155.7	9.0	0.02	0.0005	0.03	
67-66-3	Chloroform	Liquid	119	61.7	160.0	0.49	0.009	0.04	
542-88-1	Chloromethyl Ether	Liquid	115	106	30.0	0.00025	0.002	0.03	
107-30-2	Chloromethyl Methyl Ether	Liquid	81	59	224	0.0018	0.009	0.03	
3691-35-8	Chlorophacinone	Solid	375		0.00001	0.001			
1982-47-4	Chloroxuron	Solid	291		0.0000001	0.01			
21923-23-9	Chlorthiophos	Liquid	361	400	0.0004	0.0078	0.00000004	0.04	
10025-73-7	Chromic Chloride	Solid	158	1300 S	0.00001	0.00005			0.003
*7440-48-4	Cobalt	Solid	59	2870	0.00001	0.002			0.000000001
10210-68-1	Cobalt Carbonyl	Solid	342	52 D	0.1	0.00027			0.07
62207-76-5	Cobalt,((2,2'-(1,2-Ethanediylbis (Nitrilomethylidine))Bis(6-Fluoro Phenolato))(2-)-N,N',O,O')-	Solid	361		0.00001	0.003			
64-86-8	Colchicine	Solid	399	407	0.00001	0.0009			0.00001
*117-52-2	Coumafuryl	Solid	298		0.00001	4			
56-72-4	Coumaphos	Solid	363		0.0000001	0.003			
5836-29-3	Coumatetralyl	Solid	292		0.00001	0.0165			
95-48-7	Cresol, o-	Solid	108	191	0.5	0.11			0.00003
535-89-7	Crimidine	Solid	172	300	0.00001	0.0012			0.00001
4170-30-3	Crotonaldehyde	Liquid	70	104	36	0.04	0.001	0.02	
123-73-9	Crotonaldehyde, (E)-	Liquid	70	104	36	0.04	0.001	0.02	
506-68-3	Cyanogen Bromide	Solid	106	61.4	92	0.044			0.02
506-78-5	Cyanogen Iodide	Solid	153	45 S	1	0.18			0.02
2636-26-2	Cyanophos	Liquid	243	350	0.0008	0.025	0.00000007	0.03	
675-14-9	Cyanuric Fluoride	Liquid	135	73	120	0.00017	0.007	0.04	
66-81-9	Cycloheximide	Solid	281	245	0.006	0.002			0.0008
108-91-8	Cyclohexylamine	Liquid	99	134.5	10	0.16	0.0005	0.03	
*287-92-3	Cyclopentane	Liquid	70	49	317	11	0.01	0.03	
*633-03-4	C. I. Basic Green 1	Solid	483		0.00001	0.25			

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List of Extremely Hazardous Substances and Data for Hazards Analysis
(Alphabetical Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
17702-41-9	Decaborane(14)	Solid	122	213	0.1	0.01			0.0006
8065-48-3	Demeton	Liquid	258	300	0.00026	0.002	0.00000002	0.03	
919-86-8	Demeton-S-Methyl	Liquid	230	305	0.0001	0.005	0.000000008	0.03	
10311-84-9	Dialifor	Solid	394	300	0.0005	0.005			0.000001
19287-45-7	Diborane	Gas	28	-92		0.005			
8023-53-8	Dichlorobenzalkonium Chloride	Solid	423		0.00001	0.32			
111-44-4	Dichloroethyl Ether	Liquid	143	178	0.7	0.15	0.00004	0.03	
149-74-6	Dichloromethylphenylsilane	Liquid	191	205	0.4	0.02	0.00003	0.03	
62-73-7	Dichlorvos	Liquid	221	400	0.01	0.02	0.0000008	0.03	
141-66-2	Dicrotophos	Liquid	237	400	0.00001	0.0009	0.0000000008	0.03	
1464-53-5	Diepoxybutane	Liquid	86	138	16	0.0035	0.0007	0.02	
814-49-3	Diethyl Chlorophosphate	Liquid	173	210	0.2	0.008	0.00001	0.03	
1642-54-2	Diethylcarbamazine Citrate	Solid	391		0.00001	0.003			
*93-05-0	Diethyl-p-Phenylenediamine	Liquid	164	260	0.02	1.25	0.000001	0.03	
71-63-6	Digitoxin	Solid	765		0.00001	0.00018			
2238-07-5	Diglycidyl Ether	Liquid	130	260	0.09	0.045	0.000005	0.02	
20830-75-5	Digoxin	Solid	781		0.00001	0.0002			
115-26-4	Dimefox	Liquid	154	210	0.36	0.001	0.00002	0.03	
60-51-5	Dimethoate	Solid	229		0.0000085	0.03			
2524-03-0	Dimethyl Phosphorochloridothioate	Liquid	161	180	1	0.0032	0.00006	0.03	
77-78-1	Dimethyl Sulfate	Liquid	126	188	0.1	0.005	0.000006	0.03	
75-18-3	Dimethyl Sulfide	Liquid	62	37.3	520	0.0003	0.02	0.02	
75-78-5	Dimethyldichlorosilane	Liquid	129	70	139	0.003	0.008	0.04	
57-14-7	Dimethylhydrazine	Liquid	60	63.9	157	0.012	0.005	0.02	
99-98-9	Dimethyl-p-Phenylenediamine	Solid	136	262	0.0001	0.00013			0.000005
644-64-4	Dimetilan	Solid	240	350	0.0001	0.025			0.00000004
534-52-1	Dinitrocresol	Solid	198	312	0.00005	0.0005			0.000007
88-85-7	Dinoseb	Solid	240	345	0.0001	0.0045			0.000000002
1420-07-1	Dinoterb	Solid	240	350	0.00001	0.025			
78-34-2	Dioxathion	Liquid	457	250	0.01	0.0034	0.000001	0.06	
*646-06-0	Dioxolane	Liquid	74	74	70	0.21	0.003	0.02	
82-66-6	Diphacinone	Solid	340		0.00001	0.0009			
152-16-9	Diphosphoramide, Octamethyl-	Liquid	286	330	0.001	0.0008	0.0000001	0.04	
298-04-4	Disulfoton	Liquid	274	400	0.00018	0.002	0.00000002	0.03	
514-73-8	Dithiazanine Iodide	Solid	520		0.00001	0.02			
541-53-7	Dithiobiuret	Solid	135		0.00001	0.005			
316-42-7	Emetine, Dihydrochloride	Solid	554		0.00001	0.00001			
115-29-7	Endosulfan	Solid	407		0.00001	0.0008			
2778-04-3	Endothion	Solid	280		0.00001	0.017			
72-20-8	Endrin	Solid	381		0.000002	0.02			
106-89-8	Epichlorohydrin	Liquid	93	116.5	16	0.038	0.0007	0.03	
2104-64-5	EPN	Solid	323	380	0.000002	0.005			0.000000000007
50-14-6	Ergocalciferol	Solid	397		0.00001	0.04			
379-79-3	Ergotamine Tartrate	Solid	1314		0.00001	0.01			
1622-32-8	Ethanesulfonyl Chloride, 2-Chloro-	Liquid	163	200	0.6	0.0025	0.00004	0.03	
10140-87-1	Ethanol, 1,2-Dichloro-, Acetate	Liquid	157	280	0.001	0.011	0.00000006	0.03	
563-12-2	Ethion	Liquid	384	150 D	0.0000015	0.013	0.0000000002	0.09	
13194-48-4	Ethoprophos	Liquid	242	300	0.00035	0.026	0.00000003	0.03	
538-07-8	Ethylbis(2-Chloroethyl)Amine	Liquid	170	200	0.24	0.0075	0.00002	0.03	
371-62-0	Ethylene Fluorohydrin	Liquid	64	103.5	50	0.00007	0.002	0.02	
75-21-8	Ethylene Oxide	Gas	44	10.7		0.14			
107-15-3	Ethylenediamine	Liquid	60	116	15	0.49	0.0005	0.02	

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151-56-4	Ethyleneimine	Liquid	43	55	207	0.004	0.006	0.02	
*2235-25-8	Ethylmercuric Phosphate	Solid	327		0.00001	0.001			
542-90-5	Ethylthiocyanate	Liquid	87	146	4	0.1	0.0002	0.02	
22224-92-6	Fenamiphos	Solid	303	450	0.0000001	0.0009			0.0000000000001
122-14-5	Fenitrothion	Liquid	277	370	0.000006	0.0038	0.0000000006	0.03	
115-90-2	Fensulfothion	Liquid	308	440	0.00000001	0.002	0.000000000001	0.03	
4301-50-2	Fluenetil	Solid	258		0.0000025	0.006			0.0000007
7782-41-4	Fluorine	Gas	38	-188		0.039			
640-19-7	Fluoroacetamide	Solid	77	250	0.001	0.0058			0.0002
144-49-0	Fluoroacetic Acid	Solid	78	165	2	0.00047			0.0001
359-06-8	Fluoroacetyl Chloride	Liquid	96	73	80	0.01	0.004	0.03	
51-21-8	Fluorouracil	Solid	130	361	0.00001	0.019			0.004
944-22-9	Fonofos	Liquid	246	380	0.00021	0.0013	0.00000002	0.03	
50-00-0	Formaldehyde	Gas	30	-19		0.012			
107-16-4	Formaldehyde Cyanohydrin	Liquid	57	183	1.8	0.006	0.00006	0.02	
23422-53-9	Formetanate Hydrochloride	Solid	258	440	0.0000001	0.018			0.00003
2540-82-1	Formothion	Liquid	257	250	0.0000085	0.00027	0.0000000008	0.04	
17702-57-7	Formparanate	Solid	235	385	0.0000025	0.0072			0.0000003
21548-32-3	Fosthietan	Liquid	241	250	0.0000065	0.0047	0.0000000006	0.04	
3878-19-1	Fuberidazole	Solid	184		0.00001	0.0033			
110-00-9	Furan	Liquid	68	32	700	0.0012	0.03	0.03	
13450-90-3	Gallium Trichloride	Solid	176	201.3	0.2	0.032			0.0004
77-47-4	Hexachlorocyclopentadiene	Liquid	273	239	0.08	0.0002	0.000007	0.04	
*1335-87-1	Hexachloronaphthalene	Solid	335	270	0.003	0.0002			
4835-11-4	Hexamethylenediamine, N,N'-Dibutyl-	Liquid	228	205	0.0004	0.0022	0.00000003	0.04	
302-01-2	Hydrazine	Liquid	32	113.5	14.4	0.01	0.0003	0.01	
74-90-8	Hydrocyanic Acid	Gas	27	25.7		0.0055			
7647-01-0	Hydrogen Chloride (Gas Only)	Gas	36	-85		0.015			
7664-39-3	Hydrogen Fluoride	Gas	20	19.4		0.0016			
7722-84-1	Hydrogen Peroxide (Conc > 52%)	Liquid	34	152	5	0.01	0.0001	0.01	
7783-07-5	Hydrogen Selenide	Gas	81	-41		0.00066			
7783-06-4	Hydrogen Sulfide	Gas	34	-60		0.042			
123-31-9	Hydroquinone	Solid	110	285	0.001	0.02			0.0008
*53-86-1	Indomethacin	Solid	358		0.00001	0.0024			
*10025-97-5	Iridium Tetrachloride	Solid	334		0.00001	0.0047			
13463-40-6	Iron, Pentacarbonyl-	Liquid	196	103	40	0.0008 a	0.003	0.04	
297-78-9	Isobenzan	Solid	412		0.00001	0.001			
78-82-0	Isobutyronitrile	Liquid	69	103.8	50	0.025	0.002	0.02	
102-36-3	Isocyanic Acid,3,4-Dichlorophenyl Ester	Solid	188	240	0.02	0.014			0.000009
465-73-6	Isodrin	Solid	365	344	0.00001	0.007			0.004
55-91-4	Isofluorphate	Liquid	184	185	0.58	0.0036	0.00004	0.03	
4098-71-9	Isophorone Diisocyanate	Solid	222	360	0.00001	0.00123			0.000000006
108-23-6	Isopropyl Chloroformate	Liquid	123	104.6	50	0.1	0.003	0.03	
625-55-8	Isopropyl Formate	Liquid	88	68.2	100	0.0014	0.004	0.03	
119-38-0	Isopropylmethylpyrazolyl Dimethylcarbamate	Liquid	211	295	0.001	0.0056	0.00000008	0.03	
78-97-7	Lactonitrile	Liquid	71	182	1.7	0.018	0.00006	0.02	
21609-90-5	Leptophos	Solid	412	380	0.000002	0.03			0.000000009
541-25-3	Lewisite	Liquid	207	190	0.395	0.0047	0.00003	0.04	
58-89-9	Lindane	Solid	291	323.4 D	0.0000094	0.1			0.00004
7580-67-8	Lithium Hydride	Solid	8		0.00001	0.005			
109-77-3	Malononitrile	Solid	66	218	0.08	0.019			0.000005

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12108-13-3	Manganese, Tricarbonyl Methylcyclopentadienyl	Liquid	218	232	0.1	0.0006	0.000008	0.04	
51-75-2	Mechlorethamine	Liquid	156	200	0.6	0.029	0.00004	0.03	
950-10-7	Mephosfolan	Liquid	269	410	1.0000000E-10	0.009	0.000000000000009	0.03	
1600-27-7	Mercuric Acetate	Solid	319		0.00001	0.024			
7487-94-7	Mercuric Chloride	Solid	272	302	0.0004	0.03			0.02
21908-53-2	Mercuric Oxide	Solid	217		0.00001	0.016			
*108-67-8	Mesitylene	Liquid	120	165	1.8	0.24	0.0001	0.03	
10476-95-6	Methacrolein Diacetate	Liquid	172	191	0.35	0.044	0.00002	0.03	
760-93-0	Methacrylic Anhydride	Liquid	154	240	0.01	0.0045	0.0000006	0.03	
126-98-7	Methacrylonitrile	Liquid	67	90.3	90	0.003 a	0.003	0.02	
920-46-7	Methacryloyl Chloride	Liquid	105	96	40	0.0006	0.002	0.03	
30674-80-7	Methacryloyloxyethyl Isocyanate	Liquid	155	74	80	0.00027	0.005	0.04	
10265-92-6	Methamidophos	Solid	141	D	0.0003	0.0075			0.00000006
558-25-8	Methanesulfonyl Fluoride	Liquid	98	124	10	0.014	0.0005	0.03	
950-37-8	Methidathion	Solid	302		0.000001	0.02			0.0000000003
2032-65-7	Methiocarb	Solid	225	325	0.0001	0.015			0.00003
16752-77-5	Methomyl	Solid	162	335	0.00005	0.01			0.0000002
151-38-2	Methoxyethylmercuric Acetate	Solid	319		0.00001	0.025			
80-63-7	Methyl 2-Chloroacrylate	Liquid	121	140	12	0.005	0.0006	0.03	
74-83-9	Methyl Bromide	Gas	95	3.6		0.78			
79-22-1	Methyl Chloroformate	Liquid	95	71	210	0.0018	0.01	0.03	
624-92-0	Methyl Disulfide	Liquid	94	109.7	28.6	0.0001	0.001	0.03	
60-34-4	Methyl Hydrazine	Liquid	46	87.5	49.6	0.00094	0.001	0.02	
624-83-9	Methyl Isocyanate	Liquid	57	39	348	0.0047	0.01	0.02	
556-61-6	Methyl Isothiocyanate	Solid	73	119	15	0.033			0.0009
74-93-1	Methyl Mercaptan	Gas	48	6.2		0.079			
3735-23-7	Methyl Phenkapton	Liquid	349	400	0.0000035	0.011	0.0000000004	0.04	
676-97-1	Methyl Phosphonic Dichloride	Solid	133	163	1	0.0014			0.0002
556-64-9	Methyl Thiocyanate	Liquid	73	130	20	0.085	0.0008	0.02	
78-94-4	Methyl Vinyl Ketone	Liquid	70	81.4	160	0.00007	0.006	0.02	
502-39-6	Methylmercuric Dicyanamide	Solid	299		0.00003	0.02			0.0001
75-79-6	Methyltrichlorosilane	Liquid	149	67	280	0.0018	0.02	0.04	
1129-41-5	Metolcarb	Solid	165	360	0.00001	0.0048			0.00000003
7786-34-7	Mevinphos	Liquid	224	280	0.0029	0.004	0.0000002	0.03	
315-18-4	Mexacarbate	Solid	222		0.000002	0.014			0.00000003
50-07-7	Mitomycin C	Solid	334	534	0.00001	0.023			0.0008
6923-22-4	Monocrotophos	Solid	223	430	0.000007	0.00063			0.000000000002
*2763-96-4	Muscimol	Solid	114		0.00001	0.017			
505-60-2	Mustard Gas	Liquid	159	215	0.09	0.001	0.000006	0.03	
*7440-02-0	Nickel	Solid	59	2732	0.00001	0.05			0.0000001
13463-39-3	Nickel Carbonyl	Liquid	171	43	400	0.00035 a	0.03	0.05	
54-11-5	Nicotine	Liquid	162	246.7	0.04	0.0035	0.000003	0.03	
65-30-5	Nicotine Sulfate	Solid	423		0.00001	0.009			
7697-37-2	Nitric Acid	Liquid	63	83	47.8	0.026	0.002	0.02	
10102-43-9	Nitric Oxide	Gas	30	-151		0.03 a			
98-95-3	Nitrobenzene	Liquid	123	210.8	0.005	0.1	0.0000003	0.03	
1122-60-7	Nitrocyclohexane	Liquid	129	205.5	0.35	0.0015	0.00002	0.03	
10102-44-0	Nitrogen Dioxide	Gas	46	21.15		0.0094			
62-75-9	Nitrosodimethylamine	Liquid	74	151	8	0.019	0.0003	0.02	
991-42-4	Norbormide	Solid	512		0.00001	0.0038			
0	Organorhodium Complex (PMN-82-147)	Solid				0.0008			

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*65-86-1	Orotic Acid	Solid	156		0.00001	2			
*20816-12-0	Osmium Tetroxide	Solid	254	130	11	0.0001			0.002
630-60-4	Ouabain	Solid	585		0.00001	0.0083			
23135-22-0	Oxamyl	Solid	219	310	0.00023	0.0017			0.00002
78-71-7	Oxetane, 3,3-Bis(Chloromethyl)-	Liquid	155	200	0.5	0.002	0.00003	0.03	
2497-07-6	Oxydisulfoton	Liquid	274	330	0.00006	0.0035	0.000000006	0.03	
10028-15-6	Ozone	Gas	48	-111		0.002			
1910-42-5	Paraquat	Solid	257		0.0000001	0.00015			
2074-50-2	Paraquat Methosulfate	Solid	408		0.0000001	0.00015			
56-38-2	Parathion	Liquid	291	375	0.000038	0.002	0.000000004	0.03	
298-00-0	Parathion-Methyl	Solid	263	D	0.0000097	0.00034			
12002-03-8	Paris Green	Solid	1014		0.00001	0.022			
19624-22-7	Pentaborane	Liquid	63	60	170	0.0008	0.006	0.02	
*76-01-7	Pentachloroethane	Liquid	202	161	3.4	3.5	0.0003	0.04	
*87-86-5	Pentachlorophenol	Solid	266	309	0.0002	0.015			0.001
2570-26-5	Pentadecylamine	Solid	227	307.6	0.0003	0.002			0.00000001
79-21-0	Peracetic Acid	Liquid	76	105	60	0.0045	0.002	0.02	
594-42-3	Perchloromethylmercaptan	Liquid	186	147	10	0.0076	0.0007	0.04	
108-95-2	Phenol	Solid	94	181.75	0.35	0.039			0.00008
97-18-7	Phenol, 2,2'-Thiobis(4,6-Dichloro)-	Solid	356		0.0000001	0.007			
4418-66-0	Phenol,2,2'-Thiobis(4-Chloro-6-Methyl)-	Solid	315	443	0.0000001	0.0013			0.00001
64-00-6	Phenol, 3-(1-Methylethyl)-, Methylcarbamate	Solid	193	143	0.4	0.016			0.004
58-36-6	Phenoxarsine, 10,10'-Oxydi-	Solid	502		0.00001	0.014			
696-28-6	Phenyl Dichloroarsine	Liquid	223	254.4	0.033	0.004	0.000003	0.03	
59-88-1	Phenylhydrazine Hydrochloride	Solid	145	240 D	0.00001	0.25			0.03
62-38-4	Phenylmercury Acetate	Solid	337		0.000009	0.022			
2097-19-0	Phenylsilatrane	Solid	251	350	0.00001	0.001			0.0008
103-85-5	Phenylthiourea	Solid	152	320	0.000002	0.003			0.0002
298-02-2	Phorate	Liquid	260	290	0.00084	0.0001	0.00000008	0.04	
4104-14-7	Phosacetim	Solid	375	400	0.00001	0.0037			0.00000009
947-02-4	Phosfolan	Solid	255	410	0.00001	0.009			0.000000000002
75-44-5	Phosgene	Gas	99	8.2		0.0008			
732-11-6	Phosmet	Solid	317	D	0.0008	0.00054			0.000008
13171-21-6	Phosphamidon	Liquid	300	350	0.000025	0.0003	0.000000002	0.04	
7803-51-2	Phosphine	Gas	34	-88		0.028			
2703-13-1	Phosphonothioic Acid, Methyl-, O-Ethyl O-(4-(Methylthio)Phenyl) Ester	Liquid	262	298	0.0001	0.01	0.000000009	0.04	
50782-69-9	Phosphonothioic Acid, Methyl-, S-(2-(Bis(1-Methylethyl)Amino)Ethyl) O-Ethyl Ester	Liquid	267	298	0.0007	0.0009	0.00000006	0.04	
2665-30-7	Phosphonothioic Acid, Methyl-,O-(4-Nitrophenyl) O-Phenyl Ester	Liquid	309	400	0.00001	0.008	0.000000001	0.03	
3254-63-5	Phosphoric Acid, Dimethyl 4-(Methylthio) Phenyl Ester	Liquid	248	300	0.001	0.007	0.00000009	0.03	
2587-90-8	Phosphorothioic Acid, O,O-Dimethyl-S-(2-Methylthio) Ethyl Ester	Liquid	216	230		0.02		0.04	
7723-14-0	Phosphorus	Solid	31	280	0.05	0.003			0.00000005
10025-87-3	Phosphorus Oxychloride	Liquid	153	106	40	0.003	0.003	0.04	
10026-13-8	Phosphorus Pentachloride	Solid	208	160	1	0.02			0.006
1314-56-3	Phosphorus Pentoxide	Solid	142		0.00001	0.0006			
7719-12-2	Phosphorus Trichloride	Liquid	137	76	135	0.028	0.008	0.04	

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*84-80-0	Phylloquinone	Liquid	451	450	0.00000001	25	0.000000000001	0.04	
57-47-6	Physostigmine	Solid	275		0.00001	0.0045			
57-64-7	Physostigmine, Salicylate (1:1)	Solid	414	D	0.00001	0.0025			
124-87-8	Picrotoxin	Solid	603		0.00001	0.015			
110-89-4	Piperidine	Liquid	85	106	40	0.022	0.002	0.03	
5281-13-0	Piprotal	Solid	457	463	0.0000001	0.0044			0.0000004
23505-41-1	Pirimifos-Ethyl	Liquid	333	130 D	0.00029	0.025	0.00000003	0.09	
*10025-65-7	Platinous Chloride	Solid	266		0.00001	0.013			
*13454-96-1	Platinum Tetrachloride	Solid	337		0.00001	0.002			
10124-50-2	Potassium Arsenite	Solid	254		0.00001	0.014			
151-50-8	Potassium Cyanide	Solid	65		0.00001	0.005			
506-61-6	Potassium Silver Cyanide	Solid	199		0.00001	0.02			
2631-37-0	Promecarb	Solid	207	345	0.00003	0.016			0.0000003
106-96-7	Propargyl Bromide	Liquid	119	88	180	0.00003	0.01	0.03	
57-57-8	Propiolactone, Beta-	Liquid	72	162	3.4	0.0015 a	0.0001	0.02	
107-12-0	Propionitrile	Liquid	55	97.2	40	0.0037	0.001	0.02	
542-76-7	Propionitrile, 3-Chloro-	Liquid	90	175	2.5	0.009	0.0001	0.02	
70-69-9	Propiophenone, 4-Amino-	Solid	149			0.0056			
109-61-5	Propyl Chloroformate	Liquid	123	114	24	0.01	0.001	0.03	
*1331-17-5	Propylene Glycol, Allyl Ether	Liquid	116	160	2	0.51	0.0001	0.03	
75-56-9	Propylene Oxide	Liquid	58	34.23	517	0.48	0.02	0.02	
75-55-8	Propyleneimine	Liquid	57	66	149	0.12	0.005	0.02	
2275-18-5	Prothoate	Solid	285	330	0.0001	0.0017			0.000000001
*95-63-6	Pseudocumene	Liquid	120	169	1.9	0.18	0.0001	0.03	
129-00-0	Pyrene	Solid	202	404	0.00001	0.0017			0.00001
140-76-1	Pyridine, 2-Methyl-5-Vinyl-	Liquid	119	181	1.7	0.0019	0.00009	0.03	
504-24-5	Pyridine, 4-Amino-	Solid	94	273.5	0.002	0.02			0.0007
1124-33-0	Pyridine, 4-Nitro-, 1-Oxide	Solid	140	390	0.00001	0.08			0.00002
53558-25-1	Pyriminil	Solid	272		0.00001	0.0062			
*10049-07-7	Rhodium Trichloride	Solid	209	800	0.00001	0.0062			0.00002
14167-18-1	Salcomine	Solid	325		0.00001	0.039			
107-44-8	Sarin	Liquid	140	147	2.9	0.00005	0.0002	0.03	
7783-00-8	Selenious Acid	Solid	129		4	0.25			0.002
7791-23-3	Selenium Oxychloride	Liquid	166	180	2.9	0.01	0.0002	0.03	
563-41-7	Semicarbazide Hydrochloride	Solid	112		0.00001	0.1			
3037-72-7	Silane, (4-Aminobutyl)Diethoxymethyl-	Liquid	205	220	0.06	0.045	0.000005	0.03	
*128-56-3	Sodium Anthraquinone-1-Sulfonate	Solid	310		0.00001	14			
7631-89-2	Sodium Arsenate	Solid	326		0.00001	0.13			
7784-46-5	Sodium Arsenite	Solid	130		0.00001	0.01			
26628-22-8	Sodium Azide (Na(N3))	Solid	65		0.00001	0.02			
124-65-2	Sodium Cacodylate	Solid	160	D	0.00001	0.004			
143-33-9	Sodium Cyanide (Na(CN))	Solid	49	1496	0.00001	0.005			0.0000000000001
62-74-8	Sodium Fluoroacetate	Solid	100		0.00001	0.0005			
131-52-2	Sodium Pentachlorophenate	Solid	288		0.00001	0.0024			
13410-01-0	Sodium Selenate	Solid	189		0.00001	0.0016			
10102-18-8	Sodium Selenite	Solid	173		0.00001	0.0023			
10102-20-2	Sodium Tellurite	Solid	222		0.00001	0.02			
900-95-8	Stannane, Acetoxytriphenyl-	Solid	409			0.02			
57-24-9	Strychnine	Solid	334	460	0.00000001	0.0003			0.0007
60-41-3	Strychnine, Sulfate	Solid	383		0.00000001	0.005			
3689-24-5	Sulfotep	Liquid	322	310	0.00017	0.0035	0.00000002	0.04	
3569-57-1	Sulfoxide, 3-Chloropropyl Octyl	Liquid	239	338	0.0002	0.008	0.00000002	0.03	

Exhibit C-1
List of Extremely Hazardous Substances and Data for Hazards Analysis
(Alphabetical Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
7446-09-5	Sulfur Dioxide	Gas	64	-10		0.026			
7783-60-0	Sulfur Tetrafluoride	Gas	108	-40		0.0092			
7446-11-9	Sulfur Trioxide	Solid	80	45	433	0.003			0.01
7664-93-9	Sulfuric Acid	Liquid	98	290	0.000001	0.008	0.00000000005	0.02	
77-81-6	Tabun	Liquid	162	240	0.07	0.00015	0.000005	0.03	
13494-80-9	Tellurium	Solid	128	989.9	0.00001	0.02			0.00000002
7783-80-4	Tellurium Hexafluoride	Gas	242	-39 S		0.001			
107-49-3	TEPP	Liquid	290	310	0.00047	0.001	0.00000005	0.04	
13071-79-9	Terbufos	Liquid	288	315	0.0003	0.001	0.00000003	0.04	
78-00-2	Tetraethyllead	Liquid	323	110	0.2	0.004	0.00002	0.06	
597-64-8	Tetraethyltin	Liquid	235	181	2	0.007	0.0002	0.04	
75-74-1	Tetramethyllead	Liquid	267	110	22	0.004	0.002	0.05	
509-14-8	Tetranitromethane	Liquid	196	126	13	0.008 a	0.001	0.04	
*1314-32-5	Thallic Oxide	Solid	457	875	0.00001	0.002			0.003
10031-59-1	Thallium Sulfate	Solid	1527	D	0.00001	0.002			
6533-73-9	Thallous Carbonate	Solid	469		0.00001	0.002			
7791-12-0	Thallous Chloride	Solid	240	720	0.0000001	0.002			0.00007
2757-18-8	Thallous Malonate	Solid	511	300	0.00001	0.002			
7446-18-6	Thallous Sulfate	Solid	505		0.0000001	0.002			
2231-57-4	Thiocarbazide	Solid	106		0.00001	0.1			
*21564-17-0	Thiocyanic Acid, 2-(Benzothiazolylthio) Methyl Ester	Liquid	238	350	0.00001	1.6	0.0000000008	0.03	
39196-18-4	Thiofanox	Solid	218	315	0.00017	0.0085			0.00000009
*640-15-3	Thiometon	Liquid	246	340	0.0003	0.06	0.00000003	0.03	
297-97-2	Thionazin	Liquid	248	360	0.003	0.0035	0.0000003	0.03	
108-98-5	Thiophenol	Liquid	110	168.3	1	0.0014	0.00005	0.03	
79-19-6	Thiosemicarbazide	Solid	91	320	0.00001	0.0092			0.0004
5344-82-1	Thiourea, (2-Chlorophenyl)-	Solid	187	323	0.000002	0.0046			0.0001
614-78-8	Thiourea, (2-Methylphenyl)-	Solid	166		0.000002	0.05			
7550-45-0	Titanium Tetrachloride	Liquid	190	136.4	10	0.001	0.0007	0.04	
584-84-9	Toluene 2,4-Diisocyanate	Liquid	174	251	1	0.007	0.00007	0.03	
91-08-7	Toluene 2,6-Diisocyanate	Liquid	174	245	0.5	0.0009	0.00003	0.03	
110-57-6	Trans-1,4-Dichlorobutene	Liquid	125	155.5	6	0.0044	0.0003	0.03	
1031-47-6	Triamiphos	Solid	294	400	0.0000001	0.01			0.000000003
24017-47-8	Triazofos	Liquid	313	350	0.00001	0.0028	0.000000001	0.04	
76-02-8	Trichloroacetyl Chloride	Liquid	182	118	0.0000001	0.0045	0.000000000007	0.04	
115-21-9	Trichloroethylsilane	Liquid	164	97.9	0.6	0.003	0.00004	0.04	
327-98-0	Trichloronate	Liquid	334	360	20	0.01	0.002	0.04	
98-13-5	Trichlorophenylsilane	Liquid	212	201.5	0.01	0.0033	0.0000008	0.04	
*52-68-6	Trichlorophon	Solid	257	280	0.000008	0.013			
1558-25-4	Trichloro(Chloromethyl)Silane	Liquid	184	118	30	0.0003	0.002	0.04	
27137-85-5	Trichloro(Dichlorophenyl)Silane	Liquid	280	260	70	0.008	0.007	0.04	
998-30-1	Triethoxysilane	Liquid	164	132	23	0.005	0.002	0.04	
75-77-4	Trimethylchlorosilane	Liquid	109	57	71	0.05	0.004	0.03	
824-11-3	Trimethylolpropane Phosphite	Solid	162	200	0.2	0.0025			0.0001
1066-45-1	Trimethyltin Chloride	Solid	199	154	3	0.02			0.0004
639-58-7	Triphenyltin Chloride	Solid	385	400	0.000001	0.02			0.0000001
555-77-1	Tris(2-Chloroethyl)Amine	Liquid	205	256	0.011	0.0008	0.0000008	0.03	
2001-95-8	Valinomycin	Solid	1112		0.00001	0.0025			
1314-62-1	Vanadium Pentoxide	Solid	182	1750	0.0000001	0.007			0.0000000000002
108-05-4	Vinyl Acetate Monomer	Liquid	86	72	124	0.054	0.005	0.03	
*3048-64-4	Vinylnorbornene	Liquid	120	141	5	4.37	0.0003	0.03	

Exhibit C-1
List of Extremely Hazardous Substances and Data for Hazards Analysis
(Alphabetical Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
81-81-2	Warfarin	Solid	308	356	0.00001	0.02			0.0001
129-06-6	Warfarin Sodium	Solid	330		0.00001	0.009			
28347-13-9	Xylylene Dichloride	Solid	175	239	0.02	0.002			0.0003
58270-08-9	Zinc, Dichloro(4,4-Dimethyl-5((((Methyl amino)Carbonyl)Oxy)Imino) Pentanenitrile)-, (T-4)-	Solid	334		0.00001	0.009			
1314-84-7	Zinc Phosphide	Solid	258	1100	0.0000001	0.012			0.0000000002

a: ACGIH TLV values were used for these chemicals.

* Chemicals proposed for deletion.

D: Decomposes

S: Sublimes

Exhibit C-2
List of Extremely Hazardous Substances and Data for Hazards Analysis
(CAS # Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
0	Organorhodium Complex (PMN-82-147)	Solid				0.0008			
50-00-0	Formaldehyde	Gas	30	-19		0.012			
50-07-7	Mitomycin C	Solid	334	534	0.00001	0.023			0.0008
50-14-6	Ergocalciferol	Solid	397		0.00001	0.04			
51-21-8	Fluorouracil	Solid	130	361	0.00001	0.019			0.004
51-75-2	Mechlorethamine	Liquid	156	200	0.6	0.029	0.00004	0.03	
51-83-2	Carbachol Chloride	Solid	183		0.00001	0.015			
*52-68-6	Trichlorophon	Solid	257	280	0.000008	0.013			
*53-86-1	Indomethacin	Solid	358		0.00001	0.0024			
54-11-5	Nicotine	Liquid	162	246.7	0.04	0.0035	0.000003	0.03	
54-62-6	Aminopterin	Solid	440		0.00001	0.025			
55-91-4	Isofluorphate	Liquid	184	185	0.58	0.0036	0.00004	0.03	
56-25-7	Cantharidin	Solid	196	110 S	0.02	0.0043			0.02
56-38-2	Parathion	Liquid	291	375	0.000038	0.002	0.000000004	0.03	
56-72-4	Coumaphos	Solid	363		0.0000001	0.003			
57-14-7	Dimethylhydrazine	Liquid	60	63.9	157	0.012	0.005	0.02	
57-24-9	Strychnine	Solid	334	460	0.00000001	0.0003			0.0007
57-47-6	Physostigmine	Solid	275		0.00001	0.0045			
57-57-8	Propiolactone, Beta-	Liquid	72	162	3.4	0.0015 a	0.0001	0.02	
57-64-7	Physostigmine, Salicylate (1:1)	Solid	414	D	0.00001	0.0025			
57-74-9	Chlordane	Liquid	410	400	0.00001	0.05	0.000000001	0.04	
58-36-6	Phenoxarsine, 10,10'-Oxydi-	Solid	502		0.00001	0.014			
58-89-9	Lindane	Solid	291	323.4 D	0.0000094	0.1			0.00004
59-88-1	Phenylhydrazine Hydrochloride	Solid	145	240 D	0.00001	0.25			0.03
60-34-4	Methyl Hydrazine	Liquid	46	87.5	49.6	0.00094	0.001	0.02	
60-41-3	Strychnine, Sulfate	Solid	383		0.00000001	0.005			
60-51-5	Dimethoate	Solid	229		0.0000085	0.03			
62-38-4	Phenylmercury Acetate	Solid	337		0.000009	0.022			
62-53-3	Aniline	Liquid	93	184	0.67	0.038	0.00003	0.02	
62-73-7	Dichlorvos	Liquid	221	400	0.01	0.02	0.0000008	0.03	
62-74-8	Sodium Fluoroacetate	Solid	100		0.00001	0.0005			
62-75-9	Nitrosodimethylamine	Liquid	74	151	8	0.019	0.0003	0.02	
64-00-6	Phenol, 3-(1-Methylethyl)-, Methylcarbamate	Solid	193	143	0.4	0.016			0.004
64-86-8	Colchicine	Solid	399	407	0.00001	0.0009			0.00001
65-30-5	Nicotine Sulfate	Solid	423		0.00001	0.009			
*65-86-1	Orotic Acid	Solid	156		0.00001	2			
66-81-9	Cycloheximide	Solid	281	245	0.006	0.002			0.0008
67-66-3	Chloroform	Liquid	119	61.7	160.0	0.49	0.009	0.04	
70-69-9	Propiophenone, 4-Amino-	Solid	149			0.0056			
71-63-6	Digitoxin	Solid	765		0.00001	0.00018			
72-20-8	Endrin	Solid	381		0.000002	0.02			
74-83-9	Methyl Bromide	Gas	95	3.6		0.78			
74-90-8	Hydrocyanic Acid	Gas	27	25.7		0.0055			
74-93-1	Methyl Mercaptan	Gas	48	6.2		0.079			
75-15-0	Carbon Disulfide	Liquid	76	46.5	360.0	0.16	0.01	0.03	
75-18-3	Dimethyl Sulfide	Liquid	62	37.3	520	0.0003	0.02	0.02	
75-21-8	Ethylene Oxide	Gas	44	10.7		0.14			
75-44-5	Phosgene	Gas	99	8.2		0.0008			
75-55-8	Propyleneimine	Liquid	57	66	149	0.12	0.005	0.02	
75-56-9	Propylene Oxide	Liquid	58	34.23	517	0.48	0.02	0.02	
75-74-1	Tetramethyllead	Liquid	267	110	22	0.004	0.002	0.05	

Exhibit C-2
List of Extremely Hazardous Substances and Data for Hazards Analysis
(CAS # Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
75-77-4	Trimethylchlorosilane	Liquid	109	57	71	0.05	0.004	0.03	
75-78-5	Dimethyldichlorosilane	Liquid	129	70	139	0.003	0.008	0.04	
75-79-6	Methyltrichlorosilane	Liquid	149	67	280	0.0018	0.02	0.04	
75-86-5	Acetone Cyanohydrin	Liquid	85	200	0.50	0.012	0.00002	0.02	
*76-01-7	Pentachloroethane	Liquid	202	161	3.4	3.5	0.0003	0.04	
76-02-8	Trichloroacetyl Chloride	Liquid	182	118	0.0000001	0.0045	0.000000000007	0.04	
77-47-4	Hexachlorocyclopentadiene	Liquid	273	239	0.08	0.0002	0.000007	0.04	
77-78-1	Dimethyl Sulfate	Liquid	126	188	0.1	0.005	0.000006	0.03	
77-81-6	Tabun	Liquid	162	240	0.07	0.00015	0.000005	0.03	
78-00-2	Tetraethyllead	Liquid	323	110	0.2	0.004	0.00002	0.06	
78-34-2	Dioxathion	Liquid	457	250	0.01	0.0034	0.000001	0.06	
78-53-5	Amiton	Liquid	269	330	0.000001	0.0033	0.00000000009	0.03	
78-71-7	Oxetane, 3,3-Bis(Chloromethyl)-	Liquid	155	200	0.5	0.002	0.00003	0.03	
78-82-0	Isobutyronitrile	Liquid	69	103.8	50	0.025	0.002	0.02	
78-94-4	Methyl Vinyl Ketone	Liquid	70	81.4	160	0.00007	0.006	0.02	
78-97-7	Lactonitrile	Liquid	71	182	1.7	0.018	0.00006	0.02	
79-06-1	Acrylamide	Solid	71	250	0.007	0.11			0.00004
79-11-8	Chloroacetic Acid	Solid	95	189	0.5	0.0018			0.0002
79-19-6	Thiosemicarbazide	Solid	91	320	0.00001	0.0092			0.0004
79-21-0	Peracetic Acid	Liquid	76	105	60	0.0045	0.002	0.02	
79-22-1	Methyl Chloroformate	Liquid	95	71	210	0.0018	0.01	0.03	
80-63-7	Methyl 2-Chloroacrylate	Liquid	121	140	12	0.005	0.0006	0.03	
81-81-2	Warfarin	Solid	308	356	0.00001	0.02			0.0001
82-66-6	Diphacinone	Solid	340		0.00001	0.0009			
*84-80-0	Phylloquinone	Liquid	451	450	0.00000001	25	0.000000000001	0.04	
86-50-0	Azinphos-Methyl	Solid	317	400	0.0000001	0.0007			0.000000003
86-88-4	ANTU	Solid	202	400	0.000001	0.01			0.00009
*87-86-5	Pentachlorophenol	Solid	266	309	0.0002	0.015			0.001
88-05-1	Aniline, 2,4,6-Trimethyl-	Liquid	135	232	0.10	0.0029	0.000006	0.03	
88-85-7	Dinoseb	Solid	240	345	0.0001	0.0045			0.000000002
91-08-7	Toluene 2,6-Diisocyanate	Liquid	174	245	0.5	0.0009	0.00003	0.03	
*93-05-0	Diethyl-p-Phenylenediamine	Liquid	164	260	0.02	1.25	0.000001	0.03	
95-48-7	Cresol, o-	Solid	108	191	0.5	0.11			0.00003
*95-63-6	Pseudocumene	Liquid	120	169	1.9	0.18	0.0001	0.03	
97-18-7	Phenol, 2,2'-Thiobis(4,6-Dichloro)-	Solid	356		0.0000001	0.007			
98-05-5	Benzenearsonic Acid	Solid	202		0.00001	0.00027			
98-07-7	Benzotrichloride	Liquid	195	220.8	1.0	0.0007	0.00007	0.03	
*98-09-9	Benzenesulfonyl Chloride	Liquid	177	251	0.03	0.2	0.000002	0.03	
98-13-5	Trichlorophenylsilane	Liquid	212	201.5	0.01	0.0033	0.0000008	0.04	
98-16-8	Benzenamine, 3-(Trifluoromethyl)-	Liquid	161	187.5	1.0	0.0044	0.00007	0.03	
98-87-3	Benzal Chloride	Liquid	161	205	1.0	0.0023	0.00007	0.03	
98-95-3	Nitrobenzene	Liquid	123	210.8	0.005	0.1	0.0000003	0.03	
99-98-9	Dimethyl-p-Phenylenediamine	Solid	136	262	0.0001	0.00013			0.000005
100-14-1	Benzene, 1-(Chloromethyl)-4-Nitro-	Solid	172	230	0.05	0.028			0.00008
100-44-7	Benzyl Chloride	Liquid	127	179	1.0	0.0052	0.00006	0.03	
102-36-3	Isocyanic Acid,3,4-Dichlorophenyl Ester	Solid	188	240	0.02	0.014			0.000009
103-85-5	Phenylthiourea	Solid	152	320	0.000002	0.003			0.0002
106-89-8	Epichlorohydrin	Liquid	93	116.5	16	0.038	0.0007	0.03	
106-96-7	Propargyl Bromide	Liquid	119	88	180	0.00003	0.01	0.03	
*106-99-0	Butadiene	Gas	54	-4.4		4.43			
107-02-8	Acrolein	Liquid	56	52.5	220.0	0.0011	0.007	0.02	
107-07-3	Chloroethanol	Liquid	81	128	5.0	0.0033	0.0002	0.02	

Exhibit C-2
List of Extremely Hazardous Substances and Data for Hazards Analysis
(CAS # Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
107-11-9	Allylamine	Liquid	57	55	500.0	0.0032	0.02	0.02	
107-12-0	Propionitrile	Liquid	55	97.2	40	0.0037	0.001	0.02	
107-13-1	Acrylonitrile	Liquid	54	77.3	115.0	0.11	0.004	0.02	
107-15-3	Ethylenediamine	Liquid	60	116	15	0.49	0.0005	0.02	
107-16-4	Formaldehyde Cyanohydrin	Liquid	57	183	1.8	0.006	0.00006	0.02	
107-18-6	Allyl Alcohol	Liquid	58	97	23.8	0.036	0.0008	0.02	
*107-20-0	Chloroacetaldehyde	Liquid	78.5	85	100	0.069	0.004	0.03	
107-30-2	Chloromethyl Methyl Ether	Liquid	81	59	224	0.0018	0.009	0.03	
107-44-8	Sarin	Liquid	140	147	2.9	0.00005	0.0002	0.03	
107-49-3	TEPP	Liquid	290	310	0.00047	0.001	0.00000005	0.04	
108-05-4	Vinyl Acetate Monomer	Liquid	86	72	124	0.054	0.005	0.03	
108-23-6	Isopropyl Chloroformate	Liquid	123	104.6	50	0.1	0.003	0.03	
*108-67-8	Mesitylene	Liquid	120	165	1.8	0.24	0.0001	0.03	
108-91-8	Cyclohexylamine	Liquid	99	134.5	10	0.16	0.0005	0.03	
108-95-2	Phenol	Solid	94	181.75	0.35	0.039			0.00008
108-98-5	Thiophenol	Liquid	110	168.3	1	0.0014	0.00005	0.03	
*109-19-3	Butyl Isovalerate	Liquid	158	175.5	0.45	8.2	0.00003	0.03	
109-61-5	Propyl Chloroformate	Liquid	123	114	24	0.01	0.001	0.03	
109-77-3	Malononitrile	Solid	66	218	0.08	0.019			0.000005
110-00-9	Furan	Liquid	68	32	700	0.0012	0.03	0.03	
110-57-6	Trans-1,4-Dichlorobutene	Liquid	125	155.5	6	0.0044	0.0003	0.03	
110-89-4	Piperidine	Liquid	85	106	40	0.022	0.002	0.03	
*111-34-2	Butyl Vinyl Ether	Liquid	100	94	50	0.62	0.002	0.03	
111-44-4	Dichloroethyl Ether	Liquid	143	178	0.7	0.15	0.00004	0.03	
111-69-3	Adiponitrile	Liquid	108	295	0.001	0.017	0.00000005	0.02	
115-21-9	Trichloroethylsilane	Liquid	164	97.9	0.6	0.003	0.00004	0.04	
115-26-4	Dimefox	Liquid	154	210	0.36	0.001	0.00002	0.03	
115-29-7	Endosulfan	Solid	407		0.00001	0.0008			
115-90-2	Fensulfothion	Liquid	308	440	0.00000001	0.002	0.000000000001	0.03	
116-06-3	Aldicarb	Solid	190	287	0.50	0.0003			0.00004
*117-52-2	Coumafuryl	Solid	298		0.00001	4			
119-38-0	Isopropylmethylpyrazolyl Dimethylcarbamate	Liquid	211	295	0.001	0.0056	0.00000008	0.03	
122-14-5	Fenitrothion	Liquid	277	370	0.000006	0.0038	0.0000000006	0.03	
123-31-9	Hydroquinone	Solid	110	285	0.001	0.02			0.0008
123-73-9	Crotonaldehyde, (E)-	Liquid	70	104	36	0.04	0.001	0.02	
124-65-2	Sodium Cacodylate	Solid	160	D	0.00001	0.004			
124-87-8	Picrotoxin	Solid	603		0.00001	0.015			
126-98-7	Methacrylonitrile	Liquid	67	90.3	90	0.003 a	0.003	0.02	
*128-56-3	Sodium Anthraquinone-1-Sulfonate	Solid	310		0.00001	14			
129-00-0	Pyrene	Solid	202	404	0.00001	0.0017			0.00001
129-06-6	Warfarin Sodium	Solid	330		0.00001	0.009			
131-52-2	Sodium Pentachlorophenate	Solid	288		0.00001	0.0024			
140-29-4	Benzyl Cyanide	Liquid	117	233.5	1.0	0.0043	0.00005	0.02	
140-76-1	Pyridine, 2-Methyl-5-Vinyl-	Liquid	119	181	1.7	0.0019	0.00009	0.03	
141-66-2	Dicrotophos	Liquid	237	400	0.00001	0.0009	0.0000000008	0.03	
143-33-9	Sodium Cyanide (Na(CN))	Solid	49	1496	0.00001	0.005			0.0000000000001
144-49-0	Fluoroacetic Acid	Solid	78	165	2	0.00047			0.0001
149-74-6	Dichloromethylphenylsilane	Liquid	191	205	0.4	0.02	0.00003	0.03	
151-38-2	Methoxyethylmercuric Acetate	Solid	319		0.00001	0.025			
151-50-8	Potassium Cyanide	Solid	65		0.00001	0.005			
151-56-4	Ethyleneimine	Liquid	43	55	207	0.004	0.006	0.02	

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CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
152-16-9	Diphosphoramide, Octamethyl-	Liquid	286	330	0.001	0.0008	0.0000001	0.04	
*287-92-3	Cyclopentane	Liquid	70	49	317	11	0.01	0.03	
297-78-9	Isobenzan	Solid	412		0.00001	0.001			
297-97-2	Thionazin	Liquid	248	360	0.003	0.0035	0.0000003	0.03	
298-00-0	Parathion-Methyl	Solid	263	D	0.0000097	0.00034			
298-02-2	Phorate	Liquid	260	290	0.00084	0.0001	0.00000008	0.04	
298-04-4	Disulfoton	Liquid	274	400	0.00018	0.002	0.00000002	0.03	
300-62-9	Amphetamine	Liquid	135	200	0.90	0.02	0.00005	0.03	
302-01-2	Hydrazine	Liquid	32	113.5	14.4	0.01	0.0003	0.01	
309-00-2	Aldrin	Solid	365	145	0.000006	0.01			0.02
315-18-4	Mexacarbate	Solid	222		0.000002	0.014			0.00000003
316-42-7	Emetine, Dihydrochloride	Solid	554		0.00001	0.00001			
327-98-0	Trichloronate	Liquid	334	360	20	0.01	0.002	0.04	
353-42-4	Boron Trifluoride Compound with Methyl Ether (1:1)	Liquid	114	126	20.0	0.023	0.001	0.03	
359-06-8	Fluoroacetyl Chloride	Liquid	96	73	80	0.01	0.004	0.03	
371-62-0	Ethylene Fluorohydrin	Liquid	64	103.5	50	0.00007	0.002	0.02	
379-79-3	Ergotamine Tartrate	Solid	1314		0.00001	0.01			
465-73-6	Isodrin	Solid	365	344	0.00001	0.007			0.004
470-90-6	Chlorfenvinfos	Liquid	360	390	0.000004	0.01	0.0000000004	0.04	
502-39-6	Methylmercuric Dicyanamide	Solid	299		0.00003	0.02			0.0001
504-24-5	Pyridine, 4-Amino-	Solid	94	273.5	0.002	0.02			0.0007
505-60-2	Mustard Gas	Liquid	159	215	0.09	0.001	0.000006	0.03	
506-61-6	Potassium Silver Cyanide	Solid	199		0.00001	0.02			
506-68-3	Cyanogen Bromide	Solid	106	61.4	92	0.044			0.02
506-78-5	Cyanogen Iodide	Solid	153	45 S	1	0.18			0.02
509-14-8	Tetranitromethane	Liquid	196	126	13	0.008 a	0.001	0.04	
514-73-8	Dithiazanine Iodide	Solid	520		0.00001	0.02			
534-07-6	Bis(Chloromethyl) Ketone	Solid	127	173	1.0	0.00027			0.0002
534-52-1	Dinitrocresol	Solid	198	312	0.00005	0.0005			0.000007
535-89-7	Crimidine	Solid	172	300	0.00001	0.0012			0.00001
538-07-8	Ethylbis(2-Chloroethyl)Amine	Liquid	170	200	0.24	0.0075	0.00002	0.03	
541-25-3	Lewisite	Liquid	207	190	0.395	0.0047	0.00003	0.04	
541-53-7	Dithiobiuret	Solid	135		0.00001	0.005			
542-76-7	Propionitrile, 3-Chloro-	Liquid	90	175	2.5	0.009	0.0001	0.02	
542-88-1	Chloromethyl Ether	Liquid	115	106	30.0	0.00025	0.002	0.03	
542-90-5	Ethylthiocyanate	Liquid	87	146	4	0.1	0.0002	0.02	
555-77-1	Tris(2-Chloroethyl)Amine	Liquid	205	256	0.011	0.0008	0.0000008	0.03	
556-61-6	Methyl Isothiocyanate	Solid	73	119	15	0.033			0.0009
556-64-9	Methyl Thiocyanate	Liquid	73	130	20	0.085	0.0008	0.02	
558-25-8	Methanesulfonyl Fluoride	Liquid	98	124	10	0.014	0.0005	0.03	
563-12-2	Ethion	Liquid	384	150 D	0.0000015	0.013	0.0000000002	0.09	
563-41-7	Semicarbazide Hydrochloride	Solid	112		0.00001	0.1			
584-84-9	Toluene 2,4-Diisocyanate	Liquid	174	251	1	0.007	0.00007	0.03	
594-42-3	Perchloromethylmercaptan	Liquid	186	147	10	0.0076	0.0007	0.04	
597-64-8	Tetraethyltin	Liquid	235	181	2	0.007	0.0002	0.04	
614-78-8	Thiourea, (2-Methylphenyl)-	Solid	166		0.000002	0.05			
624-83-9	Methyl Isocyanate	Liquid	57	39	348	0.0047	0.01	0.02	
624-92-0	Methyl Disulfide	Liquid	94	109.7	28.6	0.0001	0.001	0.03	
625-55-8	Isopropyl Formate	Liquid	88	68.2	100	0.0014	0.004	0.03	
627-11-2	Chloroethyl Chloroformate	Liquid	143	155.7	9.0	0.02	0.0005	0.03	
630-60-4	Ouabain	Solid	585		0.00001	0.0083			

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*633-03-4	C. I. Basic Green 1	Solid	483		0.00001	0.25			
639-58-7	Triphenyltin Chloride	Solid	385	400	0.000001	0.02			0.0000001
*640-15-3	Thiometon	Liquid	246	340	0.0003	0.06	0.00000003	0.03	
640-19-7	Fluoroacetamide	Solid	77	250	0.001	0.0058			0.0002
644-64-4	Dimetilan	Solid	240	350	0.0001	0.025			0.00000004
*646-06-0	Dioxolane	Liquid	74	74	70	0.21	0.003	0.02	
675-14-9	Cyanuric Fluoride	Liquid	135	73	120	0.00017	0.007	0.04	
676-97-1	Methyl Phosphonic Dichloride	Solid	133	163	1	0.0014			0.0002
696-28-6	Phenyl Dichloroarsine	Liquid	223	254.4	0.033	0.004	0.000003	0.03	
732-11-6	Phosmet	Solid	317	D	0.0008	0.00054			0.000008
760-93-0	Methacrylic Anhydride	Liquid	154	240	0.01	0.0045	0.0000006	0.03	
786-19-6	Carbophenothion	Liquid	343	350	0.0000003	0.0068	0.00000000003	0.04	
814-49-3	Diethyl Chlorophosphate	Liquid	173	210	0.2	0.008	0.00001	0.03	
814-68-6	Acrylyl Chloride	Liquid	91	75	300.0	0.0009	0.01	0.03	
824-11-3	Trimethylolpropane Phosphite	Solid	162	200	0.2	0.0025			0.0001
900-95-8	Stannane, Acetoxytriphenyl-	Solid	409			0.02			
919-86-8	Demeton-S-Methyl	Liquid	230	305	0.0001	0.005	0.000000008	0.03	
920-46-7	Methacryloyl Chloride	Liquid	105	96	40	0.0006	0.002	0.03	
944-22-9	Fonofos	Liquid	246	380	0.00021	0.0013	0.00000002	0.03	
947-02-4	Phosfolan	Solid	255	410	0.00001	0.009			0.000000000002
950-10-7	Mephosfolan	Liquid	269	410	1.0000000E-10	0.009	0.000000000000009	0.03	
950-37-8	Methidathion	Solid	302		0.000001	0.02			0.0000000003
991-42-4	Norbormide	Solid	512		0.00001	0.0038			
998-30-1	Triethoxysilane	Liquid	164	132	23	0.005	0.002	0.04	
999-81-5	Chlormequat Chloride	Solid	158		0.00001	0.007			
1031-47-6	Triamiphos	Solid	294	400	0.0000001	0.01			0.000000003
1066-45-1	Trimethyltin Chloride	Solid	199	154	3	0.02			0.0004
1122-60-7	Nitrocyclohexane	Liquid	129	205.5	0.35	0.0015	0.00002	0.03	
1124-33-0	Pyridine, 4-Nitro-, 1-Oxide	Solid	140	390	0.00001	0.08			0.00002
1129-41-5	Metolcarb	Solid	165	360	0.0001	0.0048			0.00000003
1303-28-2	Arsenic Pentoxide	Solid	230		0.00001	0.008			
1306-19-0	Cadmium Oxide	Solid	128	1559 S	0.00001	0.004			0.000004
*1314-32-5	Thallic Oxide	Solid	457	875	0.00001	0.002			0.003
1314-56-3	Phosphorus Pentoxide	Solid	142		0.00001	0.0006			
1314-62-1	Vanadium Pentoxide	Solid	182	1750	0.0000001	0.007			0.0000000000002
1314-84-7	Zinc Phosphide	Solid	258	1100	0.0000001	0.012			0.0000000002
1327-53-3	Arsenous Oxide	Solid	198	465	0.0000001	0.0014			0.001
*1331-17-5	Propylene Glycol, Allyl Ether	Liquid	116	160	2	0.51	0.0001	0.03	
*1335-87-1	Hexachloronaphthalene	Solid	335	270	0.003	0.0002			
1397-94-0	Antimycin A	Solid	549		0.00001	0.0018			
1420-07-1	Dinoterb	Solid	240	350	0.00001	0.025			
1464-53-5	Diepoxybutane	Liquid	86	138	16	0.0035	0.0007	0.02	
1558-25-4	Trichloro(Chloromethyl)Silane	Liquid	184	118	30	0.0003	0.002	0.04	
1563-66-2	Carbofuran	Solid	221	360	0.00001	0.00043			0.00005
1600-27-7	Mercuric Acetate	Solid	319		0.00001	0.024			
1622-32-8	Ethanesulfonyl Chloride, 2-Chloro-	Liquid	163	200	0.6	0.0025	0.00004	0.03	
1642-54-2	Diethylcarbamazine Citrate	Solid	391		0.00001	0.003			
1752-30-3	Acetone Thiosemicarbazide	Solid	131		0.00001	0.1			
1910-42-5	Paraquat	Solid	257		0.0000001	0.00015			
1982-47-4	Chloroxuron	Solid	291		0.0000001	0.01			
2001-95-8	Valinomycin	Solid	1112		0.00001	0.0025			
2032-65-7	Methiocarb	Solid	225	325	0.0001	0.015			0.00003

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2074-50-2	Paraquat Methosulfate	Solid	408		0.0000001	0.00015			
2097-19-0	Phenylsilatrane	Solid	251	350	0.00001	0.001			0.0008
2104-64-5	EPN	Solid	323	380	0.000002	0.005			0.000000000007
2223-93-0	Cadmium Stearate	Solid	681		0.00001	0.0013			
2231-57-4	Thiocarbazide	Solid	106		0.00001	0.1			
*2235-25-8	Ethylmercuric Phosphate	Solid	327		0.00001	0.001			
2238-07-5	Diglycidyl Ether	Liquid	130	260	0.09	0.045	0.000005	0.02	
*2244-16-8	Carvone	Liquid	150	230	0.04	0.0037	0.000002	0.03	
2275-18-5	Prothoate	Solid	285	330	0.0001	0.0017			0.000000001
2497-07-6	Oxydisulfoton	Liquid	274	330	0.00006	0.0035	0.000000006	0.03	
2524-03-0	Dimethyl Phosphorochloridothioate	Liquid	161	180	1	0.0032	0.00006	0.03	
2540-82-1	Formothion	Liquid	257	250	0.0000085	0.00027	0.0000000008	0.04	
2570-26-5	Pentadecylamine	Solid	227	307.6	0.0003	0.002			0.00000001
2587-90-8	Phosphorothioic Acid, O,O-Dimethyl-S-(2-Methylthio) Ethyl Ester	Liquid	216	230		0.02		0.04	
2631-37-0	Promecarb	Solid	207	345	0.00003	0.016			0.0000003
2636-26-2	Cyanophos	Liquid	243	350	0.0008	0.025	0.00000007	0.03	
2642-71-9	Azinphos-Ethyl	Solid	345	400	0.0000002	0.0039			0.00000000003
2665-30-7	Phosphonothioic Acid, Methyl-,O-(4-Nitrophenyl) O-Phenyl Ester	Liquid	309	400	0.00001	0.008	0.000000001	0.03	
2703-13-1	Phosphonothioic Acid, Methyl-, O-Ethyl O-(4-(Methylthio)Phenyl) Ester	Liquid	262	298	0.0001	0.01	0.000000009	0.04	
2757-18-8	Thallous Malonate	Solid	511	300	0.00001	0.002			
2763-96-4	Muscimol	Solid	114		0.00001	0.017			
2778-04-3	Endothion	Solid	280		0.00001	0.017			
3037-72-7	Silane, (4-Aminobutyl)Diethoxymethyl-	Liquid	205	220	0.06	0.045	0.000005	0.03	
*3048-64-4	Vinylnorbornene	Liquid	120	141	5	4.37	0.0003	0.03	
3254-63-5	Phosphoric Acid, Dimethyl 4-(Methylthio) Phenyl Ester	Liquid	248	300	0.001	0.007	0.00000009	0.03	
3569-57-1	Sulfoxide, 3-Chloropropyl Octyl	Liquid	239	338	0.0002	0.008	0.00000002	0.03	
3615-21-2	Benzimidazole, 4,5-Dichloro-2-(Trifluoromethyl)-	Solid	255			0.013			
3689-24-5	Sulfotep	Liquid	322	310	0.00017	0.0035	0.00000002	0.04	
3691-35-8	Chlorophacinone	Solid	375		0.00001	0.001			
3734-97-2	Amiton Oxalate	Solid	359		0.00001	0.003			
3735-23-7	Methyl Phenkapton	Liquid	349	400	0.0000035	0.011	0.0000000004	0.04	
3878-19-1	Fuberidazole	Solid	184		0.00001	0.0033			
4044-65-9	Bitoscanate	Solid	192	290	0.0001	0.02			0.0002
4098-71-9	Isophorone Diisocyanate	Solid	222	360	0.00001	0.00123			0.000000006
4104-14-7	Phosacetim	Solid	375	400	0.00001	0.0037			0.00000009
4170-30-3	Crotonaldehyde	Liquid	70	104	36	0.04	0.001	0.02	
4301-50-2	Fluenetil	Solid	258		0.0000025	0.006			0.0000007
4418-66-0	Phenol,2,2'-Thiobis(4-Chloro-6-Methyl)-	Solid	315	443	0.0000001	0.0013			0.00001
4835-11-4	Hexamethylenediamine, N,N'-Dibutyl-	Liquid	228	205	0.0004	0.0022	0.00000003	0.04	
5281-13-0	Piprotal	Solid	457	463	0.0000001	0.0044			0.0000004
5344-82-1	Thiourea, (2-Chlorophenyl)-	Solid	187	323	0.000002	0.0046			0.0001
5836-29-3	Coumatetralyl	Solid	292		0.00001	0.0165			
6533-73-9	Thallous Carbonate	Solid	469		0.00001	0.002			
6923-22-4	Monocrotophos	Solid	223	430	0.000007	0.00063			0.000000000002
*7440-02-0	Nickel	Solid	59	2732	0.00001	0.05			0.0000001
*7440-48-4	Cobalt	Solid	59	2870	0.00001	0.002			0.000000001
7446-09-5	Sulfur Dioxide	Gas	64	-10		0.026			

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7446-11-9	Sulfur Trioxide	Solid	80	45	433	0.003			0.01
7446-18-6	Thallous Sulfate	Solid	505		0.0000001	0.002			
7487-94-7	Mercuric Chloride	Solid	272	302	0.0004	0.03			0.02
7550-45-0	Titanium Tetrachloride	Liquid	190	136.4	10	0.001	0.0007	0.04	
7580-67-8	Lithium Hydride	Solid	8		0.00001	0.005			
7631-89-2	Sodium Arsenate	Solid	326		0.00001	0.13			
7637-07-2	Boron Trifluoride	Gas	68	-127		0.028			
7647-01-0	Hydrogen Chloride (Gas Only)	Gas	36	-85		0.015			
7664-39-3	Hydrogen Fluoride	Gas	20	19.4		0.0016			
7664-41-7	Ammonia	Gas	17	-33.4		0.035			
7664-93-9	Sulfuric Acid	Liquid	98	290	0.000001	0.008	0.00000000005	0.02	
7697-37-2	Nitric Acid	Liquid	63	83	47.8	0.026	0.002	0.02	
7719-12-2	Phosphorus Trichloride	Liquid	137	76	135	0.028	0.008	0.04	
7722-84-1	Hydrogen Peroxide (Conc > 52%)	Liquid	34	152	5	0.01	0.0001	0.01	
7723-14-0	Phosphorus	Solid	31	280	0.05	0.003			0.00000005
7726-95-6	Bromine	Liquid	160	60	172.0	0.0065	0.01	0.04	
7778-44-1	Calcium Arsenate	Solid	398		0.00001	0.01			
7782-41-4	Fluorine	Gas	38	-188		0.039			
7782-50-5	Chlorine	Gas	71	-34.6		0.0073			
7783-00-8	Selenious Acid	Solid	129		4	0.25			0.002
7783-06-4	Hydrogen Sulfide	Gas	34	-60		0.042			
7783-07-5	Hydrogen Selenide	Gas	81	-41		0.00066			
7783-60-0	Sulfur Tetrafluoride	Gas	108	-40		0.0092			
7783-70-2	Antimony Pentafluoride	Liquid	217	141	7.0	0.0027	0.0006	0.04	
7783-80-4	Tellurium Hexafluoride	Gas	242	-39 S		0.001			
7784-34-1	Arsenous Trichloride	Liquid	181	130.21	10.0	0.01	0.0007	0.04	
7784-42-1	Arsine	Gas	78	-62		0.0019			
7784-46-5	Sodium Arsenite	Solid	130		0.00001	0.01			
7786-34-7	Mevinphos	Liquid	224	280	0.0029	0.004	0.0000002	0.03	
7791-12-0	Thallous Chloride	Solid	240	720	0.0000001	0.002			0.00007
7791-23-3	Selenium Oxychloride	Liquid	166	180	2.9	0.01	0.0002	0.03	
7803-51-2	Phosphine	Gas	34	-88		0.028			
8001-35-2	Camphechlor	Solid	414	D	0.4	0.02			0.003
*8023-53-8	Dichlorobenzalkonium Chloride	Solid	423		0.00001	0.32			
8065-48-3	Demeton	Liquid	258	300	0.00026	0.002	0.00000002	0.03	
*10025-65-7	Platinous Chloride	Solid	266		0.00001	0.013			
10025-73-7	Chromic Chloride	Solid	158	1300 S	0.00001	0.00005			0.003
10025-87-3	Phosphorus Oxychloride	Liquid	153	106	40	0.003	0.003	0.04	
*10025-97-5	Iridium Tetrachloride	Solid	334		0.00001	0.0047			
10026-13-8	Phosphorus Pentachloride	Solid	208	160	1	0.02			0.006
10028-15-6	Ozone	Gas	48	-111		0.002			
10031-59-1	Thallium Sulfate	Solid	1527	D	0.00001	0.002			
*10049-07-7	Rhodium Trichloride	Solid	209	800	0.00001	0.0062			0.00002
10102-18-8	Sodium Selenite	Solid	173		0.00001	0.0023			
10102-20-2	Sodium Tellurite	Solid	222		0.00001	0.02			
10102-43-9	Nitric Oxide	Gas	30	-151		0.03 a			
10102-44-0	Nitrogen Dioxide	Gas	46	21.15		0.0094			
10124-50-2	Potassium Arsenite	Solid	254		0.00001	0.014			
10140-87-1	Ethanol, 1,2-Dichloro-, Acetate	Liquid	157	280	0.001	0.011	0.00000006	0.03	
10210-68-1	Cobalt Carbonyl	Solid	342	52 D	0.1	0.00027			0.07
10265-92-6	Methamidophos	Solid	141	D	0.0003	0.0075			0.00000006
10294-34-5	Boron Trichloride	Gas	117	13		0.01			

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10311-84-9	Dialifor	Solid	394	300	0.0005	0.005			0.000001
10476-95-6	Methacrolein Diacetate	Liquid	172	191	0.35	0.044	0.00002	0.03	
12002-03-8	Paris Green	Solid	1014		0.00001	0.022			
12108-13-3	Manganese, Tricarbonyl Methylcyclopetadienyl	Liquid	218	232	0.1	0.0006	0.000008	0.04	
13071-79-9	Terbufos	Liquid	288	315	0.0003	0.001	0.00000003	0.04	
13171-21-6	Phosphamidon	Liquid	300	350	0.000025	0.0003	0.000000002	0.04	
13194-48-4	Ethoprophos	Liquid	242	300	0.00035	0.026	0.00000003	0.03	
13410-01-0	Sodium Selenate	Solid	189		0.00001	0.0016			
13450-90-3	Gallium Trichloride	Solid	176	201.3	0.2	0.032			0.0004
*13454-96-1	Platinum Tetrachloride	Solid	337		0.00001	0.002			
13463-39-3	Nickel Carbonyl	Liquid	171	43	400	0.00035 a	0.03	0.05	
13463-40-6	Iron, Pentacarbonyl-	Liquid	196	103	40	0.0008 a	0.003	0.04	
13494-80-9	Tellurium	Solid	128	989.9	0.00001	0.02			0.00000002
14167-18-1	Salcomine	Solid	325		0.00001	0.039			
15271-41-7	Bicyclo[2.2.1]Heptane-2-Carbonitrile, 5-Chloro-6-((((Methylamino)Carbonyl) Oxy)Imino)-, (1S-(1-alpha,2-beta, 4-alpha,5-alpha,6E))-	Solid	242		0.00001	0.019			
16752-77-5	Methomyl	Solid	162	335	0.00005	0.01			0.0000002
*16919-58-7	Ammonium Chloroplatinate	Solid	444		0.00001	0.00044			
17702-41-9	Decaborane(14)	Solid	122	213	0.1	0.01			0.0006
17702-57-7	Formparanate	Solid	235	385	0.0000025	0.0072			0.0000003
19287-45-7	Diborane	Gas	28	-92		0.005			
19624-22-7	Pentaborane	Liquid	63	60	170	0.0008	0.006	0.02	
*20816-12-0	Osmium Tetroxide	Solid	254	130	11	0.0001			0.002
20830-75-5	Digoxin	Solid	781		0.00001	0.0002			
20859-73-8	Aluminum Phosphide	Solid	58	320	0.00001	0.02			
21548-32-3	Fosthietan	Liquid	241	250	0.0000065	0.0047	0.0000000006	0.04	
*21564-17-0	Thiocyanic Acid, 2-(Benzothiazolylthio)	Liquid	238	350	0.00001	1.6	0.0000000008	0.03	
21609-90-5	Leptophos	Solid	412	380	0.000002	0.03			0.000000009
21908-53-2	Mercuric Oxide	Solid	217		0.00001	0.016			
21923-23-9	Chlorthiophos	Liquid	361	400	0.0004	0.0078	0.00000004	0.04	
22224-92-6	Fenamiphos	Solid	303	450	0.0000001	0.0009			0.0000000000001
23135-22-0	Oxamyl	Solid	219	310	0.00023	0.0017			0.00002
23422-53-9	Formetanate Hydrochloride	Solid	258	440	0.0000001	0.018			0.00003
23505-41-1	Pirimifos-Ethyl	Liquid	333	130 D	0.00029	0.025	0.00000003	0.09	
24017-47-8	Triazofos	Liquid	313	350	0.0001	0.0028	0.000000001	0.04	
24934-91-6	Chlormephos	Liquid	235	295	0.0056	0.007	0.0000005	0.03	
26419-73-8	Carbamic Acid, Methyl-, O-(((2,4-Dimethyl-1,3-Dithiolan-2-Yl) Methylene)Amino)-	Solid	234	400	0.0000006	0.001			0.000004
26628-22-8	Sodium Azide (Na(N3))	Solid	65		0.00001	0.02			
27137-85-5	Trichloro(Dichlorophenyl)Silane	Liquid	280	260	70	0.008	0.007	0.04	
28347-13-9	Xylylene Dichloride	Solid	175	239	0.02	0.002			0.0003
28772-56-7	Bromadiolone	Solid	527		0.00001	0.001			
30674-80-7	Methacryloyloxyethyl Isocyanate	Liquid	155	74	80	0.00027	0.005	0.04	
39196-18-4	Thiofanox	Solid	218	315	0.00017	0.0085			0.00000009
50782-69-9	Phosphonothioic Acid, Methyl-, S-(2-(Bis(1-Methylethyl)Amino)Ethyl) O-Ethyl Ester	Liquid	267	298	0.0007	0.0009	0.00000006	0.04	
53558-25-1	Pyriminil	Solid	272		0.00001	0.0062			

Exhibit C-2
List of Extremely Hazardous Substances and Data for Hazards Analysis
(CAS # Order)

CAS #	Chemical Name	Physical State	Molecular Weight	Boiling Point (oC)	Vapor Pressure @ 25 C (mm Hg)	Level of Concern (gm/m3)	Liquid Factor Ambient LFA	Liquid Factor Boiling LFB	Liquid Factor Molten LFM
58270-08-9	Zinc, Dichloro(4,4-Dimethyl-5 ((((Methylamino)Carbonyl)Oxy)Imino) Pentanenitrile)-, (T-4)-	Solid	334		0.00001	0.009			
62207-76-5	Cobalt,((2,2'-(1,2-Ethanediylbis (Nitrilomethylidene))Bis(6-Fluoro Phenolato))(2-)-N,N',O,O')-	Solid	361		0.00001	0.003			

a: ACGIH TLV values were used for these chemicals.

* Chemicals proposed for deletion.

D: Decomposes

S: Sublimes

APPENDIX D

ADDITIONAL INFORMATION ON LEVELS OF CONCERN

D. 1 INTRODUCTION

Levels of concern (LOCs), for purposes of this document, are defined as the concentrations of an extremely hazardous substance (EHS) in air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

There is at present no precise measure of LOCs for the chemicals listed as EHSs. Various organizations have been developing for the past several years acute exposure guidelines for a limited number of hazardous chemicals: the methodology, however, is still in the developmental stages. Certain of the guidelines under development and the progress to date are described in detail below. Until more precise measures are developed, surrogate or estimated measures of LOCs have been identified for the listed EHSs. Local officials may choose values for LOCs different from those estimated in this guidance, depending upon their requirements and the specific characteristics of the planning district or site and the level of protection deemed appropriate.

For the purposes of this guidance, the LOC has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" (IDLH) level published by the National Institute for Occupational Safety and Health (NIOSH) or an approximation of the IDLH from animal toxicity data (See Appendix B). Other exposure guidelines that may be used to estimate LOC include the "Threshold Limit Values" (TLVs[1]), published by the American Conference of Governmental Industrial Hygienists (ACGIH), guidelines developed by the National Research Council (NRC) of the National Academy of Sciences, (NAS), and Emergency Response Planning Guidelines (ERPGs) under development by a consortium of chemical companies. Descriptions of the development and uses of these exposure guidelines will be given in the following sections.

[1] TLVs is a registered trademark.

LOCs may be given in units of parts per million (ppm), milligrams per cubic meter (mg/m3), milligrams per liter (mg/L), or grams per liter (g/L).

The equations for determining LOC in this guidance use the units grams per cubic meter, (g/m3), so any other units, such as ppm, must be converted to g/m3. Levels given in parts per million can be converted to grams per cubic meter (g/m3) as follows:

$$\text{LOC (in g/m3)} = \frac{\text{LOC (in ppm)}}{1000} \times \frac{\text{MW}}{24.5}$$

where MW is the substance's molecular weight. For example, chlorine has an LOC (0.1 IDLH) of 2.5 ppm and a molecular weight of about 71 g/mole. Thus, the LOC in grams per cubic meter is:

$$\text{LOC (in g/m3)} = \frac{2.5 \text{ ppm}}{1000} \times \frac{71}{24.5}$$

LOC given in milligrams per cubic meter (mg/m3) can be converted to g/m3 as follows:

LOC (in g/m3) = LOC (in mg/m3)/1000

LOC given in grams per liter (g/L) can be converted to g/m3 as follows:

LOC (in g/m3) = LOC (in g/L) x 1000

LOC given in milligrams per liter (mg/L) is equivalent to LOC in g/m3:

LOC (in g/m3) = LOC (In mg/L)

D.2 LEVEL OF CONCERN BASED ON ONE-TENTH IDLH OR ONE-TENTH THE ESTIMATED IDLH

About ten years ago, NIOSH developed IDLH levels for approximately 390 chemicals from the Occupational Safety and Health Administration (OSHA) Z-1 and Z-2 lists. These are lists of toxic and hazardous substances to which employee exposure must be limited as required by the Code of Federal Regulations 29, Chapter 17, Part 1910. IDLHs were developed exclusively for respirator selection in the workplace. The definition of IDLH provided in 30 CFR 11.3 (the Occupational Safety and Health Act of 1970, PL 91-596) is: "Immediately dangerous to life or health means conditions that pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants, such as radioactive materials, which are likely to have an adverse cumulative or delayed effect on health." The IDLH concentration represents the maximum concentration of a substance in air from which healthy male workers can escape without loss of life or irreversible health effects under conditions of a maximum 30-minute exposure time. Practically, IDLH's are concentrations above which a highly reliable breathing apparatus is required with provisions for escape.

The methodology in developing IDLHs takes into account immediate reactions that could prevent escape without injury, such as severe eye irritation or lung edema. The procedure used to derive IDLH's from data from mammalian toxicity studies is outlined below:

1. Where acute exposure data are available (30 minute to 4 hour exposures), the lowest exposure concentration causing death or irreversible health effects in any species is used as the IDLH concentration. These data are often reported as lethal concentration, low (LCLO).
2. Chronic exposure data are generally not considered in developing IDLH levels for the following reason: "Chronic exposure data may have no relevance to the acute effects and should be used in determining the IDLH concentration only upon competent toxicological judgment." (NIOSH 1978[2]),
3. Where there are no toxicity data to derive an IDLH concentration, 500 times the Permissible Exposure Limit (PEL) shall be used as the IDLH level.

EPA recognizes that the IDLH was not designed as a measure of the exposure level required to protect general populations. First, the IDLH is based upon the response of a healthy, male worker population and does not take into account exposure of more sensitive individuals such as the elderly, children, or people with various health problems. Second, the IDLH is based upon a maximum 30-minute exposure period, which may not be realistic for accidental airborne releases. IDLH values have been developed for about one-fourth of the EHSs on the list. The IDLH may not indicate the concentration that could result in serious but reversible injury. Based on these conditions, one-tenth the IDLH level or an estimation of this value for substances that do not have a published IDLH, has been selected as one approximation of an LOC available for planning purposes. These IDLH values have been developed with human acute toxicity as the principal consideration and represent exposure concentrations that are one to two orders of magnitude below the median lethal concentration (LC50) or the median lethal dose (LD50) levels reported for mammalian species under experimental conditions. IDLHs were estimated from acute animal toxicity test data for substances without IDLH values. In these instances, the concentration used is determined from LC50, LCLO, LD50, or LDLO data. Inhalation data were used, if available, in preference to other data, and median lethality data were preferred to other types. The following equations show how these data are converted to air concentrations comparable to the IDLH level:

(1) estimated IDLH = LC50 x 0.1;

(2) estimated IDLH = LCLO

(3) estimated IDLH = LD50 x 0.01

(4) estimated IDLH = LDLO x 0.1

[2] See Section D.7 for all references in Appendix D.

D.3 LEVELS OF CONCERN BASED ON THRESHOLD LIMIT VALUES (TLVs[3])

ACGIH publishes an annual list of three types of workplace exposure limits for several hundred compounds. ACGIH has published three TLVs as guidelines since 1941: Threshold limit value-Time-weighted average (TLV-TWA), TLV-Short term exposure limit (TLV-STEL), and TLV-Ceiling (TLV-C).

1. The TLV-TWA is defined as the time weighted average concentration limit for a normal eight hour workday and 40 hours per week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

2. The TLV-STEL is a 15-minute time-weighted average concentration for a normal eight-hour workday and forty-hour workweek. All workers should be able to withstand up to four exposures per day of concentrations as high as the TLV-STEL with no ill effects if the TLV-TWA is not also exceeded. TLV-STELs are applied to supplement the TLV-TWA when there are recognized acute effects from a substance whose toxic effects are primarily of a chronic nature.

3. The TLV-C is the airborne concentration that should not be exceeded in the workplace under any circumstances. Ceiling limits may supplement other limits or stand alone. In many cases, ACGIH could not find sufficient toxicological data to derive TLV-STELs or TLV-Cs for chemicals which had already been assigned a TLV-TWA. In these instances, the ACGIH recommends that five times the TLV-TWA be used in place of the TLV-C and that short-term exposures not exceed 3 times- the TLV-TWA for more than a total of 30 minutes during the day.

TLVs are based primarily on acute toxicity data (LC5Os and LD50s) and irritation data (irritation of the cornea and respiratory tract). Irritation effects that are considered range from barely detectable to irreversible, in laboratory animals and human subjects documented in industrial exposures. Only some TLVs consider neurotoxic and mutagenic effects. Although TLVs are derived for the protection of healthy male workers, they occasionally consider special impacts on workers with chronic respiratory problems, TLVs do not consider reproductive effects (ACGIH 1966). ACGIH advises against using or applying the TLV levels outside the workplace.

[3] TLVs is a registered trademark.

D.4 LEVELS OF CONCERN BASED ON NATIONAL ACADEMY OF SCIENCES SHORT-TERM EXPOSURE LEVELS

For the last forty years, the NRC's Committee on Toxicology has submitted emergency exposure guidelines for chemicals of concern to the Department of Defense (DOD) (NRC 1986), These guidelines are used in planning for sudden contamination of air during military and space operations; specifically, they are used to choose protective equipment and response plans after non-routine but predictable occurrences such as line breaks, spills, and fires. These guidelines are for peak levels of exposure considered acceptable for rare situations, but are not to be applied in instances of repeated exposure.

An Emergency Exposure Guidance Level (EEGL) is defined as a concentration of a substance in air (gas, vapor, or aerosol) judged by DOD to be acceptable for the performance of specific tasks by military personnel during emergency conditions lasting 1-24 hours. Exposure to an EEGL is not considered safe, but acceptable during tasks which are necessary to prevent greater risks, such as fire or explosion. Exposures at the EEGLs may produce transient central nervous system effects and eye or respiratory irritation, but nothing serious enough to prevent proper responses to emergency conditions.

Since the 1940's, the NRC has developed EEGLs for 41 chemicals, 15 of which are listed in Section 302 of Title Ill of SARA as EHSs. Although acute toxicity is the primary basis for selecting EEGLs, long term effects from a single acute exposure are also evaluated for developmental, reproductive (in both sexes), carcinogenic, neurotoxic, respiratory and other organ-related effects. The effect determined to be the most seriously debilitating, work-limiting, or sensitive is selected as the basis for deriving the EEGL. This concentration is intended to be sufficiently low to protect against other toxic effects that may occur at higher concentrations. Factors such as age of the exposed population, length of exposure, and susceptibility or sensitivity of the exposed population are also considered in determining EEGLs.

Safety factors are used in developing EEGLs to reflect the nature and quality of the data. Safety factors for single exposures may differ from those used in chronic studies. In the absence of better information, a safety factor of 10 is suggested for EEGLs (i.e., the reported toxicity value should be divided by 10) if only animal data are available and extrapolation from animals to humans is necessary for acute, short-term effects (NRC 1986). The safety factor of 10 takes into account the possibility that some individuals might be more sensitive than the animal species tested. A factor of 10 is also suggested if the likely route of human exposure differs from the route reported experimentally (NRC 1986) (e.g., if oral data are reported and inhalation is the most likely exposure route for humans).

As noted by NRC (1986, p. 7), development of an EEGL for different durations of exposure usually begins with the shortest exposure anticipated - i.e., 10-15 minutes - and works up to the longest, such as 24 hours. Under the simplest framework, Haber's law is assumed to operate, with the product of concentration (C) and time (t) as a constant (k) for all the short periods used (Ct=k) (Casarett and Doull 1986). If Ct is 30 and t is 10, then C is 3; if Ct is 30 and t is 30, then C is 1. If detoxification or recovery occurs and data are available on 24-hour exposures, this is taken into account in modifying Ct. In some instances, the Ct concept will be inappropriate, as for materials such as ammonia that can be more toxic with high concentrations over short periods. Each material is considered in relation to the applicability of Haber's law.

Generally, EEGLs have been developed for exposure to single substances, although emergency exposures often involve complex mixtures of substances and, thus, present the possibility of toxic effects resulting from several substances. In the absence of other information, guidance levels for complex mixtures can be developed from EEGLs by assuming as a first approximation that the toxic effects are additive. When the chemical under evaluation for development of an EEGL is an animal or human carcinogen, a separate qualitative risk assessment is undertaken in recognition of the fact that even limited exposure to such an agent can theoretically increase the risk of cancer. The risk assessment is performed with the aim of providing an estimate of the acute exposure that would not lead to an excess risk of cancer greater than 1 in 10,000 exposed persons. The following mathematical approach, taken directly from NRC (1986, pp. 26-27), is applicable for EEGL corn-putations for carcinogens:

1. If there has been computed an exposure level d (usually in ppm in air), which after a lifetime of exposure is estimated to produce some "acceptable" level of excess risk of cancer -- say, 1×10^{-6} -- this has been called a "virtually safe dose" (VSD). Computation of the dose d, if not already done by a regulatory agency, will be computed by the Committee on Toxicology in accordance with generally accepted procedures used by the major regulatory agencies, i.e., using the multistage no-threshold model for carcinogenesis and the appropriate body weight/surface area adjustments when extrapolating from an animal species to humans.

2. If carcinogenic effect is assumed to be a linear function of the total (cumulative) dose, then for a single 1-day human exposure an acceptable dose (to yield the same total lifetime exposure) would be d times 25,600 (there being approximately 25,600 days in an average lifetime); the allowable 1-day (24-h) dose rate would be

$$d \times 25{,}600$$

3. Because of uncertainties about which of several stages in the carcinogenic process a material may operate in, and because of the likely low age of military persons, it can be shown from data of Crump and Howe (1984) that the maximal additional risk that

these considerations contribute is a factor of 2.8. As a conservative approach, the acceptable dose is divided by 2.8, i.e.,

$$\frac{d \times 25{,}600}{2.8}$$

If a lifetime excess risk, R, is established by DOD (for example, at 1×10^{-4}, as has been suggested by the International Council on Radiation Protection for nuclear power plant workers), then the appropriate extent of risk at the EEGL would be

$$\frac{d \times 25.600}{2.8} \times \frac{R}{\text{level of risk at d}}$$

(In the example given here, the level of risk at d was no more than 1×10^{-6}.) If R is 1×10^{-4}, then R/risk at d = $10^{-4} / 10^{-6}$ = 100 (NRC 1986).

4. If a further element of conservatism is required (for example, where animal data need to be extrapolated to estimate human risk), an additional safety factor can be used as a divisor.

The NRC's Committee on Toxicology has also developed special public exposure guidelines upon request from Department of Defense. The Short-term Public Exposure Guidance Level (SPEGL) is defined as an acceptable ceiling concentration for a single, unpredicted short-term exposure to the public. The exposure period is usually calculated to be one hour or less and never more than 24 hours. SPEGLs are generally set at 0.1 to 0.5 times the EEGL. A safety factor of 2 is often used to take into account effects on sensitive subpopulations, such as children, the aged, and people with debilitating diseases. A safety factor of 10 may be used to take into account the effects of an exposure on fetuses and newborns. Effects on the reproductive capacity of both men and women are also considered. Five SPEGLs (for hydrazine, dimethylhydrazine, monomethyl hydrazine, nitrogen dioxide, and hydrogen chloride) have been developed by the NRC: all five chemicals are on the list of EHSs.

D.5 LEVELS OF CONCERN BASED ON EMERGENCY RESPONSE PLANNING GUIDELINES

A consortium of twenty-five chemical firms has developed a uniform protocol for community exposure guidelines based upon the NRC/NAS guidelines, EEGLs, and SPEGLs. The American Industrial Hygiene Association (AIHA) is providing technical review. These guidelines are not intended for repeated exposures and their adoption and use by individual companies is intended to be voluntary.

The consortium members have identified 100 chemicals of concern: for fifteen chemicals, draft Emergency Response Planning Guidelines (ERPGs) have been developed. None of these as yet is available for review. Briefly, the recommended procedure for developing ERPGs is as follows:

1) Companies should use a multi-disciplinary team, including members from the toxicological, medical, and industrial hygiene fields, to collect and review data and draft ERPG documentation. The protocol recommends identifying producers and users of the material and requesting unpublished data on human health effects. Literature searches of computer databases are also recommended.

2) Acute toxicity data, as well as possible long-term effects from a single acute exposure, including carcinogenicity, neurotoxicity, and reproductive and developmental effects are considered. Adjustments may be made, based upon informed judgment, for the increased susceptibility of sensitive subgroups in the population. ERPGs for carcinogens may be derived using the carcinogenicity risk assessment methodology for acute exposures employed by the NRC (1986).

3) The protocol specifies that three concentration levels are needed for each chemi-

cal. The ERPG-1 is defined as the "maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor." The ERPG-2 is the concentration below which it is believed that "nearly all individuals" would come to no permanent harm after a one-hour exposure period. The ERPG-3 is the "maximum concentration below which...nearly all individuals could be exposed for up to one hour without.. life threatening health effects." (See Exhibit D-1)

4) After the ERPG Task Force reviews and edits the documentation, the guidelines and their rationales are reviewed by a Toxicology Committee within the AIHA. The committee is comprised of experts from government, industry, and academia.

5) When they are approved, the guidelines and their documentation are filed at the AIHA headquarters in Akron and will be available to the public upon request.

D.6 OSHA PERMISSIBLE EXPOSURE LIMITS AND NIOSH RECOMMENDED EXPOSURE LIMITS

OSHA Permissable Exposure Limits (PELs) are workplace exposure standards listed in 29 CFR 1910, Subpart Z, General Industry Standards for Toxic and Hazardous Chemicals.

Most of the PELs listed in 29 CFR 1910 were based on ACGIH TLVs, about 450 of which OSHA adopted in 1971 as interim standards under section 6(a) of the Occupational Safety and Health Act. Between 1972 and 1984, OSHA promulgated 9 permanent major health standards regulating worker exposure to 21 toxic chemicals or mixtures. These standards, besides establishing PELs for these chemicals or mixtures, also provided guidance on exposure monitoring, regulated areas, methods of compliance, respiratory protection, protective clothing, and hazard communication.

Chemicals and substances listed in Subpart Z were divided into 3 tables. PELs for chemicals on the first table are usually 8-hour time-weighted average (TWA) concentrations, not to be exceeded in an 8-hour workday. For chemicals on the second table, ceiling concentrations and maximum peak concentrations were given in addition to 8-hour TWA concentrations. The maximum peak concentrations have associated with them exposure durations (e.g. five minute maximum peak concentration in any 2 hour period). These concentrations should never exceed the maximum peak, and should fall between the ceiling and the maximum peak concentration for the duration indicated. The third table provided 8-hour TWA concentrations for mineral dusts.

The majority of OSHA PELs were adopted from the ACGIH TLVs available in 1971. PELs are enforceable by law, whereas the ACGIH TLVs are recommendations. It should be noted that there have been no revisions of the PELs since their adoption, although the corresponding ACGIH TLVs may have been revised.

For chemicals which NIOSH has published recommendations, the NIOSH recommended exposure limits (RELs) are found in the Pocket Guide to Chemical Hazards. RELs are 8- or 10- hour TWA concentrations and/or ceiling concentrations.

D.7 GUIDELINES AVAILABLE FOR EXTREMELY HAZARDOUS SUBSTANCES

As local planning committees may consider the use of one tenth of the IDLH inappropriate for their specific situation, Exhibits D-2 and D-3 list the guidelines that have been discussed in this appendix that are available for each chemical on the List of Extremely Hazardous Substances. Planners may wish to use these values, but should do so only after discussion of the potential implications with qualified technical personnel.

D. 8 REFERENCES

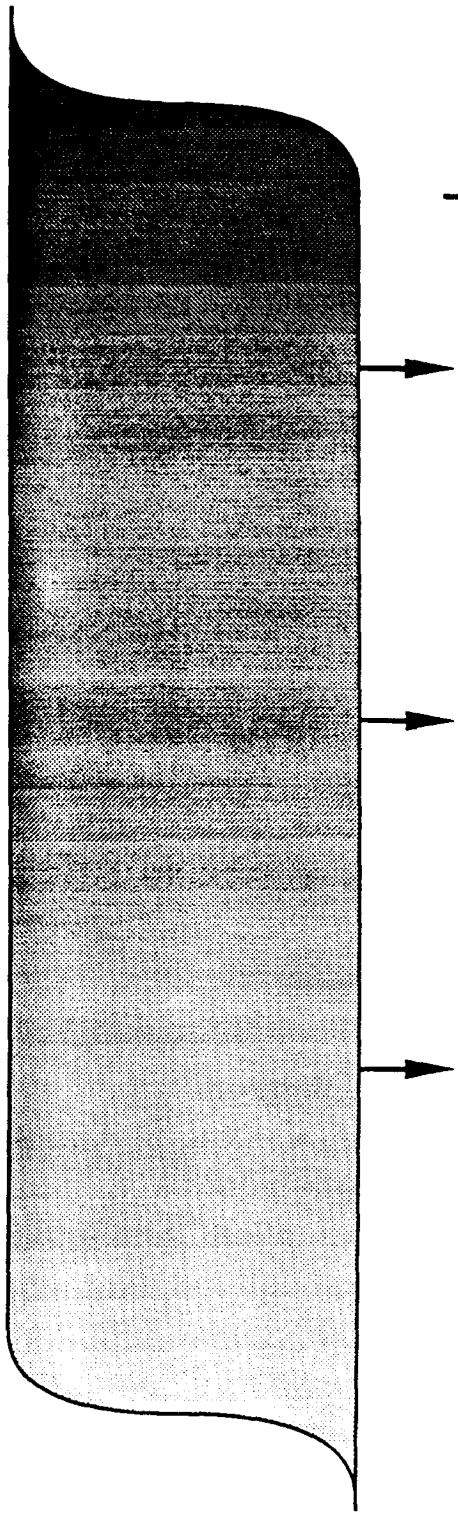
American Conference of Governmental Industrial Hygienists. 1986. Threshold Limit Values and Biological Exposure Indices for 1986-87. Cincinnati, Ohio.

Casarett and Doull. 1986. Toxicology. Edited by C.D. Klassen, M.O. Amdur, and J. Doull. New York, Macmillan Publishing.

Crump, KS. and R.S. Howe. 1984. The multistage model with a time-dependent dose pattern: applications to carcinogenic risk assessment. Risk Analysis 4: 163-176.

Exhibit D-l

Emergency Response Planning Guidelines



ERPG-3: ____________

The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

ERPG-2: ____________

The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

ERPG-1: ____________

The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or perceiving a clearly defined objectionable odor.

Adapted from Organization Resources Counselors, 1987.

NIOSH. 1978. National Institute for Occupational Safety and Health. The Standards Completion Program Draft Technical Standards Analysis and Decision Logics. NIOSH Library, Cincinnati, Ohio. Copy courtesy of Dr. Howard Ludwig, NIOSH.

NIOSH. 1985. National Institute for Occupational Safety and Health. Pocket Guide to Chemical Hazards. Washington, D.C.: U.S. Government Printing Office, DHEW (NIOSH) Publication No. 78-210.

NRC. 1979. The National Research Council. Criteria for Short-term Exposures to Air Pollutants. November 1979.

NRC. 1986, National Research Council, Committee on Toxicology. Criteria and Methods for Preparing Emergency Exposure Guidance Level (EEGL), Short-Term Public Emergency Guidance Level (SPEGL), and Continuous Exposure Guidance Level (CEGL) Documents. Washington, D.C.: National Academy Press.

Organization Resources Counselors. 1987. Memorandum to ORC Occupational Safety and Health Group from Darrell K. Mattheis and Rebecca L. Daiss, update on Emergency Response Planning Guidelines (ERPG) Task Force.. July 20, 1987.

Swank, M.G., Branson, D.R., Rampy, L.W. 1986. The Dow Program to Develop Emergency Exposure Guideline Concentrations (EEGs), February 12, 1986.

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
75865	Acetone Cyanohydrin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1752303	Acetone Thiosemicarbazide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
107028	Acrolein	5 ppm	.1 ppm (.25 mg/m^3)	--	.3 (.8 mg/m^3)	.1 ppm (.25 mg/m^3)	--	.05
79061	Acrylamide	Not Found	.3 mg/m^3	--	.6 mg/m^3	.3 mg/m^3	--	Not Found
107131	Acrylonitrile	500 ppm	2 ppm (4.5 mg/m^3)	--	Not Found	2 ppm	10 ppm/15 min.	Not Found
814686	Acrylyl Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
111693	Adiponitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
116063	Aldicarb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
309002	Aldrin	100 mg/m^3	.25 mg/m^3	--	Not Found	Not Found	--	Not Found
107186	Allyl Alcohol	150 ppm	2 ppm (5 mg/m^3)	--	4 ppm (10 mg/m^3)	2 ppm (5 mg/m^3)	--	Not Found
107119	Allylamine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
20859738	Aluminum Phosphide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
54626	Aminopterin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78535	Amiton	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3734972	Amiton Oxalate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7664417	Ammonia	500 ppm	18 mg/m^3 (25 ppm)	--	27 mg/m^3 (35 ppm)	35 mg/m^3 (35 ppm)	--	100
16919587	Ammonium Chloroplatinate*	Not Found	.002 mg/m^3	--	Not Found	.002 mg/m^3	--	Not Found
300629	Amphetamine	Not Found	Not Found	--	Not Found	1.3 mg/m^3 (1 ppm)	--	Not Found
62533	Aniline	100 ppm (380.8 mg/m^3)	2 ppm (10 mg/m^3)	--	5 ppm (20 mg/m^3)	5 ppm (19 mg/m^3)	--	Not Found
88051	Aniline, 2,4,6-Trimethyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7783702	Antimony Pentafluoride	Not Found	.5 mg/m^3	--	Not Found	.5 mg/m^3	--	Not Found
1397940	Antimycin A	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
86884	ANTU	100 mg/m^3	.3 mg/m^3	--	Not Found	.3 mg/m^3	--	Not Found
1303282	Arsenic Pentoxide	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
1327533	Arsenous Oxide	Not Found	Not Found	--	Not Found	.01 mg/m^3	--	Not Found
7784341	Arsenous Trichloride	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
7784421	Arsine	6 ppm	.2 mg/m^3 (.05 ppm)	--	Not Found	.2 mg/m^3 (.05 ppm)	--	1
2642719	Azinphos-Ethyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
86500	Azinphos-Methyl	5 mg/m^3	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
98873	Benzal Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98168	Benzenamine, 3-(Trifluoromethyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
100141	Benzene, 1-(Chloromethyl)-4-Nitro-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98055	Benzenearsonic Acid	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
98099	Benzenesulfonyl Chloride*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3615212	Benzimidazole, 4,5-Dichloro-2-(Trifluoromethyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98077	Benzotrichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
100447	Benzyl Chloride	10 ppm	1 ppm (5 mg/m^3)	--	Not Found	1 ppm (5 mg/m^3)	--	Not Found
140294	Benzyl Cyanide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
15271417	Bicyclo[2.2.1]Heptane-2-Carbonitrile, 5-Chloro-6-((((Methylamino)Carbonyl)Oxy)Imino)-, (1S-(1-alpha, 2-beta,4-alpha,5-alpha,6E))-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
534076	Bis(Chloromethyl) Ketone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4044659	Bitoscanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10294345	Boron Trichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7637072	Boron Trifluoride	100 ppm	--	3 mg/m^3 (1 ppm)	Not Found	--	3 mg/m^3 (1 ppm)	Not Found
353424	Boron Trifluoride Compound With Methyl Ether (1:1)	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
28772567	Bromadiolone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7726956	Bromine	10 ppm	.7 mg/m^3 (.1 ppm)	--	2 mg/m^3 (.3 ppm)	.7 mg/m^3 (.1 ppm)	--	Not Found
106990	Butadiene*	20000 ppm	10 ppm (22 mg/m^3)	--	Not Found	1000 ppm (2200 mg/m^3)	--	Not Found
109193	Butyl Isovalerate*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
111342	Butyl Vinyl Ether*	250 ppm**	30 mg/m^3 (5 ppm)	--	60 mg/m^3 (10 ppm)	--	90 mg/m^3 (15 ppm)	Not Found
633034	C. I. Basic Green 1*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1306190	Cadmium Oxide	40 mg/m^3	.05 mg/m^3	.05 mg/m^3	Not Found	.1 mg/m^3	.3 mg/m^3	Not Found
2223930	Cadmium Stearate	Not Found	.05 mg/m^3	--	Not Found	Not Found	--	Not Found
7778441	Calcium Arsenate	100 mg/m^3	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
8001352	Camphechlor	200 mg/m^3**	.5 mg/m^3	--	1 mg/m^3	.5 mg/m^3	--	Not Found
56257	Cantharidin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
51832	Carbachol Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
26419738	Carbamic Acid, Methyl-, O-(((2,4-Dimethyl-1, 3-Dithiolan-2-Yl)Methylene)Amino)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1563662	Carbofuran	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
75150	Carbon Disulfide	500 ppm	30 mg/m^3 (10 ppm)	--	Not Found	20 ppm	30 ppm	50
786196	Carbophenothion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2244168	Carvone*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
57749	Chlordane	500 mg/m^3	.5 mg/m^3	--	2 mg/m^3	500 ug/m^3	--	Not Found
470906	Chlorfenvinfos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7782505	Chlorine	30 ppm	3 mg/m^3 (1 ppm)	--	9 mg/m^3 (3 ppm)	--	3 mg/m^3 (1 ppm)	3
24934916	Chlormephos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
999815	Chlormequat Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
107200	Chloroacetaldehyde*	250 ppm (3 mg/m^3)	--	1 ppm	Not Found	--	1 ppm (3 mg/m^3)	Not Found
79118	Chloroacetic Acid	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
107073	Chloroethanol	10 ppm**	--	1 ppm (3 mg/m^3)	Not Found	5 ppm (16 mg/m^3)	--	Not Found
627112	Chloroethyl Chloroformate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
67663	Chloroform	1000 ppm (4883 mg/m^3)	10 ppm (50 mg/m^3)	--	50ppm (225 mg/m^3)	--	50 ppm (244 mg/m^3)	100
542881	Chloromethyl Ether	Not Found	.005 mg/m^3 (.001 ppm)	--	Not Found	Carc.; no per. exp. lim.	--	Not Found
107302	Chloromethyl Methyl Ether	Not Found	2 ppm (2 mg/m^3)	--	Not Found	Not Found	--	Not Found
3691358	Chlorophacinone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1982474	Chloroxuron	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
21923239	Chlorthiophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10025737	Chromic Chloride	Not Found	.5 mg/m^3	--	Not Found	1 mg/m^3	--	Not Found
7440484	Cobalt*	20 mg/m^3	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
10210681	Cobalt Carbonyl	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
62207765	Cobalt,((2,2'-(1,2-Ethanediylbis (Nitrilomethylidyne))Bis(6-Fluorophenolato)) (2-)-N,N',O,O')-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
64868	Colchicine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
117522	Coumafuryl*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
56724	Coumaphos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
5836293	Coumatetralyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
95487	Cresol, o-	250 ppm (1106 mg/m^3)**	5 ppm (22 mg/m^3)	--	Not Found	5 ppm (22 mg/m^3)	--	Not Found
535897	Crimidine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4170303	Crotonaldehyde	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
123739	Crotonaldehyde, (E)-	400 mg/m^3	6 mg/m^3 (2 ppm)	--	Not Found	6 mg/m^3 (2 ppm)	--	Not Found

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
506683	Cyanogen Bromid	Not Found	5 mg/m^3	--	Not Found	Not Found	--	Not Found
506785	Cyanogen Iodide	Not Found	5 mg/m^3	--	Not Found	Not Found	--	Not Found
2636262	Cyanophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
675149	Cyanuric Fluoride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
66819	Cycloheximide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
108918	Cyclohexylamine	Not Found	40 mg/m^3 (10 ppm)	--	Not Found	Not Found	--	Not Found
287923	Cyclopentane*	Not Found	1720 mg/m^3 (600 ppm)	--	2580 mg/m^3 (900 ppm)	Not Found	--	Not Found
17702419	Decaborane(14)	20 ppm	.3 mg/m^3 (.05 ppm)	--	.9 mg/m^3 (.15 ppm)	.3 mg/m^3 (.05 ppm)	--	Not Found
8065483	Demeton	20 mg/m^3	.1 mg/m^3 (.01 ppm)	--	Not Found	.1 mg/m^3	--	Not Found
919868	Demeton-S-Methyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10311849	Dialifor	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
19287457	Diborane	40 ppm	.1 mg/m^3 (.1 ppm)	--	Not Found	.1 mg/m^3 (.1 ppm)	--	Not Found
8023538	Dichlorobenzalkonium Chloride*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
111444	Dichloroethyl Ether	250 ppm	Not Found	--	Not Found	Not Found	--	Not Found
149746	Dichloromethylphenylsilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
62737	Dichlorvos	200 mg/m^3	.1 ppm (1 mg/m^3)	--	.3 ppm (3 mg/m^3)	1 mg/m^3	--	Not Found
141662	Dicrotophos	Not Found	.25 mg/m^3	--	Not Found	Not Found	--	Not Found
1464535	Diepoxybutane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
814493	Diethyl Chlorophosphate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
93050	Diethyl-p-Phenylenediamine*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1642542	Diethylcarbamazine Citrate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
71636	Digitoxin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2238075	Diglycidyl Ether	85 ppm	.5 mg/m^3 (.1 ppm)	--	--	2.8 mg/m^3 (.5 ppm)	--	Not Found
20830755	Digoxin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
115264	Dimefox	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
60515	Dimethoate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2524030	Dimethyl Phosphorochloridothioate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
77781	Dimethyl Sulfate	10 ppm (52 mg/m^3)	.1 ppm (.5 mg/m^3)	--	Not Found	1 ppm (5 mg/m^3)	--	Not Found
75183	Dimethyl Sulfide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
99989	Dimethyl-p-Phenylenediamine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75785	Dimethyldichlorosilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
57147	Dimethylhydrazine	50 ppm	1 mg/m^3 (5 ppm)	--	3 mg/m^3 (1 ppm)	Not Found	--	.24 (Spegl)
644644	Dimetilan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
534521	Dinitrocresol	5 mg/m^3	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
88857	Dinoseb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1420071	Dinoterb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78342	Dioxathion	Not Found	.2 mg/m^3	--	Not Found	Not Found	--	Not Found
646060	Dioxolane*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
82666	Diphacinone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
152169	Diphosphoramide, Octamethyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
298044	Disulfoton	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
514738	Dithiazanine Iodide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
541537	Dithiobiuret	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
316427	Emetine, Dihydrochloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
115297	Endosulfan	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
2778043	Endothion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
72208	Endrin	200 mg/m^3	.1 mg/m^3	--	.3 mg/m^3	.1 mg/m^3	--	Not Found
106898	Epichlorohydrin	100 ppm	2 ppm (10 mg/m^3)	--	5 ppm	5 ppm (19 mg/m^3)	--	Not Found
2104645	EPN	50 mg/m^3	.5 mg/m^3	--	Not Found	.5 mg/m^3	--	Not Found
50146	Ergocalciferol	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
379793	Ergotamine Tartrate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1622328	Ethanesulfonyl Chloride, 2-Chloro-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10140871	Ethanol, 1,2-Dichloro-, Acetate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
563122	Ethion	Not Found	.4 mg/m^3	--	Not Found	Not Found	--	Not Found
13194484	Ethoprophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
538078	Ethylbis(2-Chloroethyl)Amine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
371620	Ethylene Fluorohydrin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75218	Ethylene Oxide	800 ppm	2 mg/m^3 (1 ppm)	--	Not Found	1 ppm	--	20
107153	Ethylenediamine	2000 ppm	10 ppm (25 mg/m^3)	--	Not Found	10 ppm (25 mg/m^3)	--	Not Found
151564	Ethyleneimine	Not Found	1 mg/m^3 (.5 ppm)	--	Not Found	Carc.; no per.exp.lim.	--	Not Found
2235258	*Ethylmercuric Phosphate**	*Not Found*	*.01 mg/m^3*	--	*.03 mg/m^3*	*.01 mg/m^3*	*.04 mg/m^3*	Not Found
542905	Ethylthiocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
22224926	Fenamiphos	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
122145	Fenitrothion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
115902	Fensulfothion	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
4301502	Fluenetil	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7782414	Fluorine	25 ppm	2 mg/m^3 (1 ppm)	--	4 mg/m^3 (2 ppm)	.2 mg/m^3 (.1 ppm)	--	7.5
640197	Fluoroacetamide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
144490	Fluoroacetic Acid	Not Found	.05 mg/m^3	--	.15 mg/m^3	.05 mg/m^3	--	Not Found
359068	Fluoroacetyl Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
51218	Fluorouracil	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
944229	Fonofos	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
50000	Formaldehyde	100 ppm	1.5 mg/m^3 (1 ppm)	--	3 mg/m^3 (2 ppm)	3 ppm	5 ppm	Not Found
107164	Formaldehyde Cyanohydrin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
23422539	Formetanate Hydrochloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2540821	Formothion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
17702577	Formparanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
21548323	Fosthietan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3878191	Fuberidazole	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
110009	Furan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13450903	Gallium Trichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
77474	Hexachlorocyclopentadiene	Not Found	.1 mg/m^3 (.01 ppm)	--	Not Found	Not Found	--	Not Found
1335871	Hexachloronaphthalene*	2 mg/m^3	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
4835114	Hexamethylenediamine, N,N'-Dibutyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
302012	Hydrazine	80 ppm	.1 mg/m^3 (.1 ppm)	--	Not Found	.25 mg/m^3	--	.12 (Spegl)
74908	Hydrocyanic Acid	50 ppm**	--	10 mg/m^3	Not Found	11 mg/m^3 (10 ppm)	--	Not Found
7647010	Hydrogen Chloride (Gas Only)	100 ppm	--	7 mg/m^3 (5 ppm)	Not Found	--	7 mg/m^3 (5 ppm)	20 (Eegl), 1 (Speg
7664393	Hydrogen Fluoride	30 ppm	--	2.5 mg/m^3 (3 ppm)	Not Found	3 ppm	--	Not Found
7722841	Hydrogen Peroxide (Conc > 52%)	75 ppm	1.5 mg/m^3 (1 ppm)	--	Not Found	1.4 mg/m^3 (1 ppm)	--	Not Found
7783075	Hydrogen Selenide	2 ppm	.2 mg/m^3 (.05 ppm)	--	Not Found	.2 mg/m^3 (.05 ppm)	--	Not Found

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (p
7783064	Hydrogen Sulfide	300 ppm	14 mg/m^3 (10 ppm)	--	21 mg/m^3 (15 ppm)	--	20 ppm	10 (24 hr)
123319	Hydroquinone	200 mg/m^3	2 mg/m^3	--	Not Found	2 mg/m^3	--	Not Found
53861	Indomethacin*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10025975	Iridium Tetrachloride*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13463406	Iron, Pentacarbonyl-	Not Found	.8 mg/m^3 (.1 ppm)	--	1.6 mg/m^3 (.2 ppm)	Not Found	--	Not Found
297789	Isobenzan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78820	Isobutyronitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
102363	Isocyanic Acid, 3,4-Dichlorophenyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
465736	Isodrin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
55914	Isofluorphate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4098719	Isophorone Diisocyanate	Not Found	.045 mg/m^3 (.005 ppm)	--	Not Found	Not Found	--	Not Found
108236	Isopropyl Chloroformate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
625558	Isopropyl Formate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
119380	Isopropylmethylpyrazolyl Dimethylcarbamate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78977	Lactonitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
21609905	Leptophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
541253	Lewisite	Not Found	Not Found	--	Not Found	.01 mg/m^3	--	Not Found
58899	Lindane	1000 mg/m^3	.5 mg/m^3	--	1.5 mg/m^3	.5 mg/m^3	--	Not Found
7580678	Lithium Hydride	55 mg/m^3	.025 mg/m^3	--	Not Found	.025 mg/m^3	--	Not Found
109773	Malononitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
12108133	Manganese, Tricarbonyl Methylcyclopentadienyl	10000 mg/m^3**	.1 mg/m^3	--	Not Found	--	5 mg/m^3	Not Found
51752	Mechlorethamine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
950107	Mephosfolan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1600277	Mercuric Acetate	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
7487947	Mercuric Chloride	Not Found	.1 mg/m^3	--	Not Found	--	.1 mg/m^3	Not Found
21908532	Mercuric Oxide	Not Found	.1 mg/m^3	--	Not Found	--	.1 mg/m^3	Not Found
108678	Mesitylene*	Not Found	25 ppm	--	Not Found	Not Found	--	Not Found
10476956	Methacrolein Diacetate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
760930	Methacrylic Anhydride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
126987	Methacrylonitrile	Not Found	3 mg/m^3 (1 ppm)	--	Not Found	Not Found	--	Not Found
920467	Methacryloyl Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
30674807	Methacryloyloxyethyl Isocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10265926	Methamidophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
558258	Methanesulfonyl Fluoride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
950378	Methidathion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2032657	Methiocarb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
16752775	Methomyl	Not Found	2.5 mg/m^3	--	Not Found	Not Found	--	Not Found
151382	Methoxyethylmercuric Acetate	10 mg/m^3**	.01 mg/m^3	--	30 mg/m^3	.01 mg/m^3	40 ug/m^3	Not Found
74839	Methyl Bromide	2000 ppm	20 mg/m^3 (5 ppm)	--	Not Found	--	80 mg/m^3 (20 ppm)	Not Found
80637	Methyl 2-Chloroacrylate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
79221	Methyl Chloroformate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
624920	Methyl Disulfide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
60344	Methyl Hydrazine	5 ppm (9.4 mg/m^3)**	--	.35 mg/m^3	Not Found	--	.35 mg/m^3	.24 (Spegl)
624839	Methyl Isocyanate	20 ppm	.05 mg/m^3 (.02 ppm)	--	Not Found	.05 mg/m^3 (.02 ppm)	--	Not Found
556616	Methyl Isothiocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
74931	Methyl Mercaptan	400 ppm	1 mg/m^3 (.5 ppm)	--	Not Found	--	20mg/m^3 (10ppm/.5min)	Not Found
676971	Methyl Phosphonic Dichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
3735237	Methyl Phenkapton	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
556649	Methyl Thiocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78944	Methyl Vinyl Ketone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
502396	Methylmercuric Dicyanamide	Not Found	.01 mg/m3	--	.03 mg/m3	.01 mg/m3	.04 mg/m3	Not Found
75796	Methyltrichlorosilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1129415	Metolcarb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7786347	Mevinphos	40 mg/m3**	.1 mg/m3 (.01 ppm)	--	.3 mg/m3 (.03 ppm)	.1 mg/m3	--	Not Found
315184	Mexacarbate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
50077	Mitomycin C	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
6923224	Monocrotophos	Not Found	.25 mg/m3	--	Not Found	Not Found	--	Not Found
2763964	Muscimol	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
505602	Mustard Gas	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7440020	Nickel*	Potential carcin.**	1 mg/m3	--	Not Found	1 mg/m3	--	Not Found
13463393	Nickel Carbonyl	.0001 ppm	.35 mg/m3 (.05 ppm)	--	Not Found	.007 mg/m3 (.001 ppm)	--	Not Found
54115	Nicotine	35 mg/m3	.5 mg/m3	--	Not Found	.5 mg/m3	--	Not Found
65305	Nicotine Sulfate	Not Found	.5 mg/m3	--	1.5 mg/m3	Not Found	--	Not Found
7697372	Nitric Acid	100 ppm	5 mg/m3 (2 ppm)	--	10 mg/m3 (4 ppm)	5 mg/m3 (2 ppm)	--	Not Found
10102439	Nitric Oxide	100 ppm	30 mg/m3 (25 ppm)	--	Not Found	30 mg/m3 (25 ppm)	--	Not Found
98953	Nitrobenzene	200 ppm	1 ppm (5 mg/m3)	--	Not Found	1 ppm (5 mg/m3)	--	Not Found
1122607	Nitrocyclohexane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10102440	Nitrogen Dioxide	50 ppm	6 mg/m3 (3 ppm)	--	10 mg/m3 (5 ppm)	9 mg/m3 (5 ppm)	--	1 (Spegl)
62759	Nitrosodimethylamine	Not Found	Carc. potential	--	Carc. potential	Not Found	--	Not Found
991424	Norbormide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
0	Organorhodium Complex (PMN-82-147)	Not Found	1 mg/m3	--	Not Found	1 mg/m3	--	Not Found
65861	Orotic Acid*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
20816120	Osmium Tetroxide*	1 mg/m3	.002 mg/m3 (.0002 ppm)	--	.006 mg/m3 (.0006 ppm)	.002 mg/m3	--	Not Found
630604	Ouabain	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
23135220	Oxamyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78717	Oxetane, 3,3-Bis(Chloromethyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2497076	Oxydisulfoton	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10028156	Ozone	10 ppm	.2 mg/m3 (.1 ppm)	--	.6 mg/m3 (.3 ppm)	.2 mg/m3 (.1 ppm)	--	1
1910425	Paraquat	1.5 mg/m3	.1 mg/m3	--	Not Found	.5 mg/m3	--	Not Found
2074502	Paraquat Methosulfate	1.5 mg/m3**	.1 mg/m3	--	Not Found	.5 mg/m3	--	Not Found
56382	Parathion	20 mg/m3	.1 mg/m3	--	Not Found	Not Found	--	Not Found
298000	Parathion-Methyl	Not Found	.2 mg/m3	--	Not Found	Not Found	--	Not Found
12002038	Paris Green	Not Found	.2 mg/m3	--	Not Found	.01 mg/m3	--	Not Found
19624227	Pentaborane	3 ppm	.01 mg/m3 (.005 ppm)	--	.03 mg/m3 (.015 ppm)	.01 mg/m3 (.005 ppm)	--	Not Found
76017	Pentachloroethane*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
87865	Pentachlorophenol*	150 mg/m3	.5 mg/m3	--	Not Found	.5 mg/m3	--	Not Found
2570265	Pentadecylamine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
79210	Peracetic Acid	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
594423	Perchloromethylmercaptan	10 ppm	.8 mg/m3 (.1 ppm)	--	Not Found	.8 mg/m3 (.1 ppm)	--	Not Found
108952	Phenol	250 ppm	19 mg/m3 (5 ppm)	--	38 mg/m3 (10 ppm)	19 mg/m3 (5 ppm)	--	Not Found
64006	Phenol, 3-(1-Methylethyl)-, Methylcarbamate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4418660	Phenol, 2,2'-Thiobis(4-Chloro-6-Methyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
97187	Phenol, 2,2'-Thiobis(4,6-Dichloro)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
58366	Phenoxarsine, 10,10'-Oxydi-	Not Found	.2 mg/m^3	--	--	.01 mg/m^3	--	Not Found
696286	Phenyl Dichloroarsine	Not Found	Not Found	--	Not Found	.01 mg/m^3	--	Not Found
59881	Phenylhydrazine Hydrochloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
62384	Phenylmercury Acetate	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
2097190	Phenylsilatrane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
103855	Phenylthiourea	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
298022	Phorate	Not Found	.05 mg/m^3	--	.2 mg/m^3	Not Found	--	Not Found
4104147	Phosacetim	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
947024	Phosfolan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75445	Phosgene	2 ppm	.4 mg/m^3 (.1 ppm)	--	Not Found	.4 mg/m^3 (.1 ppm)	--	.2
732116	Phosmet	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13171216	Phosphamidon	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7803512	Phosphine	200 ppm	.4 mg/m^3 (.3 ppm)	--	1 mg/m^3 (1 ppm)	.4 mg/m^3 (.3 ppm)	--	Not Found
2703131	Phosphonothioic Acid, Methyl-, O-Ethyl O-(4-(Methylthio)Phenly) Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2665307	Phosphonothioic Acid, Methyl-,O-(4-Nitrophenyl) O-Phenyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
50782699	Phosphonothioic Acid, Methyl-, S-(2-(Bis (1-Methylethyl)Amino)Ethyl) O-Ethyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3254635	Phosphoric Acid, Dimethyl 4-(Methylthio) Phenyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2587908	Phosphorothioic Acid, O,O-Dimethyl-S-(2-Methylthio) Ethyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7723140	Phosphorus	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
10025873	Phosphorus Oxychloride	Not Found	.6 mg/m^3 (.1 ppm)	--	3 mg/m^3 (.5 ppm)	Not Found	--	Not Found
10026138	Phosphorus Pentachloride	200 mg/m^3	1 mg/m^3 (1 ppm)	--	Not Found	1 mg/m^3	--	Not Found
1314563	Phosphorus Pentoxide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7719122	Phosphorus Trichloride	50 ppm	1.5 mg/m^3 (.2 ppm)	--	3 mg/m^3 (.5 ppm)	3 mg/m^3 (.5 ppm)	--	Not Found
84800	Phylloquinone*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
57476	Physostigmine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
57647	Physostigmine, Salicylate (1:1)	Not Found	Not Found	Not Found	Not Found	Not Found	Not Found	Not Found
124878	Picrotoxin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
110894	Piperidine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
5281130	Piprotal	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
23505411	Pirimifos-Ethyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10025657	Platinous Chloride*	Not Found	.002 mg/m^3	--	Not Found	.002 mg/m^3	--	Not Found
13454961	Platinum Tetrachloride*	Not Found	.002 mg/m^3	--	Not Found	.002 mg/m^3	--	Not Found
10124502	Potassium Arsenite	.002 mg/m^3 15 min.**	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
151508	Potassium Cyanide	50 mg/m^3**	5 mg/m^3	--	Not Found	5 mg/m^3	--	Not Found
506616	Potassium Silver Cyanide	Not Found	5 mg/m^3	--	Not Found	Not Found	--	Not Found
2631370	Promecarb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
106967	Propargyl Bromide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
57578	Propiolactone, Beta-	Potential carcin.**	1.5 mg/m^3 (.5 ppm)	--	3 mg/m^3 (1 ppm)	Not Found	--	Not Found
107120	Propionitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
542767	Propionitrile, 3-Chloro-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
70699	Propiophenone, 4-Amino-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
109615	Propyl Chloroformate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1331175	Propylene Glycol, Allyl Ether*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75569	Propylene Oxide	2000 ppm	50 mg/m^3 (20 ppm)	--	Not Found	240 mg/m^3 (100 ppm)	--	Not Found
75558	Propyleneimine	500 ppm	5 mg/m^3 (2 ppm)	--	Not Found	5 mg/m^3 (2 ppm)	--	Not Found
2275185	Prothoate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
95636	Pseudocumene*	Not Found	25 ppm (125 mg/m^3)	--	Not Found	Not Found	--	Not Found
129000	Pyrene	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
504245	Pyridine, 4-Amino-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
140761	Pyridine, 2-Methyl-5-Vinyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1124330	Pyridine, 4-Nitro-, 1-Oxide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
53558251	Pyriminil	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10049077	Rhodium Trichloride*	Not Found	1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
14167181	Salcomine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
107448	Sarin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7783008	Selenious Acid	Not Found	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
7791233	Selenium Oxychloride	100 mg/m^3**	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
563417	Semicarbazide Hydrochloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3037727	Silane, (4-Aminobutyl)Diethoxymethyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
128563	Sodium Anthraquinone-1-Sulfonate*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7631892	Sodium Arsenate	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
7784465	Sodium Arsenite	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
26628228	Sodium Azide (Na(N3))	Not Found	.3 mg/m^3 (.1 ppm)	--	Not Found	Not Found	--	Not Found
124652	Sodium Cacodylate	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
143339	Sodium Cyanide (Na(CN))	50 mg/m^3**	5 mg/m^3	--	Not Found	5 mg/m^3	--	Not Found
62748	Sodium Fluoroacetate	5 mg/m^3	.05 mg/m^3	--	.15 mg/m^3	.05 mg/m^3	--	Not Found
131522	Sodium Pentachlorophenate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13410010	Sodium Selenate	100 mg/m^3**	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
10102188	Sodium Selenite	Not Found	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
10102202	Sodium Tellurite	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
900958	Stannane, Acetoxytriphenyl-	200 mg/m^3**	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
57249	Strychnine	3 mg/m^3	.15 mg/m^3	--	Not Found	.15 mg/m^3	--	Not Found
60413	Strychnine, Sulfate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3689245	Sulfotep	35 mg/m^3**	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
3569571	Sulfoxide, 3-Chloropropyl Octyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7446095	Sulfur Dioxide	100 ppm	5 mg/m^3 (2 ppm)	--	10 mg/m^3 (5 ppm)	13 mg/m^3 (5 ppm)	--	10
7783600	Sulfur Tetrafluoride	Not Found	--	.4 mg/m^3 (.1 ppm)	Not Found	2.5 mg/m^3	--	Not Found
7446119	Sulfur Trioxide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7664939	Sulfuric Acid	80 mg/m^3	1 mg/m^3	--	Not Found	1 mg/m^3	--	1 mg/m^3
77816	Tabun	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13494809	Tellurium	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
7783804	Tellurium Hexafluoride	1 ppm	.2 mg/m^3 (.02 ppm)	--	Not Found	.2 mg/m^3 (.02 ppm)	--	Not Found
107493	TEPP	10 mg/m^3	.004 ppm (.05 mg/m^3)	--	Not Found	.05 mg/m^3	--	Not Found
13071799	Terbufos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78002	Tetraethyllead	40 mg/m^3	.1 mg/m^3	--	Not Found	.075 mg/m^3	--	Not Found
597648	Tetraethyltin	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
75741	Tetramethyllead	40 mg/m^3	.15 mg/m^3	--	Not Found	.075 mg/m^3	--	Not Found

EXHIBIT D-2 (Alphabetical)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
509148	Tetranitromethane	5 ppm	8 mg/m^3 (1 ppm)	--	Not Found	8 mg/m^3 (1 ppm)	--	Not Found
1314325	Thallic Oxide*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10031591	Thallium Sulfate	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
6533739	Thallous Carbonate	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
7791120	Thallous Chloride	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
2757188	Thallous Malonate	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
7446186	Thallous Sulfate	20 mg/m^3**	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
2231574	Thiocarbazide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
21564170	Thiocyanic Acid, 2-(Benzothiazolylthio) Methyl Ester*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
39196184	Thiofanox	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
640153	Thiometon*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
297972	Thionazin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
108985	Thiophenol	Not Found	2 mg/m^3 (.5 ppm)	--	Not Found	Not Found	--	Not Found
79196	Thiosemicarbazide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
5344821	Thiourea, (2-Chlorophenyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
614788	Thiourea, (2-Methylphenyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7550450	Titanium Tetrachloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
584849	Toluene 2,4-Diisocyanate	10 ppm	.04 mg/m^3 (.005 ppm)	--	.15 mg/m^3 (.02 ppm)	--	.14 mg/m^3 (.02 ppm)	Not Found
91087	Toluene 2,6-Diisocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
110576	Trans-1,4-Dichlorobutene	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1031476	Triamiphos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
24017478	Triazofos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
76028	Trichloroacetyl Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1558254	Trichloro(Chloromethyl)Silane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
27137855	Trichloro(Dichlorophenyl)Silane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
115219	Trichloroethylsilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
327980	Trichloronate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98135	Trichlorophenylsilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
52686	Trichlorophon*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
998301	Triethoxysilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75774	Trimethylchlorosilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
824113	Trimethylolpropane Phosphite	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1066451	Trimethyltin Chloride	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
639587	Triphenyltin Chloride	Not Found	100 ug/m^3	--	Not Found	.1 mg/m^3	--	Not Found
555771	Tris(2-Chloroethyl)Amine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2001958	Valinomycin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1314621	Vanadium Pentoxide	70 mg/m^3	.05 mg/m^3	--	Not Found	--	.5mg/m^3 dust; .1mg/m^3 fume	Not Found
108054	Vinyl Acetate Monomer	Not Found	30 mg/m^3 (10 ppm)	--	60 mg/m^3 (20 ppm)	Not Found	--	Not Found
3048644	Vinylnorbornene*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
81812	Warfarin	200 mg/m^3	.1 mg/m^3	--	.3 mg/m^3	.1 mg/m^3	--	Not Found
129066	Warfarin Sodium	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
28347139	Xylylene Dichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
58270089	Zinc, Dichloro(4,4-Dimethyl-5(((Methylamino) Carbonyl)Oxy)Imino)Pentanenitrile)-, (T-4)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1314847	Zinc Phosphide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

* These chemicals have been proposed for delisting because they do not meet acute toxicity criteria. ** Non-specific chemicals

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
0	Organorhodium Complex (PMN-82-147)	Not Found	1 mg/m^3	--	Not Found	1 mg/m^3	--	Not Found
50000	Formaldehyde	100 ppm	1.5 mg/m^3 (1 ppm)	--	3 mg/m^3 (2 ppm)	3 ppm	5 ppm	Not Found
50077	Mitomycin C	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
50146	Ergocalciferol	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
51218	Fluorouracil	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
51752	Mechlorethamine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
51832	Carbachol Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
52686	Trichlorophon*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
53861	Indomethacin*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
54115	Nicotine	35 mg/m^3	.5 mg/m^3	--	Not Found	.5 mg/m^3	--	Not Found
54626	Aminopterin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
55914	Isofluorphate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
56257	Cantharidin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
56382	Parathion	20 mg/m^3	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
56724	Coumaphos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
57147	Dimethylhydrazine	50 ppm	1 mg/m^3 (5 ppm)	--	3 mg/m^3 (1 ppm)	Not Found	--	.24 (Spegl)
57249	Strychnine	3 mg/m^3	.15 mg/m^3	--	Not Found	.15 mg/m^3	--	Not Found
57476	Physostigmine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
57578	Propiolactone, Beta-	Potential carcin.**	1.5 mg/m^3 (.5 ppm)	--	3 mg/m^3 (1 ppm)	Not Found	--	Not Found
57647	Physostigmine, Salicylate (1:1)	Not Found	Not Found	Not Found	Not Found	Not Found	Not Found	Not Found
57749	Chlordane	500 mg/m^3	.5 mg/m^3	--	2 mg/m^3	500 ug/m^3	--	Not Found
58366	Phenoxarsine, 10,10'-Oxydi-	Not Found	.2 mg/m^3	--	--	.01 mg/m^3	--	Not Found
58899	Lindane	1000 mg/m^3	.5 mg/m^3	--	1.5 mg/m^3	.5 mg/m^3	--	Not Found
59881	Phenylhydrazine Hydrochloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
60344	Methyl Hydrazine	5 ppm (9.4 mg/m^3)**	--	.35 mg/m^3	Not Found	--	.35 mg/m^3	.24 (Spegl)
60413	Strychnine, Sulfate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
60515	Dimethoate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
62384	Phenylmercury Acetate	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
62533	Aniline	100 ppm (380.8 mg/m^3)	2 ppm (10 mg/m^3)	--	5 ppm (20 mg/m^3)	5 ppm (19 mg/m^3)	--	Not Found
62737	Dichlorvos	200 mg/m^3	.1 ppm (1 mg/m^3)	--	.3 ppm (3 mg/m^3)	1 mg/m^3	--	Not Found
62748	Sodium Fluoroacetate	5 mg/m^3	.05 mg/m^3	--	.15 mg/m^3	.05 mg/m^3	--	Not Found
62759	Nitrosodimethylamine	Not Found	Carc. potential	--	Carc. potential	Not Found	--	Not Found
64006	Phenol, 3-(1-Methylethyl)-, Methylcarbamate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
64868	Colchicine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
65305	Nicotine Sulfate	Not Found	.5 mg/m^3	--	1.5 mg/m^3	Not Found	--	Not Found
65861	Orotic Acid*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
66819	Cycloheximide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
67663	Chloroform	1000 ppm (4883 mg/m^3)	10 ppm (50 mg/m^3)	--	50 ppm (225 mg/m^3)	--	50 ppm (244 mg/m^3)	100
70699	Propiophenone, 4-Amino-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
71636	Digitoxin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
72208	Endrin	200 mg/m^3	.1 mg/m^3	--	.3 mg/m^3	.1 mg/m^3	--	Not Found
74839	Methyl Bromide	2000 ppm	20 mg/m^3 (5 ppm)	--	Not Found	--	80 mg/m^3 (20 ppm)	Not Found
74908	Hydrocyanic Acid	50 ppm**	--	10 mg/m^3	Not Found	11 mg/m^3 (10 ppm)	--	Not Found
74931	Methyl Mercaptan	400 ppm	1 mg/m^3 (.5 ppm)	--	Not Found	--	20mg/m^3 (10ppm/.5min)	Not Found
75150	Carbon Disulfide	500 ppm	30 mg/m^3 (10 ppm)	--	Not Found	20 ppm	30 ppm	50
75183	Dimethyl Sulfide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75218	Ethylene Oxide	800 ppm	2 mg/m^3 (1 ppm)	--	Not Found	1 ppm	--	20
75445	Phosgene	2 ppm	.4 mg/m^3 (.1 ppm)	--	Not Found	.4 mg/m^3 (.1 ppm)	--	.2

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
75558	Propyleneimine	500 ppm	5 mg/m^3 (2 ppm)	--	Not Found	5 mg/m^3 (2 ppm)	--	Not Found
75569	Propylene Oxide	2000 ppm	50 mg/m^3 (20 ppm)	--	Not Found	240 mg/m^3 (100 ppm)	--	Not Found
75741	Tetramethyllead	40 mg/m^3	.15 mg/m^3	--	Not Found	.075 mg/m^3	--	Not Found
75774	Trimethylchlorosilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75785	Dimethyldichlorosilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75796	Methyltrichlorosilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
75865	Acetone Cyanohydrin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
76017	Pentachloroethane*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
76028	Trichloroacetyl Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
77474	Hexachlorocyclopentadiene	Not Found	.1 mg/m^3 (.01 ppm)	--	Not Found	Not Found	--	Not Found
77781	Dimethyl Sulfate	10 ppm (52 mg/m^3)	.1 ppm (.5 mg/m^3)	--	Not Found	1 ppm (5 mg/m^3)	--	Not Found
77816	Tabun	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78002	Tetraethyllead	40 mg/m^3	.1 mg/m^3	--	Not Found	.075 mg/m^3	--	Not Found
78342	Dioxathion	Not Found	.2 mg/m^3	--	Not Found	Not Found	--	Not Found
78535	Amiton	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78717	Oxetane, 3,3-Bis(Chloromethyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78820	Isobutyronitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78944	Methyl Vinyl Ketone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
78977	Lactonitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
79061	Acrylamide	Not Found	.3 mg/m^3	--	.6 mg/m^3	.3 mg/m^3	--	Not Found
79118	Chloroacetic Acid	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
79196	Thiosemicarbazide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
79210	Peracetic Acid	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
79221	Methyl Chloroformate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
80637	Methyl 2-Chloroacrylate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
81812	Warfarin	200 mg/m^3	.1 mg/m^3	--	.3 mg/m^3	.1 mg/m^3	--	Not Found
82666	Diphacinone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
84800	Phylloquinone*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
86500	Azinphos-Methyl	5 mg/m^3	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
86884	ANTU	100 mg/m^3	.3 mg/m^3	--	Not Found	.3 mg/m^3	--	Not Found
87865	Pentachlorophenol*	150 mg/m^3	.5 mg/m^3	--	Not Found	.5 mg/m^3	--	Not Found
88051	Aniline, 2,4,6-Trimethyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
88857	Dinoseb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
91087	Toluene 2,6-Diisocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
93050	Diethyl-p-Phenylenediamine*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
95487	Cresol, o-	250 ppm (1106 mg/m^3)**	5 ppm (22 mg/m^3)	--	Not Found	5 ppm (22 mg/m^3)	--	Not Found
95636	Pseudocumene*	Not Found	25 ppm (125 mg/m^3)	--	Not Found	Not Found	--	Not Found
97187	Phenol, 2,2'-Thiobis(4,6-Dichloro)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98055	Benzenearsonic Acid	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
98077	Benzotrichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98099	Benzenesulfonyl Chloride*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98135	Trichlorophenylsilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98168	Benzenamine, 3-(Trifluoromethyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98873	Benzal Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
98953	Nitrobenzene	200 ppm	1 ppm (5 mg/m^3)	--	Not Found	1 ppm (5 mg/m^3)	--	Not Found
99989	Dimethyl-p-Phenylenediamine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
100141	Benzene, 1-(Chloromethyl)-4-Nitro-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
100447	Benzyl Chloride	10 ppm	1 ppm (5 mg/m^3)	--	Not Found	1 ppm (5 mg/m^3)	--	Not Found
102363	Isocyanic Acid, 3,4-Dichlorophenyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
103855	Phenylthiourea	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
106898	Epichlorohydrin	100 ppm	2 ppm (10 mg/m^3)	--	5 ppm	5 ppm (19 mg/m^3)	--	Not Found
106967	Propargyl Bromide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
106990	Butadiene*	20000 ppm	10 ppm (22 mg/m^3)	--	Not Found	1000 ppm (2200 mg/m^3)	--	Not Found
107028	Acrolein	5 ppm	.1 ppm (.25 mg/m^3)	--	.3 (.8 mg/m^3)	.1 ppm (.25 mg/m^3)	--	.05
107073	Chloroethanol	10 ppm**	--	1 ppm (3 mg/m^3)	Not Found	5 ppm (16 mg/m^3)	--	Not Found
107119	Allylamine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
107120	Propionitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
107131	Acrylonitrile	500 ppm	2 ppm (4.5 mg/m^3)	--	Not Found	2 ppm	10 ppm/15 min.	Not Found
107153	Ethylenediamine	2000 ppm	10 ppm (25 mg/m^3)	--	Not Found	10 ppm (25 mg/m^3)	--	Not Found
107164	Formaldehyde Cyanohydrin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
107186	Allyl Alcohol	150 ppm	2 ppm (5 mg/m^3)	--	4 ppm (10 mg/m^3)	2 ppm (5 mg/m^3)	--	Not Found
107200	Chloroacetaldehyde*	250 ppm (3 mg/m^3)	--	1 ppm	Not Found	--	1 ppm (3 mg/m^3)	Not Found
107302	Chloromethyl Methyl Ether	Not Found	2 ppm (2 mg/m^3)	--	Not Found	Not Found	--	Not Found
107448	Sarin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
107493	TEPP	10 mg/m^3	.004 ppm (.05 mg/m^3)	--	Not Found	.05 mg/m^3	--	Not Found
108054	Vinyl Acetate Monomer	Not Found	30 mg/m^3 (10 ppm)	--	60 mg/m^3 (20 ppm)	Not Found	--	Not Found
108236	Isopropyl Chloroformate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
108678	Mesitylene*	Not Found	25 ppm	--	Not Found	Not Found	--	Not Found
108918	Cyclohexylamine	Not Found	40 mg/m^3 (10 ppm)	--	Not Found	Not Found	--	Not Found
108952	Phenol	250 ppm	19 mg/m^3 (5 ppm)	--	38 mg/m^3 (10 ppm)	19 mg/m^3 (5 ppm)	--	Not Found
108985	Thiophenol	Not Found	2 mg/m^3 (.5 ppm)	--	Not Found	Not Found	--	Not Found
109193	Butyl Isovalerate*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
109615	Propyl Chloroformate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
109773	Malononitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
110009	Furan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
110576	Trans-1,4-Dichlorobutene	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
110894	Piperidine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
111342	Butyl Vinyl Ether*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
111444	Dichloroethyl Ether	250 ppm**	30 mg/m^3 (5 ppm)	--	60 mg/m^3 (10 ppm)	--	90 mg/m^3 (15 ppm)	Not Found
111693	Adiponitrile	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
115219	Trichloroethylsilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
115264	Dimefox	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
115297	Endosulfan	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
115902	Fensulfothion	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
116063	Aldicarb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
117522	Coumafuryl*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
119380	Isopropylmethylpyrazolyl Dimethylcarbamate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
122145	Fenitrothion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
123319	Hydroquinone	200 mg/m^3	2 mg/m^3	--	Not Found	2 mg/m^3	--	Not Found
123739	Crotonaldehyde, (E)-	400 mg/m^3	6 mg/m^3 (2 ppm)	--	Not Found	6 mg/m^3 (2 ppm)	--	Not Found
124652	Sodium Cacodylate	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
124878	Picrotoxin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
126987	Methacrylonitrile	Not Found	3 mg/m^3 (1 ppm)	--	Not Found	Not Found	--	Not Found
128563	Sodium Anthraquinone-1-Sulfonate*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
129000	Pyrene	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
129066	Warfarin Sodium	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
131522	Sodium Pentachlorophenate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
140294	Benzyl Cyanide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
140761	Pyridine, 2-Methyl-5-Vinyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
141662	Dicrotophos	Not Found	.25 mg/m^3	--	Not Found	Not Found	--	Not Found
143339	Sodium Cyanide (Na(CN))	50 mg/m^3**	5 mg/m^3	--	Not Found	5 mg/m^3	--	Not Found
144490	Fluoroacetic Acid	Not Found	.05 mg/m^3	--	.15 mg/m^3	.05 mg/m^3	--	Not Found
149746	Dichloromethylphenylsilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
151382	Methoxyethylmercuric Acetate	10 mg/m^3**	.01 mg/m^3	--	30 mg/m^3	.01 mg/m^3	40 ug/m^3	Not Found
151508	Potassium Cyanide	50 mg/m^3**	5 mg/m^3	--	Not Found	5 mg/m^3	--	Not Found
151564	Ethyleneimine	Not Found	1 mg/m^3 (.5 ppm)	--	Not Found	Carc.; no per.exp.lim.	--	Not Found
152169	Diphosphoramide, Octamethyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
287923	Cyclopentane*	Not Found	1720 mg/m^3 (600 ppm)	--	2580 mg/m^3 (900 ppm)	Not Found	--	Not Found
297789	Isobenzan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
297972	Thionazin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
298000	Parathion-Methyl	Not Found	.2 mg/m^3	--	Not Found	Not Found	--	Not Found
298022	Phorate	Not Found	.05 mg/m^3	--	.2 mg/m^3	Not Found	--	Not Found
298044	Disulfoton	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
300629	Amphetamine	Not Found	Not Found	--	Not Found	1.3 mg/m^3 (1 ppm)	--	Not Found
302012	Hydrazine	80 ppm	.1 mg/m^3 (.1 ppm)	--	Not Found	.25 mg/m^3	--	.12 (Spegl)
309002	Aldrin	100 mg/m^3	.25 mg/m^3	--	Not Found	Not Found	--	Not Found
315184	Mexacarbate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
316427	Emetine, Dihydrochloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
327980	Trichloronate,	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
353424	Boron Trifluoride Compound With Methyl Ether (1:1)	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
359068	Fluoroacetyl Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
371620	Ethylene Fluorohydrin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
379793	Ergotamine Tartrate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
465736	Isodrin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
470906	Chlorfenvinfos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
502396	Methylmercuric Dicyanamide	Not Found	.01 mg/m^3	--	.03 mg/m^3	.01 mg/m^3	.04 mg/m^3	Not Found
504245	Pyridine, 4-Amino-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
505602	Mustard Gas	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
506616	Potassium Silver Cyanide	Not Found	5 mg/m^3	--	Not Found	Not Found	--	Not Found
506683	Cyanogen Bromid	Not Found	5 mg/m^3	--	Not Found	Not Found	--	Not Found
506785	Cyanogen Iodide	Not Found	5 mg/m^3	--	Not Found	Not Found	--	Not Found
509148	Tetranitromethane	5 ppm	8 mg/m^3 (1 ppm)	--	Not Found	8 mg/m^3 (1 ppm)	--	Not Found
514738	Dithiazanine Iodide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
534076	Bis(Chloromethyl) Ketone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
534521	Dinitrocresol	5 mg/m^3	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
535897	Crimidine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
538078	Ethylbis(2-Chloroethyl)Amine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
541253	Lewisite	Not Found	Not Found	--	Not Found	.01 mg/m^3	--	Not Found

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
541537	Dithiobiuret	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
542767	Propionitrile, 3-Chloro-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
542881	Chloromethyl Ether	Not Found	.005 mg/m^3 (.001 ppm)	--	Not Found	Carc.; no per. exp. lim.	--	Not Found
542905	Ethylthiocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
555771	Tris(2-Chloroethyl)Amine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
556616	Methyl Isothiocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
556649	Methyl Thiocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
558258	Methanesulfonyl Fluoride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
563122	Ethion	Not Found	.4 mg/m^3	--	Not Found	Not Found	--	Not Found
563417	Semicarbazide Hydrochloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
584849	Toluene 2,4-Diisocyanate	10 ppm	.04 mg/m^3 (.005 ppm)	--	.15 mg/m^3 (.02 ppm)	--	.14 mg/m^3 (.02 ppm)	Not Found
594423	Perchloromethylmercaptan	10 ppm	.8 mg/m^3 (.1 ppm)	--	Not Found	.8 mg/m^3 (.1 ppm)	--	Not Found
597648	Tetraethyltin	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
614788	Thiourea, (2-Methylphenyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
624839	Methyl Isocyanate	20 ppm	.05 mg/m^3 (.02 ppm)	--	Not Found	.05 mg/m^3 (.02 ppm)	--	Not Found
624920	Methyl Disulfide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
625558	Isopropyl Formate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
627112	Chloroethyl Chloroformate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
630604	Ouabain	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
633034	C. I. Basic Green 1*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
639587	Triphenyltin Chloride	Not Found	100 ug/m^3	--	Not Found	.1 mg/m^3	--	Not Found
640153	Thiometon*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
640197	Fluoroacetamide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
644644	Dimetilan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
646060	Dioxolane*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
675149	Cyanuric Fluoride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
676971	Methyl Phosphonic Dichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
696286	Phenyl Dichloroarsine	Not Found	Not Found	--	Not Found	.01 mg/m^3	--	Not Found
732116	Phosmet	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
760930	Methacrylic Anhydride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
786196	Carbophenothion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
814493	Diethyl Chlorophosphate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
814686	Acrylyl Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
824113	Trimethylolpropane Phosphite	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
900958	Stannane, Acetoxytriphenyl-	200 mg/m^3**	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
919868	Demeton-S-Methyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
920467	Methacryloyl Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
944229	Fonofos	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
947024	Phosfolan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
950107	Mephosfolan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
950378	Methidathion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
991424	Norbormide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
998301	Triethoxysilane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
999815	Chlormequat Chloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1031476	Triamiphos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1066451	Trimethyltin Chloride	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
1122607	Nitrocyclohexane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
1124330	Pyridine, 4-Nitro-, 1-Oxide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1129415	Metolcarb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1303282	Arsenic Pentoxide	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
1306190	Cadmium Oxide	40 mg/m^3	.05 mg/m^3	.05 mg/m^3	Not Found	.1 mg/m^3	.3 mg/m^3	Not Found
1314325	Thallic Oxide*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1314563	Phosphorus Pentoxide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1314621	Vanadium Pentoxide	70 mg/m^3	.05 mg/m^3	--	Not Found	--	.5 mg/m^3 dust; .1 mg/m^3 fume	Not Found
1314847	Zinc Phosphide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1327533	Arsenous Oxide	Not Found	Not Found	--	Not Found	.01 mg/m^3	--	Not Found
1331175	Propylene Glycol, Allyl Ether*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1335871	Hexachloronaphthalene*	2 mg/m^3	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
1397940	Antimycin A	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1420071	Dinoterb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1464535	Diepoxybutane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1558254	Trichloro(Chloromethyl)Silane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1563662	Carbofuran	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
1600277	Mercuric Acetate	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
1622328	Ethanesulfonyl Chloride, 2-Chloro-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1642542	Diethylcarbamazine Citrate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1752303	Acetone Thiosemicarbazide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
1910425	Paraquat	1.5 mg/m^3	.1 mg/m^3	--	Not Found	.5 mg/m^3	--	Not Found
1982474	Chloroxuron	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2001958	Valinomycin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2032657	Methiocarb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2074502	Paraquat Methosulfate	1.5 mg/m^3**	.1 mg/m^3	--	Not Found	.5 mg/m^3	--	Not Found
2097190	Phenylsilatrane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2104645	EPN	50 mg/m^3	.5 mg/m^3	--	Not Found	.5 mg/m^3	--	Not Found
2223930	Cadmium Stearate	Not Found	.05 mg/m^3	--	Not Found	Not Found	--	Not Found
2231574	Thiocarbazide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2235258	Ethylmercuric Phosphate*	Not Found	.01 mg/m^3	--	.03 mg/m^3	.01 mg/m^3	.04 mg/m^3	Not Found
2238075	Diglycidyl Ether	85 ppm	.5 mg/m^3 (.1 ppm)	--	--	2.8 mg/m^3 (.5 ppm)	--	Not Found
2244168	Carvone*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2275185	Prothoate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2497076	Oxydisulfoton	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2524030	Dimethyl Phosphorochloridothioate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2540821	Formothion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2570265	Pentadecylamine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2587908	Phosphorothioic Acid, O,O-Dimethyl-S-(2-Methylthio) Ethyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2631370	Promecarb	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2636262	Cyanophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2642719	Azinphos-Ethyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2665307	Phosphonothioic Acid, Methyl-,O-(4-Nitrophenyl) O-Phenyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2703131	Phosphonothioic Acid, Methyl-, O-Ethyl O-(4-(Methylthio)Phenyl) Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
2757188	Thallous Malonate	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
2763964	Muscimol	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
2778043	Endothion	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3037727	Silane, (4-Aminobutyl)Diethoxymethyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3048644	Vinylnorbornene*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3254635	Phosphoric Acid, Dimethyl 4-(Methylthio) Phenyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3569571	Sulfoxide, 3-Chloropropyl Octyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3615212	Benzimidazole, 4,5-Dichloro-2-(Trifluoromethyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3689245	Sulfotep	35 mg/m^3**	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
3691358	Chlorophacinone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3734972	Amiton Oxalate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3735237	Methyl Phenkapton	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
3878191	Fuberidazole	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4044659	Bitoscanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4098719	Isophorone Diisocyanate	Not Found	.045 mg/m^3 (.005 ppm)	--	Not Found	Not Found	--	Not Found
4104147	Phosacetim	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4170303	Crotonaldehyde	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4301502	Fluenetil	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4418660	Phenol, 2,2'-Thiobis(4-Chloro-6-Methyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
4835114	Hexamethylenediamine, N,N'-Dibutyl-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
5281130	Piprotal	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
5344821	Thiourea, (2-Chlorophenyl)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
5836293	Coumatetralyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
6533739	Thallous Carbonate	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
6923224	Monocrotophos	Not Found	.25 mg/m^3	--	Not Found	Not Found	--	Not Found
7440020	Nickel*	Potential carcin.**	1 mg/m^3	--	Not Found	1 mg/m^3	--	Not Found
7440484	Cobalt*	20 mg/m^3	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
7446095	Sulfur Dioxide	100 ppm	5 mg/m^3 (2 ppm)	--	10 mg/m^3 (5 ppm)	13 mg/m^3 (5 ppm)	--	10
7446119	Sulfur Trioxide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7446186	Thallous Sulfate	20 mg/m^3**	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
7487947	Mercuric Chloride	Not Found	.1 mg/m^3	--	Not Found	--	.1 mg/m^3	Not Found
7550450	Titanium Tetrachloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
7580678	Lithium Hydride	55 mg/m^3	.025 mg/m^3	--	Not Found	.025 mg/m^3	--	Not Found
7631892	Sodium Arsenate	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
7637072	Boron Trifluoride	100 ppm	--	3 mg/m^3 (1 ppm)	Not Found	--	3 mg/m^3 (1 ppm)	Not Found
7647010	Hydrogen Chloride (Gas Only)	100 ppm	--	7 mg/m^3 (5 ppm)	Not Found	--	7 mg/m^3 (5 ppm)	2 (Eegl), 1 (Speg
7664393	Hydrogen Fluoride	30 ppm	--	2.5 mg/m^3 (3 ppm)	Not Found	3 ppm	--	Not Found
7664417	Ammonia	500 ppm	18 mg/m^3 (25 ppm)	--	27 mg/m^3 (35 ppm)	35 mg/m^3 (35 ppm)	--	100
7664939	Sulfuric Acid	80 mg/m^3	1 mg/m^3	--	Not Found	1 mg/m^3	--	1 mg/m^3
7697372	Nitric Acid	100 ppm	5 mg/m^3 (2 ppm)	--	10 mg/m^3 (4 ppm)	5 mg/m^3 (2 ppm)		Not Found
7719122	Phosphorus Trichloride	50 ppm	1.5 mg/m^3 (.2 ppm)	--	3 mg/m^3 (.5 ppm)	3 mg/m^3 (.5 ppm)	--	Not Found
7722841	Hydrogen Peroxide (Conc > 52%)	75 ppm	1.5 mg/m^3 (1 ppm)	--	Not Found	1.4 mg/m^3 (1 ppm)	--	Not Found
7723140	Phosphorus	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
7726956	Bromine	10 ppm	.7 mg/m^3 (.1 ppm)	--	2 mg/m^3 (.3 ppm)	.7 mg/m^3 (.1 ppm)	--	Not Found
7778441	Calcium Arsenate	100 mg/m^3	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
7782414	Fluorine	25 ppm	2 mg/m^3 (1 ppm)	--	4 mg/m^3 (2 ppm)	.2 mg/m^3 (.1 ppm)	--	7.5

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
7782505	Chlorine	30 ppm	3 mg/m^3 (1 ppm)	--	9 mg/m^3 (3 ppm)	--	3 mg/m^3 (1 ppm)	3
7783008	Selenious Acid	Not Found	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
7783064	Hydrogen Sulfide	300 ppm	14 mg/m^3 (10 ppm)	--	21 mg/m^3 (15 ppm)	--	20 ppm	10 (24 hr)
7783075	Hydrogen Selenide	2 ppm	.2 mg/m^3 (.05 ppm)	--	Not Found	.2 mg/m^3 (.05 ppm)	--	Not Found
7783600	Sulfur Tetrafluoride	Not Found	--	.4 mg/m^3 (.1 ppm)	Not Found	2.5 mg/m^3	--	Not Found
7783702	Antimony Pentafluoride	Not Found	.5 mg/m^3	--	Not Found	.5 mg/m^3	--	Not Found
7783804	Tellurium Hexafluoride	1 ppm	.2 mg/m^3 (.02 ppm)	--	Not Found	.2 mg/m^3 (.02 ppm)	--	Not Found
7784341	Arsenous Trichloride	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
7784421	Arsine	6 ppm	.2 mg/m^3 (.05 ppm)	--	Not Found	.2 mg/m^3 (.05 ppm)	--	1
7784465	Sodium Arsenite	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
7786347	Mevinphos	40 mg/m^3**	.1 mg/m^3 (.01 ppm)	--	.3 mg/m^3 (.03 ppm)	.1 mg/m^3	--	Not Found
7791120	Thallous Chloride	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
7791233	Selenium Oxychloride	100 mg/m^3**	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
7803512	Phosphine	200 ppm	.4 mg/m^3 (.3 ppm)	--	1 mg/m^3 (1 ppm)	.4 mg/m^3 (.3 ppm)	--	Not Found
8001352	Camphechlor	200 mg/m^3**	.5 mg/m^3	--	1 mg/m^3	.5 mg/m^3	--	Not Found
8023538	Dichlorobenzalkonium Chloride*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
8065483	Demeton	20 mg/m^3	.1 mg/m^3 (.01 ppm)	--	Not Found	.1 mg/m^3	--	Not Found
10025657	Platinous Chloride*	Not Found	.002 mg/m^3	--	Not Found	.002 mg/m^3	--	Not Found
10025737	Chromic Chloride	Not Found	.5 mg/m^3	--	Not Found	1 mg/m^3	--	Not Found
10025873	Phosphorus Oxychloride	Not Found	.6 mg/m^3 (.1 ppm)	--	3 mg/m^3 (.5 ppm)	Not Found	--	Not Found
10025975	Iridium Tetrachloride*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10026138	Phosphorus Pentachloride	200 mg/m^3	1 mg/m^3 (1 ppm)	--	Not Found	1 mg/m^3	--	Not Found
10028156	Ozone	10 ppm	.2 mg/m^3 (.1 ppm)	--	.6 mg/m^3 (.3 ppm)	.2 mg/m^3 (.1 ppm)	--	1
10031591	Thallium Sulfate	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
10049077	Rhodium Trichloride*	Not Found	1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
10102188	Sodium Selenite	Not Found	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
10102202	Sodium Tellurite	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
10102439	Nitric Oxide	100 ppm	30 mg/m^3 (25 ppm)	--	Not Found	30 mg/m^3 (25 ppm)	--	Not Found
10102440	Nitrogen Dioxide	50 ppm	6 mg/m^3 (3 ppm)	--	10 mg/m^3 (5 ppm)	9 mg/m^3 (5 ppm)	--	1 (Spegl)
10124502	Potassium Arsenite	.002 mg/m^3 15 min.**	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
10140871	Ethanol, 1,2-Dichloro-, Acetate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10210681	Cobalt Carbonyl	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found
10265926	Methamidophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10294345	Boron Trichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10311849	Dialifor	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
10476956	Methacrolein Diacetate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
12002038	Paris Green	Not Found	.2 mg/m^3	--	Not Found	.01 mg/m^3	--	Not Found
12108133	Manganese, Tricarbonyl Methylcyclopentadienyl	10000 mg/m^3**	.1 mg/m^3	--	Not Found	--	5 mg/m^3	Not Found
13071799	Terbufos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13171216	Phosphamidon	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13194484	Ethoprophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13410010	Sodium Selenate	100 mg/m^3**	.2 mg/m^3	--	Not Found	.2 mg/m^3	--	Not Found
13450903	Gallium Trichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
13454961	Platinum Tetrachloride*	Not Found	.002 mg/m^3	--	Not Found	.002 mg/m^3	--	Not Found
13463393	Nickel Carbonyl	.0001 ppm	.35 mg/m^3 (.05 ppm)	--	Not Found	.007 mg/m^3 (.001 ppm)	--	Not Found
13463406	Iron, Pentacarbonyl-	Not Found	.8 mg/m^3 (.1 ppm)	--	1.6 mg/m^3 (.2 ppm)	Not Found	--	Not Found
13494809	Tellurium	Not Found	.1 mg/m^3	--	Not Found	.1 mg/m^3	--	Not Found

EXHIBIT D-3 (Cas #)

Published toxicity guidelines for Extremely Hazardous Substances that could be used for the Level of Concern (Continued)

Cas #	Chemical Name	IDLH	TLV-TWA	TLV-TWA CEIL	TLV-STEL	OSHA PEL	PEL CEIL	EEGL/SPEGL (ppm)
14167181	Salcomine	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
15271417	Bicyclo[2.2.1]Heptane-2-Carbonitrile, 5-Chloro-6-((((Methylamino)Carbonyl)Oxy)Imino)-, (1S-(1-alpha, 2-beta,4-alpha,5-alpha,6E))-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
16752775	Methomyl	Not Found	2.5 mg/m^3	--	Not Found	Not Found	--	Not Found
16919587	Ammonium Chloroplatinate*	Not Found	.002 mg/m^3	--	Not Found	.002 mg/m^3	--	Not Found
17702419	Decaborane(14)	20 ppm	.3 mg/m^3 (.05 ppm)	--	.9 mg/m^3 (.15 ppm)	.3 mg/m^3 (.05 ppm)	--	Not Found
17702577	Formparanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
19287457	Diborane	40 ppm	.1 mg/m^3 (.1 ppm)	--	Not Found	.1 mg/m^3 (.1 ppm)	--	Not Found
19624227	Pentaborane	3 ppm	.01 mg/m^3 (.005 ppm)	--	.03 mg/m^3 (.015 ppm)	.01 mg/m^3 (.005 ppm)	--	Not Found
20816120	Osmium Tetroxide*	1 mg/m^3	.002 mg/m^3 (.0002 ppm)	--	.006 mg/m^3 (.0006 ppm)	.002 mg/m^3	--	Not Found
20830755	Digoxin	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
20859738	Aluminum Phosphide	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
21548323	Fosthietan	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
21564170	Thiocyanic Acid, 2-(Benzothiazolylthio) Methyl Ester*	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
21609905	Leptophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
21908532	Mercuric Oxide	Not Found	.1 mg/m^3	--	Not Found	--	.1 mg/m^3	Not Found
21923239	Chlorthiophos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
22224926	Fenamiphos	Not Found	.1 mg/m^3	--	Not Found	Not Found	--	Not Found
23135220	Oxamyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
23422539	Formetanate Hydrochloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
23505411	Pirimifos-Ethyl	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
24017478	Triazofos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
24934916	Chlormephos	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
26419738	Carbamic Acid, Methyl-, O-(((2,4-Dimethyl-1, 3-Dithiolan-2-Yl)Methylene)Amino)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
26628228	Sodium Azide (Na(N3))	Not Found	.3 mg/m^3 (.1 ppm)	--	Not Found	Not Found	--	Not Found
27137855	Trichloro(Dichlorophenyl)Silane	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
28347139	Xylylene Dichloride	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
28772567	Bromadiolone	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
30674807	Methacryloyloxyethyl Isocyanate	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
39196184	Thiofanox	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
50782699	Phosphonothioic Acid, Methyl-, S-(2-(Bis (1-Methylethyl)Amino)Ethyl) O-Ethyl Ester	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
53558251	Pyriminil	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
58270089	Zinc, Dichloro(4,4-Dimethyl-5(((((Methylamino) Carbonyl)Oxy)Imino)Pentanenitrile)-, (T-4)-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found
62207765	Cobalt,((2,2'-(1,2-Ethanediylbis (Nitrilomethylidyne))Bis(6-Fluorophenolato)) (2-)-N,N',O,O')-	Not Found	Not Found	--	Not Found	Not Found	--	Not Found

* These chemicals have been proposed for delisting because they do not meet acute toxicity criteria.

** Non-specific chemical

APPENDIX E

SAMPLE PROFILE AND EMERGENCY FIRST AID TREATMENT

EPA has prepared chemical profiles of the extremely hazardous substances (EHSs) listed in Exhibits C-1 and C-2. Emergency first aid treatment guides are also available for a number of EHSs. A chemical profile for each substance and, in some cases, an emergency first aid treatment guide, are available in hard copy or on IBM compatible floppy disks. This appendix provides, as an example, the profile and emergency first aid treatment guide for acrolein.

EPA CHEMICAL PROFILE

Date: October 31, 1985
Revision: November 30, 1987

CHEMICAL IDENTITY -- ACROLEIN

CAS Registry Number: 107-02-8

Synonyms: Acraldehyde; Acrylaldehyde; Acrylic Aldehyde; Ally1 Aldehyde; Aqualin; Aqualine; Ethylene Aldehyde; Magnacide H; NSC 8819; Propenal; 2-Propenal; Prop-2-en-l-al; 2-Propen-l-one

Chemical Formula: C3H40

Molecular Weight: 56.06

SECTION I -- REGULATORY INFORMATION

CERCLA (SARA) 1986:

Toxicity Value Used for Listing Under Section 302: LC50 inhalation (mouse) 0.15 mg/liter/6 hours (*NIOSH/RTECS 1985)

TPQ: 500 (pounds)

RQ: 1 (pounds)

Section 313 Listed (Yes or No): Yes

SECTION II -- PHYSICAL/CHEMICAL CHARACTERISTICS

Physical State: Liquid

Boiling Point: 126F, 52.5C (*Merck 1983)

Specific Gravity (H20-1): 0.8389 at 20C; 0.8621 at 0C (*Merck 1983)

Vapor Pressure (mmHg): 210 at 68F, 20C; 135.71 at 50F, 10C (*Weed Science Society of America 1974)

Melting Point: -126F, -88C (*Merck 1983)

Vapor Density (AIR-l): 1.94 (*Encyc Occupat Health and Safety 1983)

Evaporation Rate (Butyl acetate-l): Not Found

ACROLEIN

SECTION II -- PHYSICAL/CHEMICAL CHARACTERISTICS (continued)

Solubility in Water: Soluble in 2-3 parts water (*Merck 1983)

Appearance and Odor: Colorless or yellowish liquid with extremely sharp, disagreeable, acrid, irritating odor (*Sax 1979, *CHRIS 1980)

SECTION III -- HEALTH HAZARD DATA

OSHA PEL: TWA 0.1 ppm (0.25 mg/m3) (NIOSH 1987, p. 44)

ACGIH TLV: TWA 0.1 ppm (0.25 mg/m3); STEL 0.3 ppm (0.8 mg/m3) (ACGIH 1986-87, p. 9)

IDLH: 5 ppm (NIOSH 1987, p. 44)

Other Limits Recommended: EEGL 0.05 ppm (60 minutes) (NRC 1984a, pp. 27-34)

Routes of Entry: Inhalation: Yes (*NIOSH/RTECS 1985)
Skin: Yes (*NIOSH/RTECS 1985)
Ingestion: Yes (*Gosselin 1984)

Health Hazards (Acute, Delayed, and Chronic): Extremely toxic; probable oral human lethal dose is S-50 mg/kg, between 7 drops and one teaspoon for a 70 kg (150 lb.) person (*Gosselin 1984). Inhalation of air containing 10 ppm of acrolein may be fatal in a few minutes (*NRC 1981). Death from cardiac failure accompanied by hyperemia and hemorrhage of the lungs and degeneration of the bronchial epithelium is possible. Acrolein causes acute respiratory and eye irritation; severe gastrointestinal distress with slowly developing pulmonary edema (lungs fill up with fluid); and skin irritation (Gosselin 1984, p. 11-186).

Medical Conditions Generally Aggravated by Exposure: Not Found

SECTION IV -- FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used): -15F, -26C (CC); less than OF, -18C (OC) (*NFPA 1978)
Flammable Limits:
LEL: 2.8% (*NFPA 1978)
UEL: 31% (*NFPA 1978)

Extinguishing Methods: Dry chemical, alcohol foam, or carbon dioxide. Water may be ineffective, but can be used to keep containers cool (*NFPA 1978).

ACROLEIN

SECTION IV -- FIRE AND -EXPLOSION HAZARD DATA (continued)

Special Fire Fighting Procedures: In advanced or massive fires, fire fighting should be done from safe distance or from protected location. Use dry chemical, alcohol foam, or carbon dioxide. Water may be ineffective, but should be used to keep fire-exposed containers cool. If a leak or spill has not ignited, use water spray to disperse vapors. If it is necessary to stop a leak, use water spray to protect men attempting to do so. Water spray may be used to flush spills away from exposures and to dilute spills to nonflammable mixtures (*NFPA 1978). Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Isolate for l/2 mile in all directions if tank car or truck is involved in fire (DOT 1987, Guide 30).

Unusual Fire and Explosion Hazards: Under fire conditions, polymerization may occur. If inside a container, violent rupture of the container may take place (*NFPA 1978).

NFPA Flammability Rating: 3

SECTION V -- REACTIVITY DATA

Stability: Unstable: Yes (*Merck 1983)
Stable:

Conditions to Avoid: Exposure to alkalis or strong acids (*Encyc Occupat Safety and Health 1983) or to oxygen (*NFPA 1978).

Incompatibility (Materials to Avoid): Alkalis or strong acids act as catalysts, causing a condensation reaction and liberating energy. Reaction may be very rapid and violent (*Encyc Occupat Health and Safety 1983). Readily converted by oxygen to hazardous peroxides and acids (*NFPA 1978).

Hazardous Decomposition or Byproducts: When heated to decomposition, it emits highly toxic fumes (*Sax 1975).

Hazardous Polymerization: May Occur: Yes (*NFPA 1978)
May Not Occur:

Conditions to Avoid: Elevated temperatures, such as fire conditions. (Polymerization inside container could cause violent rupture of container under fire conditions.) (*NFPA 1978)

ACROLEIN

SECTION VI -- USE INFORMATION

Acrolein is used in manufacture of colloidal forms of metals; making plastics, perfumes: as a warning agent in methyl chloride refrigerant; and has been used in military poison gas mixtures (*Merck 1983). It is also used as an intermediate in the production of glycerine, methionine, acrylic acid, and esters (*SRI). Acrolein is also an intermediate for glycerol, polyurethane, polyester resins, and pharmaceuticals (*Hawley 1981). Additionally, acrolein is used as an aquatic herbicide, biocide, slimicide (*Farm Chemicals Handbook 1984) and molluscicide (*Kearney and Kaufman 1975).

SECTION VII -- PRECAUTIONS FOR SAFE HANDLING AND USE
(Steps to be Taken in Case Material is Released or Spilled)

When handling acrolein, no skin surface should be exposed (*NFPA 1978). Remove all ignition sources. Ventilate area of spill or leak. For large quantities, cover with sodium bisulfite, add small amount of water and mix. Then, after 1 hour, flush with large amounts of water and wash site with soap solution. Liquid should not be allowed to enter confined space, such as sewer, because of possibility of explosion. Take up spill for disposal by absorbing it in vermiculite, dry sand, or earth and disposing in a secured landfill or combustion chamber (*NIOSH 1981).

SECTION VIII -- PROTECTIVE EQUIPMENT FOR EMERGENGY SITUATIONS

For emergency situations, wear a positive pressure, pressure-demand, full facepiece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical resistant suit. See the introduction and comment section at the beginning of the profiles for additional information.

Suit Material Performance (based on EPA/USCG "Guidelines", 1987)
(Chemical Resistance/Amount of Data):

Butyl:	Good/Limited
Butyl/Neoprene:	Poor/Many
CPE:	Poor/Many
Nitrile:	Poor/Many
Viton:	Poor/Many
Viton/Chlorobutyl:	Good/Limited

SECTION IX -- EMERGENGY TREATMENT INFORMATION

See Emergency First Aid Treatment Guide

Emergency First Aid Treatment Guide
for
ACROLEIN

(107-02-8)

This guide should not be construed to authorize emergency personnel to perform the procedures or activities indicated or implied. Care of persons exposed to toxic chemicals must be directed by a physician or other competent authority.

Substances Characteristics:

Pure Form - Colorless or slightly yellow liquid.

Odor - Extremely sharp.

Commercial Forms - 92 to 99% pure liquid.

Uses - Chemical intermediate, manufacture of plastics, perfumes, paper, colloidal forms of metals; component of military poison gas mixture, liquid fuel, antimicrobial agent, aquatic pesticide; warning agent in methyl chloride refrigerant.

Materials to Avoid - Strong acid, alkali, caustic soda, oxidizers, oxygen (except for use in emergency life support).

Other Names - Acquinite, acraldehyde, acrylaldehyde, acrylic aldehyde, ally1 aldehyde, ethylene aldehyde, Magnacide H, 2-Propenal.

Personal Protective Equipment: See Chemical Profile Section VIII.

Emergency Life-Support Equipment and Supplies That May Be Required:
Compressed oxygen, forced-oxygen mask, soap, water, milk, activated charcoal, saline cathartic or sorbitol.

Signs and Symptoms of Acute Acrolein Exposure:

Warning: Acrolein is highly irritating to skin and mucous membranes. Caution is advised.

Signs and symptoms of acute exposure to acrolein may be severe and include shortness of breath, tightness of chest, pulmonary edema, and coma. Lacrimation (tearing), nausea, vomiting, and diarrhea may occur. Acrolein will irritate or burn the skin and mucous membranes. Eye contact may cause irritation, swelling, discharge and/or cornea1 injury.

ACROLEIN

Emergency Life-Support Procedures:

Acute exposure to acrolein may require decontamination and life support for the victims. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination.

Inhalation Exposure:

1. Move victims to fresh air. Emergency personnel should avoid self-exposure to acrolein.

2. Evaluate vital signs including pulse and respiratory rate and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.

3. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

4. RUSH to a health care facility.

Dermal/Eye Exposure:

1. Remove victims from exposure. Emergency personnel should avoid self-exposure to acrolein.

2. Evaluate vital signs including pulse and respiratory rate and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.

3. Remove contaminated clothing as soon as possible (and place in plastic bag).

4. If eye exposure has occurred, eyes must be flushed with lukewarm water for at least 15 minutes.

5. Wash exposed skin areas THOROUGHLY with soap and water.

6. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

7. RUSH to a health care facility.

ACROLEIN

Ingestion Exposure:

1. Evaluate vital signs including pulse and respiratory rate and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.

2. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

3. Give the victims water or milk: children up to 1 year old, 125 mL (4 oz or l/2 cup); children 1 to 12 years old, 200 mL (6 oz or 3/4 cup); adults, 250 mL (8 oz or 1 cup). Water or milk should not be given if victims are not conscious and alert.

4. Activated charcoal may be administered if victims are conscious and alert. Use 15 to 30 gm (l/2 to 1 oz) for children, 50 to 100 gm (l-3/4 to 3-l/2 oz) for adults, with 125 to 250 mL (l/2 to 1 cup) of water.

5. Promote excretion by administering a saline cathartic or sorbitol to conscious and alert victims. Children require 15 to 30 gm (l/2 to 1 oz) of cathartic; 50 to 100 gm (l-3/4 to 3-l/2 oz) is recommended for adults.

6. RUSH to a health care facility.

APPENDIX F
FIRE AND REACTIVITY HAZARDS

Congress mandated in Title Ill of SARA that local emergency planning committees (LEPCs) focus initially on acute toxicity hazards related to extremely hazardous substances (EHSs). Other hazards may warrant consideration in emergency preparedness and response planning. This appendix is a brief discussion of fire and reactivity hazards.

Fire Hazards. Flammable materials, particularly those that will ignite at a relatively low temperature (i.e., that have low flash points), clearly may be a hazard to communities. There are several major types of fires that may be associated with hazardous material discharges, with the type of fire being a function not only of the characteristics and properties of the spilled substance but the circumstances surrounding the accident. The types are:

- **Flame Jets.** Tanks, cylinders, and pipelines which contain gases under pressure (i.e., compressed gases or liquefied gases) may discharge gases at a high speed if they are somehow punctured or broken during an accident. If the gas is flammable and encounters an ignition source, a flame jet of considerable length (possibly hundreds of feet) may form from a hole less than a foot in diameter.
- **BLEVEs.** Boiling Liquid Expanding Vapor Explosions (BLEVEs) are among the most feared events when tanks of hazardous materials are exposed to fire or physical damage or other events that cause excessive pressures within the tank. A BLEVE could occur when flames impinge upon the vapor space (unwetted internal surface) of the tank where there is no liquid to absorb heat. As the vapor space is heated, the pressure inside the tank (even after the relief valve opens) becomes so great that it eventually vents itself through the weakest area of the tank. As the pressure inside is increasing, the flames weaken the structural integrity of the tank, thus creating the conditions for venting. This sudden venting of pressure and vaporization of product involves the violent rupture of the container, with rocketing fragments. If the container stored a flammable liquid or gas, a large rising fireball will form, the size of which will vary with the amount of hazardous material present.
- **Vapor or Dust Cloud Fires and Explosions.** Vapors evolved from a pool of volatile liquid or gases venting from a punctured or otherwise damaged container, if not ignited immediately, will form a plume or cloud of gas or vapor that moves in the downwind direction. If this cloud or plume contacts an ignition source, a wall of flame may flash back towards the source of the gas or vapor, sometimes with explosive force. Similarly, fires may flash through airborne clouds of combustible dusts. Dusts may explode under some conditions (e.g., grain elevator explosions).
- **Liquid Pool Fires.** A liquid pool fire is a fire involving a quantity of liquid fuel such as gasoline spilled on the surface of the land or water. An added complication is that the liquid fuel, depending on terrain, may flow downslope from the accident site and into sewers, drains, surface waters, and other catchments.
- **Flammable Solid Fires.** A “flammable solid” may cause fires through friction or retained heat from manufacturing or processing. It can be ignited readily and when ignited burns vigorously and persistently. Included in this class are spontaneously combustible (pyrophoric) and water-reactive materials. Fires involving these materials present a difficult challenge to firefighters, particularly when water cannot be used.

Reactivity Hazards. Some of the more common and/or dangerous types of reactions, and how they may alter the outcome of an accidental release, are outlined below:

- **Reactions with Water or Moist Air.** Some substances generate heat when mixed with water. Some strong acids may evolve large amounts of fumes when in contact with water or moisture in the air. These fumes, which may consist of a mixture of fine droplets of acid in air and acid vapors, are usually highly irritating, corrosive, and heavier than air. Other materials may ignite, evolve flammable gases, or otherwise react violently when in contact with water. Knowledge of the reactivity of any substance with water is especially important when water is present in the spill area. Uninformed firefighters can worsen a situation by applying water to the water-reactive chemicals.
- **Reactions with Combustible Organic Materials.** Strong oxidizing or reducing agents have the common characteristic of being able to decompose organic materials and react with a variety of inorganic materials while generating heat, flammable gases, and possibly toxic gases. If the heat generated is sufficient to ignite a combustible material or a flammable gas (when confined), either a fire or explosion may occur.
- **Polymerization Reactions.** Many plastics are manufactured by means of a polymerization reaction in which molecules are linked together into long chains. Some of the chemicals capable of polymerizing have a strong tendency to do so even under normal ambient conditions and are especially prone to polymerize if heated above a certain temperature or if contaminated. Once polymerization starts, a chain reaction may occur that develops high pressures and temperatures within containers and can lead to possible rupture of the container and discharge of flammable and/or toxic gases if safety and control systems malfunction or are lacking.
- **Decomposition Reactions.** Some chemical molecules are unstable and can break apart in a runaway reaction once the process is initiated. Various contaminants or heat may start a reaction. Containers may rupture or vent various flammable and/or toxic gases.

  Decomposition and polymerization reactions are hazardous only if they become uncontrolled and start a chain reaction that cannot be stopped with available equipment, materials, or safety systems.
- **Corrosivity.** The process by which a chemical gradually eats away or dissolves another material is referred to as corrosion. It represents yet another type of chemical reactivity that must be considered in assessing the hazards of any given material. The word "corrosive" is also used descriptively to indicate that a substance may cause chemical burns of the skin, eyes, or other bodily tissues.
- **Other Reactivity Hazards.** In addition to the types of reactions discussed above, hazards can result from the following situations:
  - The combination of various chemicals may produce new chemicals with hazards quite different and possibly more severe than those associated with the original materials.
  - Some combinations may result in spontaneous fires: spontaneous explosions: formation of substances which will ignite or explode if shocked, heated or subjected to friction: generation of toxic gases, liquids, or solids; or generation of flammable gases, liquids, or solids.

APPENDIX G

EQUATIONS USED FOR THE ESTIMATION OF VULNERABLE ZONES

G. 1 INTRODUCTION

Chapter 3 presents a tabular method for estimation of the radius of the vulnerable zone (VZ) for releases of gases, liquids, and solids. This appendix contains the equations used to derive the tables found in Chapter 3. Section G.2 discusses the derivation of the release rate term of the vulnerable zone calculation. For liquids, a liquid factor including many of the variables that affect rate of evaporation is used for the estimate: this factor is also described in Section G.2.

Section G.3 discusses the derivation of the relationship between downwind distance, as a function of rate of release, and level of concern (LOC) as presented in Exhibits 3-1 to 3-4 in Chapter 3.

The calculations are based on applications of the dispersion model described in the Workbook of Atmospheric Dispersion Estimates, Public Health Service Publication No. 999-AP-26, 1970 (popularly known as Turner's Workbook). Estimates of dispersion distribution parameters are those of Briggs, based on McElroy and Pooler's experiments, given in the Handbook of Atmospheric Diffusion, Department of Energy Publication No. DOE/TIC-11223, 1982.

The following assumptions are made concerning the circumstances of the credible worst case release (these assumptions are designed to be conservative and represent adverse conditions for screening purposes) :

- Rural flat terrain with no obstacles (e.g., hills) that would interfere with the downwind movement of the plumes (obstacles would increase the dispersion capability of the plume);
- Ground level release (releases from elevated sources tend to disperse more readily than ground level releases);
- F Stability and 1.5 meters per second (3.4 miles per hour) wind speed, representing stable air and low wind speed (the VZ calculated under these conditions is larger than that calculated under conditions usually considered typical); and
- Continuous release (consistent with a catastrophic loss) rather than a brief "puff."

The following assumptions are made concerning the substance released:

- There is no phase change and the plume is at ambient temperature (phase changes and temperature changes would cause variations in dispersion and evaporation (volatilization) rates).
- The substance released is neutrally buoyant in air. Dense gases are treated the same way as neutrally buoyant gases in this analysis. (The behavior of a dense gas is different, but for the calculations presented in this appendix, the concentrations along the centerline of the plume are considered. These concentrations are comparable for dense gases and neutrally buoyant gases);
- A Gaussian distribution of the plume's spread, in both horizontal and vertical planes, was assumed in the dispersion estimates:
- Gases are released over a ten minute period:
- Liquids are instantaneously spilled from containment onto a flat, level surface forming a 0.033 ft (1 cm) deep pool and are allowed to evaporate at ambient or boiling conditions:
- Solids in powder form (<100 microns particle size) behave like gases and are also released in ten minutes:

- Solids in solution are assumed to behave as a finely dispersed aerosol and are released in ten minutes:
- Solids in molten form are assumed to behave as liquids. The quantity molten is assumed to lose containment instantaneously, forming a 0.033 ft (1 cm) deep pool on a flat, level surface and volatilizing at its melting point temperature: and
- Solids in "brick" form (i.e., not powdered, in solution, vaporized, or molten) are not likely to be released.

G.2 ESTIMATION OF AIRBORNE QUANTITY RELEASED FOR LIQUIDS

The rate of release of a chemical is needed for calculation of the radius of the VZ. It is dependent on the quantity of chemical released, the nature of the release scenario (i.e., pool of liquid, release of pressure relief valve, etc.), and the properties of the chemical released. For spilled pools of chemicals, the rate of release is usually taken to be the evaporation rate (rate of volatilization). Using the assumptions presented above, the following equation is used to calculate the rate of release to air for liquids (in lbs/min) :

$$(1)\quad QR = \frac{(60\ \text{sec/min} \times MW \times K \times A \times VP \times (929\text{cm}^2/\text{ft}^2,}{R \times (T1+273) \times (760\ \text{mm Hg/atm}) \times 454\ \text{g/lb}}$$ (Clement 1981)

where: QR = Rate of release to air (lbs/min);
MW = Molecular weight (g/g mole);
K = Gas phase mass transfer coefficient (cm/sec);
A = Surface area of spilled material (ft^2);
VP = Vapor pressure of material at temperature T1 (mm Hg);
R = 82.05 atm cm^3/g mole K; and
T1 = Temperature at which the chemical is stored (^{0}C).

The equation for the evaporation rate (rate of volatilization) can be rewritten as follows:

$$(2)\quad QR = \frac{0.162 \times MW \times K \times A \times VP}{R\ (T1+273)}$$

K can be estimated based on a known value for a reference compound as follows:

$$(3)\quad K = K_{ref} \times (MW_{ref}/MW)^{1/3}$$ (Clement 1981)

Using water as the reference compound:

$$(4)\quad K_{ref}\ K_{water} = 0.25 \times (u)^{0.78}$$ (Mackay and Matsugo 1973)

where: u = Windspeed (m/sec)

Combining Equations 3 and 4:

$$(5)\quad K = 0.25\ (u)^{078} \times (18/MW)^{1/3}$$

Combining equations for QR and K yields the following equations:

$$(6)\quad QR = \frac{0.162 \times 0.25 \times (u)^{0.78} \times (18)^{1/3} \times MW^{2/3} \times Ax\ VP}{R \times (T1 + 273)}$$

$$(7)\quad QR = \frac{0.106 \times (u)^{0,78} \times MW^{2/3} x\ Ax\ VP}{R \times (T1 + 273)}$$

Calculation of the surface area (A) of the spilled material is carried out as described in the following sections.

G.2.1 CALCULATION OF SURFACE AREAS OF POOLS OF SPILLED LIQUIDS

For diked areas, the surface area is assumed to be the area inside the dike (unless the surface area of the spill is smaller than the diked area). If the area is not diked, the following assumptions are used to calculate the surface area of the spill:

Density = 62.4 lb/ft^3 (i.e., all liquids are assumed to have the same density as water)

Depth of pool is 0.033 ft (I cm)

The surface area of the spilled liquid (ft^2) is:

$$(8)\quad A = \frac{QS\ (lbs)}{62.4\ lb/f^3 \times 0.033ft} = 0.49 \times QS$$

where: QS = Quantity spilled (lbs); and
A = Surface area (ft^2).

Substituting for A in Equation 7, the quantity released to air per minute (QR) can be estimated as follows:

$$(9)\quad QR = \frac{0.106 \times (u)^{0.78} \times MW^{2/3} \times 0.49 \times QS \times VP}{82.05 \times (T1 + 273)}$$

G. 2.2 LIQUID FACTORS

Equation (9) may be simplified by separating all the chemical specific parameters, such as vapor pressure and molecular weight, and the temperature into a "liquid factor." The "liquid factor" therefore includes all the terms of Equation (9), except the quantity spilled (QS) and the wind speed term. For ambient temperatures, VP is the vapor pressure measured at T1 (ambient temperature). The liquid factor at ambient conditions (LFA) is calculated as:

$$(10)\ LFA = \frac{0.106 \times MW^{2/3} \times 0.49 \times VP}{82.05 \times (T1 + 273)}$$

For a liquid at its boiling temperature, VP is assumed to be 760 mm Hg at T1, the normal boiling point of the liquid. The liquid factor at the boiling point (LFB) is calculated as:

$$(11)\ LFB = \frac{0.106 \times MW^{2/3} \times 0.49 \times 760}{82.05 \times (\text{Boiling point} + 273)}$$

For a solid at its melting point, VP is the vapor pressure measured at T1 (melting point). The liquid factor at the melting point (LFM) is calculated as:

$$(12)\ LFM = \frac{0.106 \times MW^{2/3} \times 0.49 \times VP\ \text{melting}}{82.05 \times (\text{melting point} + 273)}$$

The liquid factor multiplied by the quantity spilled and the wind speed term ($u^{0.78}$) gives the airborne quantity release rate:

$$(13)\ QR = QS \times u^{0.78} \times (LFA, LFB, \text{ or } LFM)$$

For diked areas:

$$(14)\ QR = \frac{(LFA, LFB, \text{ or } LFM) \times \text{Diked Area } (ft^2) \times u^{0.78}}{0.49}$$

Liquid factors for listed substances that are liquid at ambient conditions, or solid with potential for handling at molten state, are listed in Appendix C.

G.3 ESTIMATION OF A VULNERABLE ZONE

The following equation, based on Turner's Workbook, was used to derive the vulnerable zone radius. The concentration downwind of a release is given by:

$$(15)\ C = \frac{QR}{\pi \sigma_y \sigma_z u}$$ (Turner 1970, Equation 3.4)

for a ground level release with no effective plume rise where:

C = Airborne concentration, gm/m3
QR = Rate of release to air, gm/sec
π = 3.141
σ_y σ_z = dispersion deviation, horizontal (y), and vertical (z)
u = windspeed, m/sec

This equation represents the steady state concentration at some distance downwind and is applicable for release ranging from 10 minutes to one hour.

$$(16)\quad \sigma_y \quad \sigma_z = \frac{QR\ (g/sec)}{3.141 \times u \times c}$$

$$\sigma_y \quad \sigma_z = \frac{0.318 \times QR\ (g/sec)}{u \times c}$$

QR (lb/min) = QR (g/sec) x (60 sec/min x 1 lb/454 g)

QR (lb/min) = 0.132 x (QR g/sec)

QR (g/sec) = (QR g/sec) / 0.132

$$\sigma_y \quad \sigma_z = \frac{0.318 \times QR\ (lbs/min)}{0.312 \times u \times C}$$

$$(17)\quad \sigma_y \quad \sigma_z = \frac{2.41 \times QR\ (lb/min)}{u \times c}$$

As downwind distance increases, the σ_y σ_z product increases. For practical use to be made of the diffusion formula, numerical values of the diffusion coefficients σ_y and σ_z must be determined. To deal with the resulting wide variations in turbulent properties, meteorologists have introduced stability classes into which atmospheric conditions are classified. Briggs (1973) used McElroy and Pooler's 1968 diffusion experiment to develop formulas for σ_y and σ_z as functions of distance, shown in Exhibit G-1. To use these equations to determine distances, it will be necessary to use trial and error methods or a computer. For the development of this guidance, both rural (open country) and urban conditions for F atmospheric stability (the most stable class used for this guidance) and D atmospheric stability (neutral class assumed for overcast conditions during day or night, regardless of wind speed) were used.

EXHIBIT G-1

FORMULAS RECOMMENDED BY BRIGGS (1973)

for $\sigma_v(d)$ and $\sigma_z(d)$ $(10^2 < d < 10^4$ m)

Pasquill Stability Type	σ_y,m	σ_z,m
	Open-Country Conditions	
A	$0.22d(1+0.0001d)^{-1/2}$	$0.20d$
B	$0.16d(1+0.0001d)^{-1/2}$	$0.12d$
C	$0.11d(1+0.0001d)^{-1/2}$	$0.08d(1+0.0002d)^{-1/2}$
D	$0.08d(1+0.0001d)^{-1/2}$	$0.06d(1+0.0015d)^{-1/2}$
E	$0.06d(1+0.0001d)^{-1/2}$	$0.03d(1+0.0003d)^{-1}$
F	$0.04d(1+0.0001d)^{-1/2}$	$0.016d(1+0.0003d)^{-1}$
	Urban Conditions	
A-B	$0.32d(1+0.0004d)^{-1/2}$	$0.24d(l+0.001d)^{1/2}$
C	$0.22d(l+0.0004d)^{-1/2}$	$0.20d$
D	$0.16d(l+0.0004d)^{-1/2}$	$0.14d(1+0.0003d)^{-1/2}$
E-F	$0.11d(1+0.0004d)^{-1/2}$	$0.08d(l+0.00015d)^{-1/2}$

NOTE: *d = downwind distance.*

G.4 REFERENCES

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APPENDIX H

GENERAL CONSIDERATIONS FOR EVACUATION OR IN-PLACE SHELTERING

An accidental release of hazardous materials sometimes necessitates evacuation of people from certain areas to prevent injury or death. These areas can include those directly affected by toxic fumes and gases or fire and those areas that may be potentially affected during the course of the incident (e.g., through wind shift, a change in site conditions). Evacuation is a complex undertaking. Rather than attempting to provide specific step-by-step guidance for each possible scenario, we will discuss in this appendix general considerations that should be addressed in advance by the local emergency planning committee (LEPC). Specifically, this appendix will discuss: deciding whether evacuation is appropriate and necessary (Section H.1); steps in conducting an evacuation (Section H.2); and in-place sheltering as an alternative to evacuation (Section H.3).

> This document will not give you evacuation distances nor provide definitive guidance on estimating evacuation zones.
>
> Decisions about whether or not to evacuate as well as about evacuation distances are incident-specific and must be made at the time of an actual release.
>
> The estimated vulnerable zones should be used for planning purposes only and should not be used as an evacuation zone

H.1 MAKING A DECISION ON EVACUATION

The first evacuation consideration, determining whether an evacuation is necessary, involves a comprehensive effort to identify and consider both the nature of and circumstances surrounding the released hazardous material and its effect on people. No safe exposure levels have been established for the extremely hazardous substances (EHSs) and therefore it is not possible to calculate evacuation distances using the methods outlined in this guidance. Section H. 1.1 discusses how hazardous conditions and inherent properties of the released materials affect evacuation decisions. Section H. 1.2 discusses how life safety factors affect the decision on whether or not to order an evacuation.

The Department of Transportation's (DOT's) Emergency Response Guidebook provides initial isolation and evacuation distances for transportation incidents. The evacuation distances given in the guidebook are preceded by the following advice: "The [initial isolation/evacuation] table is useful only for the first twenty to thirty minutes of an incident.. . . There are several good reasons for suggesting that the use of the table be limited specifically to the initial phase of a no-fire spill incident during transport. The best calculations for these tables are not reliable for long vapor travel times or distances. At their best they are estimates for a cool, overcast night with gentle and shifting winds moving **a** non-reactive, neutrally-buoyant vapor." The DOT Emergency Response Guidebook is intended to help first responders to make informed judgments during the initial phases of a hazardous materials transportation incident. LEPCs are cautioned not to use it as a substitute for a specific plan for responses to hazardous materials incidents.

H. 1.1 Hazardous Conditions Affecting **Evacuation Decisions**

Numerous factors affect the spread of hazardous substances into the area surrounding a leaking/burning container or containment vessel. Evacuation decision-makers must carefully consider each of these factors in order to determine the conditions created by the release, the areas that have been or will be affected, and the health effects on people. The factors that affect evacuation include amount of released material(s), physical and chemical properties of the released material(s), health **hazards,** dispersion pattern, atmospheric conditions, dispersion medium, rate of release, and potential duration of release. Each of these factors is explained below.

To begin with, it is necessary to know the material's physical and chemical properties, including:

- Physical State - solid, liquid, or gas:
- Odor, color, visibility;
- Flammability: flashpoint, ignition temperature, flammable limits;
- Specific Gravity: whether material sinks or floats on water:
- Vapor Density: whether vapors rise or remain near ground level;
- Solubility: whether material readily mixes with water;
- Reactivity: whether material reacts with air, water, or other materials:
- Crucial Temperatures: boiling point, freezing point.

It is also necessary to know the health effects resulting from a short-term exposure:

- Acute or chronic hazards:
- Respiratory hazards:
- Skin and eye hazards: and

  Ingestion hazards.

Another consideration is the dispersion pattern of the released hazardous material, for example:

- Does the release follow the contours of the ground?
- Is it a plume (vapor cloud from a point source) ?
- Does the release have a circular dispersion pattern (dispersing in all directions)?

Atmospheric conditions must also be addressed when determining the appropriate evacuation response to a hazardous material release. Atmospheric conditions that may affect the movement of material and evacuation procedures include:

- Wind (speed and direction);
- Temperature:
- Moisture (precipitation, humidity);
- Air dispersion conditions (inversion or normal); and
- Time of **day** (daylight or darkness).

Other considerations important in **making evacu**ation decisions include:

- Whether the hazardous material is being released into air, land, and/or water **and its** concentration in air or water:
- Size and potential duration of the release: and
- Rate of release of the material, as well as the projected rate (the rate of release may change during the incident).

H.1.2 LIFE SAFETY FACTORS TO CONSIDER IN PLANNING AN EVACUATION

Life safety factors to consider when planning an evacuation include the number and types of people that require evacuation and the resources needed to conduct a safe and effective evacuation. Whether the people are actually located in an area that contains hazards or are located in an area that is only threatened by hazards is a critical component of evacuation planning .

Populations in a Hazardous Area

When considering people who are actually located within a hazardous area, the LEPC must address whether responsible authorities should order people to remain indoors, rescue individuals from the area, or order a general evacuation. The "remain indoors" option should be considered when the hazards are too great to risk exposure of evacuees. (See Section H.3 for further discussion of in-place sheltering.) It may be necessary to rescue people from the **hazard**ous area, but this would involve supplying protective equipment for evacuees to ensure their safety. The third option is to order a general evacuation. In this case people must evacuate by means of private transportation or by transportation provided by local or State government, a private sector company, or volunteer groups.

Populations in a Threatened Area

For an area that is only threatened by a hazardous release, it should be determined whether potential evacuees can be evacuated before hazards reach the area. To safely evacuate the area, a significant amount of lead time may be required. Depending on the hazards and their movement (as described above), evacuation assistance personnel may not have much lead time.

Identifying People to be Evacuated

Numerous factors must be considered to ensure that an evacuation is conducted in a safe and effective manner, including how many people will be involved, where they are located, their degree of mobility, and whether there are any communication barriers to address. Potential evacuees may be found in many different locations:

- Residences
- Educational institutions
- Medical institutions
- Health care facilities
- Child care facilties
- Correctional facilities
- Offices
- Commercial establishments
- Manufacturing/industrial/research facilities
- Government facilities
- Places of public assembly
- Parks and other recreational areas
- Sporting arenas/stadiums
- Roadways

In addition to the above considerations, the LEPC must determine what persons will require special assistance in evacuating the area and whether there exist any barriers to communication between evacuees and evacuation assistance personnel. Special consideration should be given to:

- Persons lacking private transportation
- The elderly
- Children
- Handicapped persons
- The infirm
- Prisoners
- Non-English speaking persons

Resources Needed

To accomplish a safe and effective evacuation, the LEPC must provide for appropriate and sufficient resources, including personnel, vehicles, and equipment appropriate for emergency situations.

Among the agencies that would likely supply personnel during an evacuation operation are the Red Cross, police department, fire department, and emergency medical service agencies.

In addition to personnel, specially equipped vehicles may have to be put in service, including:

- Lift-equipped buses and taxi cabs for handicapped persons:
- Ambulances for infirm and handicapped persons: and
- Vehicles for transporting persons lacking private transportation.

Making prior arrangements to ensure the availability of these vehicles in times of emergency will result in a more timely and effective evacuation.

The type of equipment that will be necessary during an evacuation includes:

- Protective gear for evacuation assistance personnel (e.g., masks to protect the lungs, protective covering for the skin and eyes);
- Protective gear for evacuees who may have to be taken through an area of heavy chemical concentration:
- Communication equipment (e.g. portable and mobile radios, mobile public address systems, bull horns); and
- Evacuation tags (a tag or marker attached to **a** door to indicate that the occupants have been notified) for buildings that have been evacuated.

H.2 CONDUCTING AN EVACUATION

Should it be decided that an area is to be evacuated, the evacuation must be conducted in a well-coordinated, thorough, and safe manner. Evacuation involves a number of steps, which include assigning tasks to evacuation assistance personnel, informing potential evacuees, providing transportation as necessary, providing emergency medical care as necessary, providing security for evacuated areas, and sheltering evacuees as necessary.

H.2.1 Evacuation Tasks

The first step is to assign tasks to evacuation assistance personnel. These tasks include information concerning:

- The specific area to evacuate
- Protective gear to be worn
- Instructions to be given to evacuees
- Transportation of evacuees who are without private transportation
- Assistance to special populations
- Shelter locations
- Security for evacuated areas
- Traffic and pedestrian control
- Communication procedures

The progress of the evacuation efforts must be monitored by those in charge who should also provide continuous direction to evacuation assistance personnel.

H.2.2 Evacuation Warning and Instruction

The second step in an evacuation is to inform people that they must evacuate and to provide them with accurate instructions. This procedure can be accomplished in several ways:

- Door-to-Door. Requires significant manpower; is a slow process but is very thorough.
- Public Address System (from a mobile unit or within a building). Requires less manpower than a door-to-door evacuation and is quicker to accomplish but is not as thorough.
- Combination of Door-to-Door and Public Address System. For some sections of an area door-to-door notification may be more expeditious, whereas in other areas evacuation instructions given via a public address system may be adequate and less time consuming.

The potential evacuees might also be alerted to the emergency by means of an alerting and warning system that prompts them to tune in to their radios for instructions from the Emergency Broadcast System or a similar broadcast system.

H.2.3 Movement of Evacuees

The third step in an evacuation is to provide movement assistance to evacuees. Movement assistance includes:

- Arranging transportation for evacuees who are without private transportation:
- Arranging for movement of the infirm and handicapped:
- Traffic control:
- Encouraging evacuees to move along in an expeditious manner.

Buses and/or vans will be needed for transportation of large groups of evacuees. Evacuating the infirm and handicapped will involve lift-equipped buses, vans, and/or ambulances. Traffic control involves restricting access of vehicles into the evacuated area and facilitating speedy vehicular movement out of the evacuation area.

H.2.4 Emergency Medical Care for Evacuees

Should evacuees become exposed to hazards during an evacuation, emergency medical care must be provided. If a hazardous vapor cloud were to move suddenly upon **a** large group of people being evacuated, numerous casualties would be possible. For this reason, it is advantageous to have emergency medical service (basic and advanced life support) units standing by in case they are needed.

H.2.5 Security in Evacuated Areas

Once an area is evacuated, law enforcement personnel must guard the area to prevent looting and other unauthorized actions. Security forces operating in or around an evacuated area must be dressed in appropriate chemical protective gear.

H.2.6 Sheltering of Evacuees

The final step in the evacuation process is to provide shelter to the evacuees. Merely advising people to evacuate an area is inadequate. Providing shelter for them in **a** safe and comfortable building is of great importance, particularly at night or during inclement weather. In order to effectively serve the needs of evacuees, a shelter should have the following facilities, services, and characteristics:

- One qualified person to serve as Shelter Manager -- usually a Red Cross or local government representative
- Sufficient space to avoid overcrowding
- Restroom facilities
- Shower facilities
- Specialized facilities for the handicapped
- Chairs, tables, and other furniture
- Adequate lighting, temperature control, ventilation, and uncontaminated water
- Telephone system and/or two-way radio
- Food and refreshments
- Adequate safety features to meet fire, building, and health requirements
- Medical surveillance and care
- Care for the young, elderly, and handicapped
- Information available for evacuees concerning the emergency
- Sufficient parking near the shelter

Shelters should be identified and management and operational procedures should be established as part of a preparedness plan. When selecting shelters, locations must be chosen that are in areas beyond current and projected areas of hazard contamination. To ensure that evacuees are continuously sheltered in safe areas, the following actions are necessary:

- Collect and evaluate data on the spread of hazards toward shelters.
- Establish and maintain communications with shelters.
- Make provisions for the monitoring of hazards in and around each shelter and evaluate the resulting data.
- Advise shelter managers when shelters will have to be evacuated because of approaching hazards.

Should shelters have to be evacuated, alternate locations must be identified and shelter coordinators notified.

To ensure the health and safety of evacuees at shelters, provisions should be made for evacuee medical surveillance and care. This is especially important for evacuees who may have been exposed to hazardous materials vapors. Ideally, each shelter should have medical professionals assigned to care for evacuees. They must be alert to symptoms caused by hazardous materials and be responsible for treating victims or calling for emergency medical assistance. Evacuees showing symptoms should be separated from those unaffected. The medical professional can also assist evacuees who need prescription medicines.

H.2.7 Re-entry into Evacuated Areas

Before making the decision to authorize re-entry, data collected by the monitoring crews must be verified and the advice of health officials considered.

Once the decision to authorize re-entry has been made, re-entry operations must be coordinated. These operations may be looked upon as an evacuation in reverse, as many of the same steps must be undertaken. Re-entry operations involve:

- Notifying people that they can return to evacuated areas.
- Providing evacuees with special information or instructions.
- Coordinating transportation for evacuees who require it.
- Providing traffic control and security in areas being re-entered.
- Advising people to report lingering vapors or other hazards to emergency services.
- Advising people to seek medical treatment for unusual symptoms that may be attributable to the hazardous materials release.

H.3 IN-PLACE SHELTERING

Evacuation decisions are of necessity very incident-specific and the use of judgment will be necessary. If the release occurs over an extended period of time, or if there is a fire that cannot be controlled within a short time, then evacuation may be the sensible option. Evacuation during incidents involving the airborne release of EHSs is sometimes, but by no means always, necessary. Airborne toxicants can be released and move downwind so rapidly that there would be no time to evacuate residents. For short-term releases, often the most prudent course of action for the protection of the nearby residents would be to remain inside with the doors and windows closed and the heating and air conditioning systems shut off. An airborne cloud will frequently move past quickly. Vulnerable populations, such as the elderly and sick, may sustain more injury during evacuation, than they would by staying inside and putting simple countermeasures into effect.

There are other disadvantages associated with evacuation during incidents involving airborne releases of EHSs. Changes in wind velocity and direction are difficult to predict and could be very important if evacuation were undertaken during a release. Differences in temperature between air layers could also cause the toxic cloud to disperse in ways that would be hard to predict. These factors and others make it difficult to estimate how long the community would be exposed to a toxic cloud. Also, no safe exposure or concentration levels have been established for the general population with regard to releases of chemicals included on the list of EHSs.

In-place sheltering, therefore, may be a sensible course of action, when the risks associated with an evacuation are outweighed by the benefits of in-place sheltering. In order for this protection measure to be effective, the affected population must be advised to follow the guidelines listed below:

- Close all doors to the outside and close and lock all windows. (Windows seal better when locked). Seal gaps under doorways and windows with wet towels and those around doorways and windows with duct tape or similar thick tape.
- Building superintendents should set all ventilation systems to 100 percent recirculation so that no outside air is drawn into the structure. Where this is not possible, ventilation systems should be turned off.
- Turn off all heating systems and air conditioners.
- Seal any gaps around window type air-conditioners, bathroom exhaust fan grilles, range vents, dryer vents, etc. with tape and plastic sheeting, wax paper, or aluminum wrap.
- Turn off and cover all exhaust fans in kitchens, bathrooms, and other spaces.
- Close all fireplace dampers.
- Close as many internal doors as possible in homes or other buildings.
- If an outdoor explosion is possible, close drapes, curtains, and shades over windows. Stay away from windows to prevent potential injury from flying glass.
- If you suspect that the gas or vapor has entered the structure you are in, hold a wet cloth over your nose and mouth.
- Tune in to the Emergency Broadcast System channel on the radio or television for information concerning the hazardous materials incident and in-place sheltering.

It should be understood that following the above guidelines will increase the effectiveness of in-place sheltering as a protective action. Following these guidelines does not ensure that this type of protective action will indeed be effective.

APPENDIX I

INFORMATION COLLECTION TO EVALUATE SITES FOR EMERGENCY PLANNING

1.1 OVERVIEW

This appendix presents a process for collecting information that will be needed to assess the hazards posed by particular sites and to develop community emergency plans. The National Response Team's Hazardous Materials Emergency Planning Guide (NRT-1) should be consulted when preparing such plans. The process focuses on an examination of the sites that use, produce, process, or store extremely hazardous substances (EHSs). The types of information to be collected include descriptions of the chemicals present, ongoing measures for the control of potential releases, and the available response resources and capabilities at the site and within the community, including existing emergency plans. Initial requests for information should be made in a way that promotes continued cooperation between the personnel at the sites and the community planners. The information should be sought in a way that encourages facilities to participate actively in the planning process along with local government and other community groups. Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) requires facilities to assist local planning committees by supplying information and designating an emergency planning coordinator (see Chapter 1). The Chemical Manufacturers Association (CMA) has published A Manager's Guide to Title III that suggests ways for participants in the Community Awareness and Emergency Response (CAER) program to cooperate with local planning committees.

Many sites will already have safety and contingency plans in response to regulatory requirements or as part of normal operating procedures. The community should learn what the facility is doing to identify and deal with the possible release of acutely toxic chemicals. The plant site may have identified community impacts resulting from accidental chemical releases and have taken measures to reduce risks. The planners can then identify what additional steps and resources, such as personnel, training, and equipment, might be needed at the facility or in the community.

The information collection process is outlined here as a series of discussion points, which are presented as examples of the types of information that a community may want to use to assess potential hazards. A community planning committee may use some, all, or none of these discussion points. Depending on the community's initial perception of potential risks, the discussion points can be tailored by the committee to meet specific local needs. Some of these points will be rather simple and direct, such as those used to determine what EHSs are located at a site, and their quantity. Other points should generate additional discussion, for example, whether any EHSs are handled or stored near other chemicals that are flammable, explosive, or reactive. If such a situation does exist, subsequent discussions should be designed to: (1) identify these chemicals, (2) determine how the facility isolates the chemical of concern (e.g., the chemical of concern is stored in fire-proof containers, or the adjacent flammable, explosive, or reactive chemical is stored under conditions to prevent leakage or explosion), and (3) what additional precautions are taken to ensure that a release will not affect the surrounding community.

Planners should always be aware that:

- The specific identity of an EHS may sometimes be withheld as a trade secret. In the absence of specific chemical identity, however, important information such as the physical state and the levels of concern (LOCs), as defined in this document, should be provided.
- The information-gathering effort should not be adversarial but rather an attempt by all concerned to cooperate in describing and solving a potential problem facing the entire community:
- Facilities may be sensitive concerning what they consider proprietary business information:

- Asking a particular question does not imply that there is a definite problem, but rather shows a desire to identify and address potential problems: and

- Title Ill of SARA requires facilities to provide information to planners that will enable hazards analysis.

1.2 ORGANIZATION

The suggested discussion points for gathering and analyzing information for a hazard assessment are presented in four sections:

- Site activities and management programs:
- Site location information;
- Site measures for managing and controlling chemical releases; and
- Site interface with community response and preparedness programs.

Information obtained from these discussion points and the information sources discussed in Chapter 2 will assist the planners in assessing site-specific hazards and should be considered along with the factors used for assessing chemical releases outlined in Chapter 2 and detailed in Appendix H. Even if the sites have safety and contingency plans in place, the community planners should not neglect the procedures suggested in Chapters 2 and 3, as they will enable the community to assess hazards posed by different sites and to develop contingency plans in order of priority.

The discussion points outlined here are far ranging. Not all of them will be necessary to elicit information required for site-specific assessment. However, most will need to be discussed for the final phase of this program, the formulation of emergency plans. For this reason they are included here. Planners may select those points that best suit their needs for each phase of the process.

The first section outlines the points of information that the community planners will want to obtain about the type and quantity of chemicals used, produced, processed, or stored and to evaluate the appropriateness and timeliness of any planning that may already have been done at the site. If little emergency preparedness work has been done, the planners need to know the site's chemical handling and processing activities, related management programs, and capability for responding to chemical release emergencies.

Next, the planners will want to find out about those physical, topographic, meteorological, and demographic factors that, although external to the facility itself, have an important bearing on how to prepare for an emergency involving a release from the facility. The facility may already have assembled this kind of information as part of its internal planning process.

Most companies, for reasons of plant and employee safety, community concern, regulatory requirements, or as a matter of corporate policy, have analyzed the potential on-site and off-site impact of a chemical release. Plans for promoting on-site safety, emergency plans, and liquid spill and hazardous waste release prevention plans may already have been developed as a result of standard industrial practice or regulatory requirements. If such plans are available, they can be a valuable starting point for the larger task facing the planners, that is, developing an up-to-date comprehensive community emergency plan, in addition to the initial task of ranking the site-specific hazards.

The final step for the community planners is that of developing, or updating, the community emergency plan. NRT-1 should be consulted for this step. Based on emergency planning efforts that may already have been undertaken at the site, as well as on the planners' assessment of the site's activities and management programs, the planners can assess the adequacy of the site's emergency plans and those of the community. A solid foundation will now exist upon which future cooperative planning and updating can occur.

1.3 SITE ACTIVITIES AND MANAGEMENT PROGRAMS

This section contains example discussion points that will assist planners in collecting basic information about the site's processes and related management programs. With this information and using the procedures outlined in Chapter 2 and 3, the planners can assess a site's potential hazards as well as evaluate its emergency response resources and capabilities. This information will also be useful in developing a community emergency plan. The planners first need information about the hazardous materials that exist at the site and then about how these materials are handled and managed.

1. Chemicals of Concern That Could Be Released:

- Chemicals used, produced, processed, or stored that meet the criteria (see Appendix B) or are on EPA's EHS list (see Appendix C), whether or not they exceed the threshold planning quantities (TPQs). (The specific chemical identity of an EHS may sometimes be withheld as a trade secret. In the absence of the specific identity, however, important information such as the physical state and the LOC, as defined in this document, should be obtained.)
- Chemicals that could result from reaction, combustion, or decomposition of chemicals at the site.
- High temperature, high pressure processing and storage of chemicals.

2. Shipping and Transfer of EHSs:

- Frequency of shipments (daily, weekly, irregular schedule).
- Quantity of shipments (tons, gallons, number of drums, tanks, and vats).
- Form of shipment (e.g., tank truck, rail car, drums, boxes, carboys, pipelines, barges).
- Transportation routes through the community (roads, railroads, pipelines).
- Unloading systems:
  - o pumping versus gravity feed systems, and
  - o underground versus aboveground pipelines.
- Unloading procedures:
  - o monitoring by plant personnel, and
  - o remote monitoring by tank level gauges, alarms, automatic cut-off valves, and similar means.

3. Storage Conditions:

- Quantities normally stored in aboveground tanks and underground tanks.
- Drum storage areas (indoors and outdoors).
- Storage of gas cylinders.
- Use and operation of secondary spill-containment systems.
- Techniques used for the separation of incompatible chemicals.
- Special systems used for the storage of reactive, flammable, and explosive chemicals.

4. Handling Procedures for EHSs:

- Special safety systems used in connection with high temperature or high pressure operations.
- Secondary equipment containment systems for reactor and other processes.
- Pumping versus gravity-feed systems.
- Materials handling by automatic systems versus manual systems.
- Use of alarm systems for tank level gauging, temperature and pressure sensing.
- Redundancy for critical process (i.e., availability of back-up equipment in case of failure, or automatic system shut-down after a system failure).
- Frequency of inspection and testing of critical process equipment, alarm systems and similar equipment.

5. Site Management Characteristics:

- Hours of operation and production rates during different shifts (planning needs may differ between day and night shifts),
- Degree of around-the-clock coverage by trained, responsible, and fully authorized technical and management staff.

- Plant security (e.g., fencing, guards on duty, remote sensing by TV monitors, alarm connections to local police and fire departments).
- Plant wastewater and stormwater drainage: direct discharges to local surface water versus discharge to on-site or off-site treatment plants.
- Site emissions to the air covered by Federal and State environmental regulations.
- Hazardous and non-hazardous solid wastes generated, treated, stored, or disposed on-site. Wastes transported off-site.

6. Site Process Design and General Operations:

- Listing and description of relevant site processes for synthesis, manufacture, formulation, repackaging, distribution, and handling of EHSs.
- Design and construction specifications covering such aspects as handling temperature and pressure, and materials' compatibility.
- Process design to consider safety devices, alarms, and back-up systems to ensure the integrity of the process and to protect the facility during normal and unusual conditions of operation.
- Programs for managing changes in the design or operation of process equipment and changes in chemical component amounts, concentrations, or types.
- Preventive maintenance programs for facilities and equipment critical to safe process operation.
- Maintenance training and implementation that addresses the potential for preventing or controlling the release of EHSG.
- Description of "best engineering practice" and "state-of-the-art" process design, construction, operation, and maintenance for similar facilities within the industry.

1.4 SITE LOCATION INFORMATION

These example discussion points allow the community planners to describe the vulnerable zone in greater detail and to assess the adequacy of both site and community preparedness programs.

1. Significant Physical, Topographic, and Meteorological Features:

   - Distance to site fenceline or boundaries from Chemical storage and process areas.
   - Transportation access/egress including surface, air, and water routes.
   - Terrain characteristics of importance such as mountains, hills, canyons, valleys, and plains.
   - Meteorological features, including profiles of wind speed and direction, precipitation, and temperature.
   - Distance to nearest surface-water body, including drainage ditches and other conduits, and flood plains.

2. Site Demographic Characteristics:

   - Distance to nearby populations such as communities, subdivisions, commercial or industrial sites, and transportation corridors.
   - Distance to public facilities such as schools, hospitals, parks, playgrounds and stadiums.
   - Numbers of people within vulnerable zone distances and a characterization of how those numbers can fluctuate hourly, daily, and seasonally.
   - Value of property and commercial goods located within potential vulnerable zone.

1.5 SITE MEASURES FOR MANAGING AND CONTROLLING CHEMICAL RELEASES

This section contains example discussion points to help the community understand those actions already taken by a facility to identify hazardous situations and to describe the potential effects on people, property, and the environment. The planners should identify the control measures site management has put in place to control releases of EHSs, their by-products and decomposition products, or other chemicals that meet the criteria. Facilities are defined under Section 302 of Title III of SARA (see glossary).

1. Site, Community, and Environmental Impacts of Potential Emergencies:

   - Site analyses or models to predict location, intensity, and duration of hazards related to chemical releases.
   - Community, State, or Federal activities or studies that the site has integrated with their own release modeling efforts.
   - Past experiences or incidents at the site.
   - Past experiences with similar chemicals and processes.
   - Past facility and transportation incidents in the community involving hazardous materials. Relationship of past response efforts to possible future needs. Note that transporters are not required to keep historical records.
   - Activities or studies by trade groups, professional societies, or academia that could be of value.

2. Control and Response Plans in Operation, under Development, or on File:

   - Spill Prevention Control and Countermeasures (SPCC) Plan covering the release of hazardous substances as defined under authority of the Clean Water Act.
   - General site safety plan covering routine and non-routine operations, maintenance, emergencies, training, and inspections.
   - Site emergency response and preparedness plans.
   - Resource Conservation and Recovery Act of 1976 (RCRA) Part B Emergency Response Plan covering site and community response procedures and contingencies for release to the environment of hazardous wastes as required by the regulations under RCRA in 1976 and as amended in 1980 and 1984.
   - Site and corporate policies for developing, implementing, and updating all such plans.

3. Equipment Available On-Site for Emergency Response:

   - Basis for having such equipment on-site.
   - Description of "good practice" and "state-of-the-art" equipment for similar facilities within and chemicals handled by the industry.
   - Fire-fighting systems (fire hydrants, sprinklers, extinguishers, chemical fire retardants, protective clothing).
   - Fogging or misting systems for vapor release control.
   - Neutralization materials for acids or caustics.
   - Dedicated dump tanks, absorbers, scrubbers, or flares for liquid/vapor release control.
   - Absorbants, foams, and specialized Chemical agents for containing and controlling releases.
   - Emergency power systems in case of power outage.
   - Containment booms for surface-water spills.

4. Leak and Spill Detection Systems:

   - Basis for installation of these systems.
   - Description of "good practice" and "state-of-the-art" systems for similar chemicals handled by the industry.
   - Gas detection monitors or explosimeters for determining sources and severity of leaks.
   - Oil spill detection devices for nearby sewers or drains to surface-water bodies.

- Wind direction indicators for determining the direction of released chemical aerosols or vapors.
- Chemical spill detection systems for corrosives, organics, and other volatilizable liquid spills.
- Degree to which such systems are remotely monitored and can initiate an automatic response.
- Activation sensors for rupture disks and relief valves.
- Sensors to detect overfilling of tanks and initiate automatic response.

5. Site Emergency Response Procedures:

   - Chain of command for leak or spill notification within the plant (24-hour notification system).
   - Employee evacuation plan.
   - Response procedures for operations and staff personnel.

6. Community Notification Procedures:

   - Criteria for notifying the community of a release.
   - Procedures for notification, such as sounding alarms and contacting community officials, local police and fire departments, nearby populations, and the media.
   - Ongoing education of citizens and workers to inform them of the exact meaning of notification alarms.

7. Outside Emergency Response Resources:

   - Contracts with local cleanup contractors.
   - Arrangements with local hospitals or other medical facilities.
   - Mutual aid agreement with other local industries.

8. Training and Preparedness:

   - Frequency of employee training in emergency response procedures.
   - Extent of emergency response training (training sessions, emergency drills, involvement of local police and fire departments in emergency training and drills, which employees receive training).
   - Frequency of updating of contingency plans (regular basis or only after changes in plant operating procedures).
   - Inspection of emergency equipment (frequency and extent).
   - Description of "good practice" and "state-of-the-art" practices for similar facilities within the industry.

I.6 SITE INTERACTIONS WITH COMMUNITY RESPONSE AND PREPAREDNESS PROGRAMS

These discussion points help the community evaluate its emergency response resources and capabilities and those of the facilities. They are designed to identify planning activities, resources used, and response capabilities established within the community. Information will be required from a Variety of local emergency response agencies and government agencies. These discussion points may need to be addressed only once for the entire community. This information will be used directly to develop the community emergency plan and will assist the planners in evaluating what emergency response resources may be needed in addition to those already in place or planned by the facility or community.

1. Planning Documents and Activities:

   - Existing community hazardous chemical emergency plans.
   - Current status of community emergency plan or planning process for EHSs or other hazardous chemical emergencies.
   - Status of technical reference library or other information systems for response procedures for chemicals.
   - Structure and authority of existing community planning and coordination body (e.g.,

task force, advisory board, interagency committee) to plan for and deal with emergencies.

- Status of previous surveys or assessments of potential risks to the community from facility or transportation accidents involving hazardous chemicals.
- Status of any existing assessments of prevention and response capabilities within the community's own local emergency response network.
- Frequency of training seminars, exercises, or mock accidents performed by the community in conjunction with local industry or other organizations.
- Integration of any existing hazardous chemical plans into any existing community contingency plans for other emergencies.

2. Planning Review and Update:

- Community personnel and programs for periodic analysis, review, and update of the community contingency plan.
- Corporate and on-site facility officials designated to maintain and update the site contingency plan and to interact with the local emergency planning group.
- Corporate and facility policies in this regard.

3. Training and Preparedness:

- Capacity and level of expertise of the community's emergency medical facilities, equipment, and personnel.
- Arrangements for assistance from or mutual aid agreements with other jurisdictions or organizations (e.g., other communities, counties, or States; industry; military installations; Federal facilities; response organizations).
- Availability of any specific chemical or toxicological expertise in the community -- either in industry, colleges and universities, or on a consultant basis.
- Availability of equipment and materials on the local level to respond to emergencies. Accessibility of equipment, materials, and manpower in emergency situations.
- Completeness of a list of important resources and their availability for speedy response activities: wreck clearing, transfer, transport, cleanup, disposal, analytical sampling laboratories, and detoxifying agents.
- Training and equipment available to the local emergency services (fire, police, medical).
- Proximity of specialized industry response teams (e.g.) CHLOREP, AAR/BOE), State/ Federal response teams, or contractor response teams available to the community. Average time for them to arrive on the scene.
- Definition of community emergency transportation network.
- Designation of specific evacuation routes; public awareness of evacuation routes.
- Designation of specific access routes designated for emergency response and services personnel to reach facilities or accident sites.
- Other procedures for protecting citizens during emergencies (e.g., remain indoors, wear gas masks).

4. Community, State, and Federal Agencies and Other Organizations that Can Contribute to or Should Have a Role in the Contingency Planning Process :

- Fire Department.
- Police/Sheriff/Highway Patrol.
- Emergency Medical/Paramedic Services associated with local hospitals or fire or police departments.
- Emergency Management Agency/Civil Defense.
- Public Health Agency.
- Environmental Agency..

- Red Cross.
- Other local community resources such as transportation department, public housing, communications.

5. Communications:

- A list of specific community points of contact and a description of what their duties and responsibilities are in an emergency.
- Agencies involved, areas of responsibility (e.g., emergency response, evacuation, emergency shelter, medical/health care, food distribution, control of access to accident site, public/media liaison, liaison with Federal and State responders, locating and manning the command center), the name of the contact, position, 24-hour telephone number, and the chain of command.
- Status of the emergency communications network in the community to alert the public, keep the public informed with up-to-date information, and provide communications between the command center, the accident site, and off-scene support.
- Components available for the communications network (e.g., special radio frequency, network channel, siren, dedicated phone lines, computer hook-up).
- Status of community source list with the name, position, and phone number of a contact person for technical information assistance. This can be Federal, State, industry associations, and local professional groups.

APPENDiX J

METHODS FOR EVALUATING HAZARDS USED BY FACILITIES

J.1 INTRODUCTION

Many facilities will have undertaken detailed analyses of their plant operations. This appendix describes three procedures which they may have used to evaluate hazards in everyday operating procedures. They are Hazard and Operability Study (HAZOP), Event Tree Analysis, and Fault Tree Analysis. Some community planners may wish to use these methods or at least be familiar with them. It may be possible for planners to use such studies if they are available for the facilities of concern. The prodcures discussed below, as well as others, are described in detail in Guidelines for Hazard Evaluation Procedures prepared by Battelle Columbus Division for the Center for Chemical Plant Safety of the American Institute of Chemical Engineers (AIChE). These methods for risk analysis are highly complex and the methodologies employed are under continual development by experts in the field. It is therefore suggested that planners intending to use these methodologies seek appropriate technical support.

J.2 HAZARD AND OPERABILITY STUDY

A HAZOP is a technique commonly used by chemical process facilities to identify hazards and difficulties that prevent efficient operation. There are two versions of the technique, one which deals with "deviations" and the other with "disturbances." "Deviations" are caused by malfunction or maloperation of a specific production system. 'Disturbances" include problems caused by influences outside the specified system, including other activities and the environment.

The first version of HAZOP to be developed and the most widely known was aimed at deviations and is called a "Guide Word" HAZOP. Each element of the process is evaluated separately. The purpose of the element is specified and notational deviations are generated by associating this purpose of the element with distinctive words or phrases called "guide words." These guide words are "no" or **"not,"** "more," "less," "as well as," " part of," "reverse," and "other than" which, broadly speaking, cover all possible types of deviation.

For each notational deviation, a determination must be made whether this is a possible situation (e.g., no flow or reverse flow in a transfer line that should have forward flow). If this is possible, the conditions in which that situation might occur and the possible hazardous consequences must be identified. The guide words are applied to all materials and all operating parameters (e.g., flow, temperature, pressure). The guide words are applied not only to the equipment, but also to the operating procedures. All phases of operation (e.g., startup, normal operation, shutdown, backwash) must also be included. As would be expected, this approach can be time-consuming and the time taken can vary from several days for a small production unit, to several months for a complex facility.

The second version of HAZOP studies is called a "creative checklist" HAZOP. This version has been developed as a complement to the guide word HAZOP to cover "disturbances." It is of particular value in two situations. These are to enable a HAZOP study to be carried out very early in the design process, even before the detailed design necessary for a "guide word" HAZOP is available; and to cover hazards which may be caused by interactions between units which could be perfectly safe if built in isolation, but may be capable of adverse interactions. This second method uses a checklist of known major hazards and nuisances. The checklist would contain words such as "fire," "explosion," "toxicity," "corrosion," "dust," and "smell." The checklist is initially applied to every material likely to be present; raw materials, intermediates, finished products, by-products and effluents. This establishes qualitatively whether hazards and nuisances exist and also provides a quantitative data base of the numerical intensities of different hazards. Thus "fire" would result in not only a note that a material is flammable but numerical measurements such as a "flash point" and "flammable limits."

Any missing data are pinpointed and timely steps taken to collect such data.

The Second method continues with the association of the same checklist with each item of equipment. The materials present in such equipment, together with the inventories, are known as the "materials hazards." As the analysis proceeds, the potential for all major hazards including interactions between units or the unit and its environment are identified. The flow of hazards can be in both directions. For example, the environment may pose hazards to the unit (e.g., flooding and earthquakes), which would have to be considered in the siting, design, and layout of the unit. Although less well known than the guide word HAZOP, the creative checklist HAZOP has been found to be a quick and valuable complementary approach.

While local emergency planners will not possess the resources or need to perform a HAZOP on all facilities in the community, the concept of analyzing deviations from normal performance could be the best way to analyze the most hazardous elements found in the community. For example, if a shipping error caused a volume of a hazardous chemical to be delivered to a local facility that exceeded the capacity of the chemical material loading area, where would the excess material be placed? If part of a train stored on the local rail siding caught fire, is there sufficient space available to segregate the chlorine tank cars that are often kept there?

J.3 EVENT TREE ANALYSIS

Event tree analysis is a systematic approach that focuses primarily on a chain of events or occurrences. While the possible outcome of some events may be intuitive, complex situations must be broken down into a series of sequential events.

The steps in event tree analysis are:

1. Identify the actors in an emergency (e.g., hazardous materials, response personnel);
2. Identify the conditions present;
3. Track what the actors will do under the current conditions: and
4. Visualize the effect of the activities on the outcome of the event.

The following example analysis from Analysis of Hazardous Materials emergencies for Emergency Program Managers: Student Manual FEMA SM-110 (see Appendix L) visualizes the potential outcome of a leaking vessel (in this case a drum) of flammable liquid engulfed in a fire. In this situation, the actors and their activities include:

- Burning fuel is heating the drum:
- Drum is absorbing heat from the burning fuel and heating the contents; and
- Contents of drum are absorbing heat from the drum.

The complex activities of the emergency are divided into sequential events in which the burning fuel generates heat, causing the drum contents to change physical state (liquid to gas). This expansion of the contents will raise the pressure in the drum and stress the drum components.

The possible activities of the drum can then be evaluated. Possibilities include:

- The flat drum head will begin to round out as the internal pressure continues to rise:
- The weld between the drum head and the drum wall will begin to yield: and
- The drum head will separate from the drum wall.

When the drum head breaks away from the side wall, activities of the contents could include:

- As the pressure is relieved through the breach in the drum, the heated contents will expand and flow through the breach.
- Drum contents will escape to the atmosphere, creating a new actor -- vaporized flammable contents.
- Escaping contents will produce a propulsive effect on the drum, propelling it like a rocket.

- If the drum is still surrounded by the burning fuel, the vaporized contents will ignite, forming a fireball and escalating the problem.

When the drum is open, possible activities of the drum and contents include:

- The drum, propelled by the escaping contents, may fly along a trajectory that is dependent upon where the drum was heated. Obstructions may change the direction or distance of travel.
- The released contents may fall along the flight path of the drum, leaving a trail of burning material along the ground.

The third step in event tree analysis visualizes the sequential interrelationship of the actors. Each event is broken down and placed in logical sequence to make the possible points of intervention readily apparent. In this way, the application of event tree analysis provides a detailed understanding of the mechanical, chemical, and thermal interactions that affect the behavior of actors in an emergency.

Four general factors that affect the behavior of hazardous materials in an emergency are:

- Inherent properties and quantity of the hazardous material:
- Built-in characteristics of the container;
- Natural laws of physics and chemistry; and
- Environment, including the physical surroundings (terrain) and the conditions (weather).

These factors and their interrelationships can provide a basis for visualizing what will happen in an emergency involving hazardous materials.

For most events involving hazardous materials, the scenario begins with a container (e.g., tank, pipe, drum, cylinder, bag) that under normal conditions holds a hazardous material. The event begins when the container is disturbed or stressed in some way. When the stress exceeds the capacity of the container, a breach of the container's integrity occurs and some type of release will occur. The escaping matter and/or energy will follow the patterns governed by the natural laws of physics and chemistry to disperse into the surrounding environment. As the material comes in contact with vulnerable elements in the environment, the duration and intensity of the exposure influences the type of event that results. These basic elements of hazardous events are combined to form a model for the behavior of hazardous materials.

Stress Stage of the Behavior Model

Stress is an applied force or system of forces that tends to strain or deform a container and may trigger **a** change in the condition of the contents. There are three basic forms of stress: thermal, mechanical, and chemical. Thermal stress results from the effects of extreme temperature changes which may be caused by fire, sparks, friction, electricity, radiative transfer, or extremes of cold or heat.

Mechanical stress is caused by an object which physically contacts the container. The object may puncture, gouge, bend, break, tear or split the container. A chemical stress is caused by a chemical action such **as** acids corroding the container, pressure generated by decomposition, polymerization, or runaway reactions.

Breach Stage of the Behavior Model

If the container is stressed beyond its structural limits, it will open or breach. Different containers breach in different ways:

- Disintegration, which is the total loss of integrity (e.g., a glass jar shattering).
- Attachments open up (e.g., a pressure relief device malfunctions).
- Punctures from external sources.
- A split, tear or crack of a container (e.g., torn bags or boxes, or split or cracked drums).

Release Stage of the Behavior Model

Once the container is breached, the material can escape to the environment. There are four types of release:

- Violent rupture causes runaway cracking of closed containers and Boiling Liquid Expanding Vapor Explosion (BLEVE), and occurs in less than one second.

- Rapid release through pressure relief devices, damaged valves, punctures, or broken piping will take several seconds to several minutes.
- A spill or leak, which is a non-violent flow through opening in fittings, splits or tears, and punctures may take minutes to days.
- Detonation is an explosive chemical reaction which occurs in less than 1 /100th of a second. Examples are military munitions, dynamite, and organic peroxides.

Dispersal Stage of the Behavior Model

Once the hazardous material is released into the surrounding environment, the event is likely to escalate in intensity. The properties and characteristics of the material, in combination with the laws of physics and chemistry, will determine the pattern of the distribution of matter and energy. The forms that the matter or energy may take include: fragments, powder, dust, schrapnel, liquid, vapor, vaporizing liquid, gases, infared rays, and shock waves. Factors that will affect the movement of materials include temperature differentials, density with respect to water and air, wind speed and direction, and gravity. The dispersion path that is followed may be linear, radial, random, or could follow the contour, upward or outward. The dispersion pattern may be in the form of a cloud, cone, plume, stream, or irregular deposits.

Dispersion patterns will also depend on the physical form of the material (i.e., gas, liquid, or solid). Gases escaping under pressure (e.g., leaks from a cylinder) form a cloud or plume. If enclosed, the cloud will fill the available space: if not enclosed, it may be carried by the wind as a plume. If the vapor's density is greater than air, the material may settle into depressions or travel along the ground as a plume.

Liquids may flow along the ground as a stream while simultaneously vaporizing and acting as a gas (stream with plume) or may be absorbed into the ground or onto clothing worn at the scene (irregular deposits). Solids may scatter (irregular deposits), form dust clouds that are carried by the wind (plume), or stick to surfaces (irregular deposits).

Exposure Stage of the Behavior Model

As the hazardous material moves away from the point of release, exposure to the surrounding environment may occur through a variety of pathways including: ingestion, physical contact, and inhalation. Duration of the exposure and Concentration of the material are particularly important aspects of the exposure event.

Damage Stage of the Behavior Model

Damage due to the exposure to the hazardous material includes aspects of the susceptibility of the environment or population. Such susceptibility will differ markedly depending on the time of day, season of the year, age of the population, and ability of the population to escape or otherwise mitigate the event.

The types of damage which may occur include: thermal (heat and cold), radioactive, asphyxiation, toxic or poison, corrosive or chemical, disease (viral or bacterial), and physical or mechanical.

Damage can be expressed in terms of: fatalities, injuries, property destruction, critical system disruption, and environmental disruption.

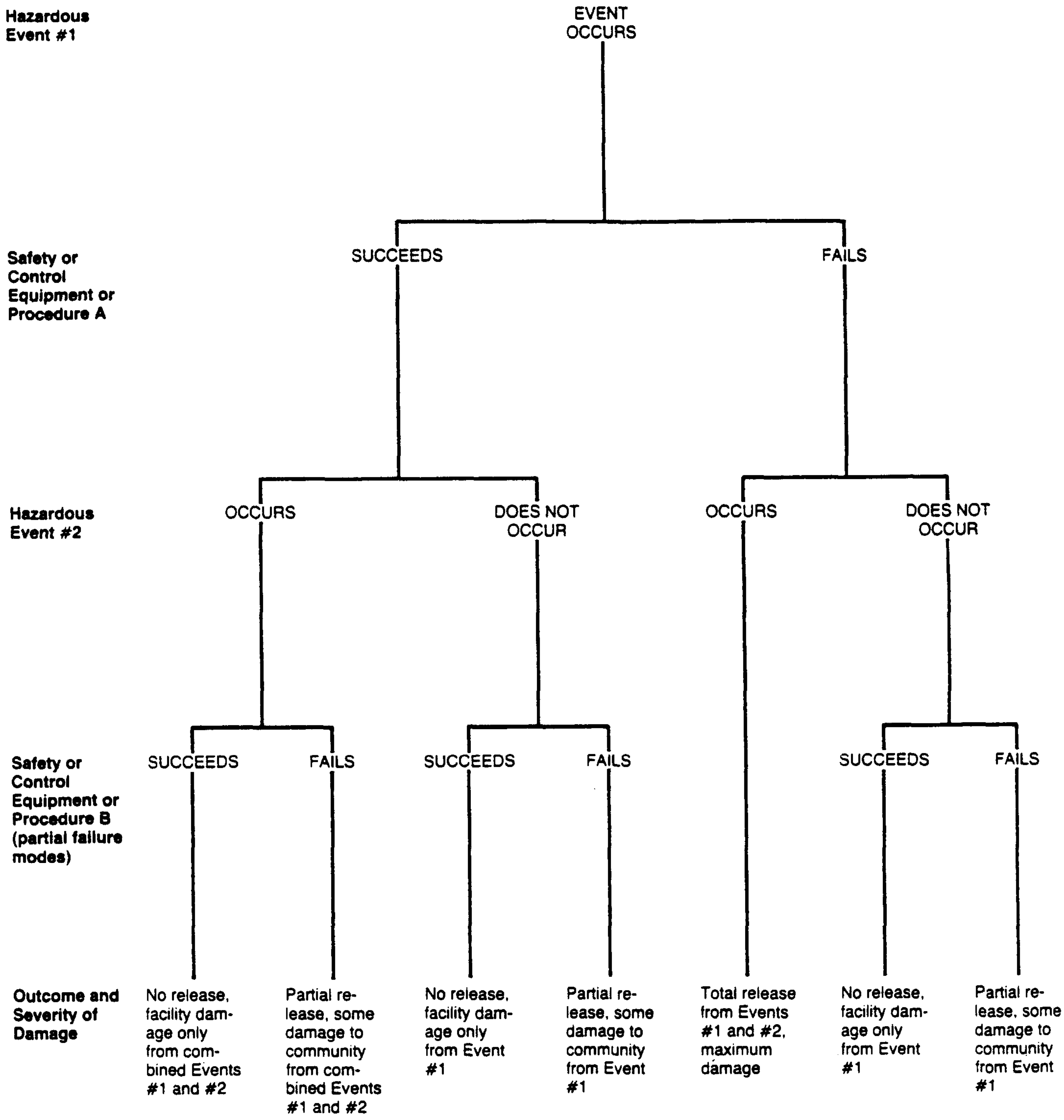
As shown in Exhibit J-1, event tree analysis traces each event, as it occurs or does not occur, and each safety or control equipment or procedure to identify the possible outcome. Note that several paths through the event tree can have similar or identical outcomes. It is important to trace all possible events through all paths that can affect the outcome. In addition to identifying the possible outcomes and their relative severity, an event tree can visually represent the potential importance of possible equipment or procedures in mitigating the severity of damage. In the example in Exhibit J-1, if both hazardous events occur and procedure A fails, the control procedure B is completely ineffective in altering the outcome or severity of damage.

5.4 FAULT TREE ANALYSIS

Fault tree analysis (FTA) is an analytical technique used to determine the means by which an

Exhibit J-l

Sample Event Tree Analysis



unwanted event, such as a release of toxic materials, could possibly occur. The technique, which in structure is similar to the event analysis technique, involves the development of fault tree diagrams which illustrate the "chain of events" required for a particular event to occur.

Fault tree analysis reverses the normal sequence of events and places the undesirable event under study (i.e., head event) at the top of the diagram. The incident is assumed to have occurred and sub-events which represent the means by which this event could occur are inserted below. Sub-events which are interrelated (i.e., dependent incidents), in that they must both occur before the subsequent event can occur, are related by a logical "and." Sub-events which are unrelated in that the occurrence of any one sub-event would cause the subsequent event, are connected with a logical "or." For example, in the analysis of the overflow of a storage tank that is being filled with gasoline, in which the storage tank has a high-level alarm, the associated fault tree might be constructed as in Exhibit J-2. The head event is that the tank overflows.

The fault tree technique only considers those actions which must occur for the head event to occur, and therefore isolates the events of importance from the many possible events. In the example, in order for the tank to overfill, there must be an increase in the tank level of the flammable liquid (gasoline) (sub-event 1) and no corrective action taken before overfilling (sub-event 2).

Since both sub-event 1 and sub-event 2 must occur before the head event occurs, the two events are connected to the head event by an "and" (i.e., sub-event 1 and sub-event 2 must occur to have the head event occur).

The fault tree analysis continues down the tree and breaks each of the sub-events into their components in a similar manner (i.e., if no corrective action occurs, there must be a high level alarm failure or an operator failure).

Sub-event 2 would then be divided into:

Sub-event 2.1. High Level Alarm Fails

Sub-event 2.2. Operator Fails

The analysis continues until the sub-events can not be practically subdivided further. The determination of this point is left to the judgement of the analyst. Exhibit J-2 illustrates an example of the beginning of a simple fault tree: however, this event might need to be subdivided further to reach the practical limits of the analysis.

As the number of sub-events increases due to system complexity, the fault tree can become very complex. The analyst can limit the effort involved by carefully selecting the scope of the head event and by limiting the level of detail considered in the analysis.

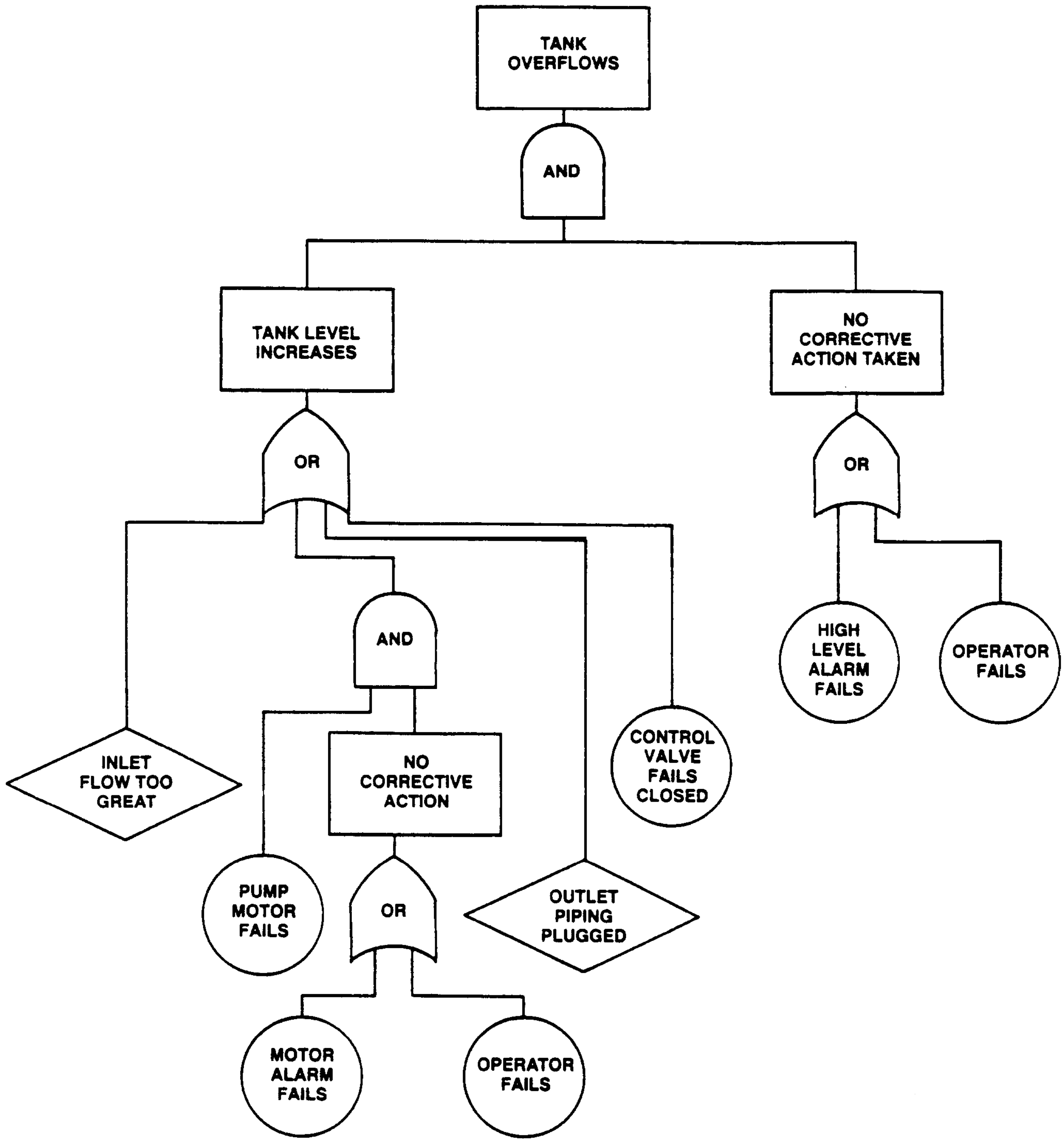
Fault tree analysis is useful for describing the interrelationship of events or components of a system which must "fail" for an accident to occur. Since only the negative actions (i.e., failures), and only those actions related to the actual head event are considered, the technique is often an efficient means of analyzing complex scenarios or systems.

J.5 FAILURE MODES, EFFECTS, AND CRITICALITY ANALYSIS

As described in the AIChE document, Guidelines for Hazard Evaluation Procedure, Failure Modes, Effects, and Criticality Analysis (FMECA) and Failure Modes and Effects Analysis (FMEA) identify and tabulate equipment and system failure modes and the potential effects on the system or plant for each failure mode. The failure mode is a description of how equipment fails (e.g., open, closed, on, off, or leaks). The effect is the accident or system response resulting from the failure. The FMECA also includes a criticality ranking for each failure mode. Single failure modes that result in or contribute to a major accident are identified; however, FMECA is not efficient for identifying combinations of equipment failures that lead to accidents. FMECA may be used to supplement more detailed hazard assessments such as HAZOP or Fault Tree Analysis. Results of this type of analysis include worst-case estimates of the consequences of single failures and a relative ranking of equipment failures based on estimates of failure probability and/or hazard severity.

Exhibit J-2

Example Fault Tree



Source: *Process Safety Management*, (Control of Acute Hazards)
Chemical Manufacturers Association, Washington, D.C. May 1985

APPENDIX K

EVALUATION GUIDE FOR AVAILABLE COMPUTER APPLICATIONS ADDRESSING HAZARDOUS MATERIALS EMERGENCY RESPONSE PLANNING

PURPOSE OF THIS CHECKLIST

This appendix contains a checklist of criteria developed to help local emergency planning committees (LEPCs), or other groups considering purchasing software, to identify computerized applications to assist in emergency response planning as outlined in the chapters of this document. The checklist identifies many of the ways that software applications can be of assistance. The priorities and needs of the local planning district will dictate which criteria are to be considered and may require development of additional criteria.

SOURCES OF INFORMATION USED TO DEVELOP THE CHECKLIST

The checklist criteria were developed from information in the National Response Team's Hazardous Materials Emergency Planning Guide (NRT-1) and this technical guidance document. NRT-1 was designed to help local communities respond to potential incidents involving hazardous materials. This guidance document supplements NRT-1 by identifying the facility and transportation route information necessary for hazards analysis and emergency planning, providing guidelines for determining vulnerable zones, and outlining the process for analyzing risks.

Understanding the planning processes described in these documents and how the information being assembled will be used is a prerequisite for determining which computer application will best address the specific set of needs involved.

STRUCTURE OF THE CHECKLIST

Section 1. Provides a checklist for evaluating the computer hardware (equipment) and additional software (programs) required to operate the system. The flexibility and ease of use of the system and the availability of training and other types of vendor support are also addressed.

The next sections of the checklist are based on the structure of this Guidance Document, and include:

Section 2. Hazards Identification (assembling facility, transportation route, and chemical data);

Section 3. Vulnerability Analysis (modeling of releases);

Section 4. Risk Analysis (ranking of hazards); and

Section 5. Emergency Response Planning (assembling hazards identification, vulnerability analysis, and risk analysis information).

Section 6. Regulatory Requirements. This section describes a few of the ways that a software application can explain the requirements under Title III and assist in compliance with requirements, such as tracking deadlines and responding to requests for information.

NOTE: This checklist highlights some important user costs to be considered, however the total system cost is difficult to represent. Some software applications may require the purchase of specialized hardware or additional software from other manufacturers. Vendors may include fees for tailoring of the software application to meet a user's needs in the original price. Training, manuals, technical support services, additional data entry, software updates, and additional copies of the software may be included or may need to be purchased separately.

1 *National Response Team. Hazardous Materials Emergency Planning Guide. NRT-1 (March 1987).*

In addition to the initial purchase costs of the application, the long-term investment required to install, maintain, and operate the full working system must be considered. Such costs will include: assembling the required data: validating and entering the data: training new personnel; purchasing updated software: and correcting and amending the data as changes occur. These costs will apply to some extent to any application purchased. Assistance in estimating some of these costs may be available from data processing professionals within the State government or from computer-oriented firms located within the district.

SUGGESTED PROCEDURE FOR EVALUATING EMERGENCY RESPONSE PLANNING SOFTWARE APPLICATIONS

The suggested procedure for LEPCs to use the checklist is as follows:

1. Identify the local district's need to manage emergency response planning information under NRT-1 and this Guidance Document. Understanding how the information is to be used in the planning process is an essential first step to focusing the evaluation on the needs.
2. Select the criteria on the checklist which most closely represent the local district's needs and priorities for emergency response planning. It is not expected that all criteria listed will apply.
3. Develop any additional criteria required to address local needs and priorities (e.g., consistency with the type of computer equipment that is already available).
4. Rank the criteria according to levels of importance (e.g., must be met, would be valuable, can be delayed).
5. Identify vendors and their emergency response software from the available literature, advertising, and other sources. An initial list of commercial software applications will be made available through the Environmental Protection Agency (EPA) emergency preparedness coordinator in each EPA regional office.
6. Request information from the vendors (e.g., sales literature, demonstration software, cost information, and current users of the application who can be contacted as references).
7. Review the information and complete a checklist for each software application.

6\. Contact vendors to request any additional information and to clarify data on the applications which seem best suited to the need.

CAUTIONS: An evaluation include the specific priorities and needs of the individual jurisdiction.

Any comparison of the cost of computer applications requires the assessment of many factors in addition to the purchase price identified by the vendor. (See NOTE on previous page for a detailed discussion of costs.)

Computer systems are continually being modified and refined. The results of the evaluation will become out-of-date and should be repeated if the purchase of a system is delayed.

CRITERIA FOR THE REVIEW OF COMMERCIALLY AVAILABLE SOFTWARE APPLICATIONS FOR EMERGENCY RESPONSE PLANNING

Computer System Requirements (Hardware, Software, Support, Etc.)

Objective: Provide a basis to evaluate the functional capabilities, design limitations, and operational requirements of the system, and to evaluate the vendor's ability and willingness to support the system.

Criteria	Explanation/Examples
1. Demonstrations of the software application are available?	Either a professional sales demo or current user demo may be available.
2. Documentation of the software is available for review?	User's manuals and other explanatory material from the vendor.
3. Software application is available for a trial evaluation?	30-day free trial may be available from the vendor.
4. Vendor is willing to modify the application?	The application may require changes by the vendor to allow specific community needs to be addressed.
5. Software is compatible with hardware that is already available or hardware that can be easily obtained?	Microcomputer; monitor: graphics board: modem: phone line: math co-processor: data storage space: digitizer: printer or plotter.
6. Computer system hardware memory can be expanded to meet the anticipated needs?	Hardware can accept additional memory required to load the software and modify the largest data file needed.
7. Requires additional software to be purchased from other companies to function?	Operating system: printer interface: graphics package.
8. Sold as modular components which are priced separately?	Modules may be selected and assembled to meet specific requirements (NOTE: the software may require purchasing several modules to function properly.)
9. Total system cost is consistent with budget capabilities of user?	Costs of hardware, software, training, and data input may be hidden.

Computer System Requirements (Continued)

Criteria	Explanation/Examples
10. Limits hardware and data access by unauthorized users?	Access may be limited through passwords and/or encryption of stored data.
11. User friendly and requires a minimal amount of user training?	Menu driven: provides help screens: clearly presented instructions: uses a mouse or touch screen.
12. Vendor provides additional training which may be required?	Training classes and materials may be required when the system is installed and as employees are hired: cost of training should be considered.
13. Allows data that was entered by the system vendor to be updated by the user?	Allows modification of procedures for handling a spill or release according to facility or community practices.
14. Allows new types of data to be entered by the user which were not included in the vendor's application?	A new field of data can be added to the database (e.g., new type of chemical information: facility response procedures).
15. Limits copying or distribution by copyright or copy protection?	Some vendors limit the ability to make copies of the software and require copies to be purchased for each user.
16. Validates data as it is entered or stored in the application?	Tests data against valid ranges (e.g., pH <14) or lists of acceptable data (e.g., chemical names).
17. In addition to using established keywords, allows searches to be performed with criteria chosen by the user?	Data can be identified by other than preset criteria such as through a menu (e.g., user defined searches).
18. Quality data sources were used and updates will be available as source information changes?	Chemical data content is current and generally accepted by science and health agencies such as EPA, OSHA, NIH, NOAA, U.S.Coast Guard, DOT, and others: cost and timeliness of updates should be considered.
19. Allows reports or graphs to be designed by the user?	User can specify data to be included, physical layout, and headings for columns of data.

Computer System Requirements (Continued)

Criteria	Explanatiorn/Examples
20. Allows data to be transferred (input and output) with other types of software packages and hardware systems?	System can communicate with other systems (e.g., Lotus, dBASE, ASCII and DIF data formats: Macintosh and IBM equipment).
21 Is in use by others who are willing to provide information on their experience?	Vendors may provide names of current users of the system who would be willing to discuss their experience.
22 Will the system software and data be updated by the vendor?	New capabilities that are compatible with the current system may be added.
23 Vendor provides continued service and support if the user experiences any type of difficulties in operating the system?	If this type of service is available, a maintenance and support fee will probably be charged.

HAZARDS IDENTIFICATION

Objective: Provide information on the identity, quantity, location, physical properties, and toxicity of chemicals at sites within the planning district.

Criteria	Explanation/Examples
Facilities	
1. Accepts data on one or more manufacturing and storage facilities?	Locations: activities: and inspection records.
2. Accepts chemical inventory and storage data?	Chemical names; quantities: site location(s); storage methods, temperature, and pressure.
3. Accepts information concerning facility accident potential or history?	Events that could result in damage; anticipated damage and consequences: and historical accident records.
4. Records or describes engineering controls and safeguards at specific facilities?	Detection, fire suppression, and security systems: containment and drainage systems: and utility shutoffs.

HAZARDS IDENTIFICATION (Continued)

Criteria	Explanation/Examples
Transportation Routes	
1. Records shipping routes taken to deliver materials to facilities (e.g., highway, rail, and air)?	Identifies route taken and materials transported.
2. Accepts information on the major safety characteristics of routes?	Routes may create problems because of: width: access: traffic patterns: and jurisdictions.
3. Logs transportation data, schedules, and exceptions?	Tracks planned cargo shipments for location and time expected.
Chemical Information	
1. Database contains information concerning the extremely hazardous substances?	As required by the Title Ill regulations (i.e., threshold planning quantities).
2. Contains information about the chemical and physical properties?	Flammability; reactivity; corrosivity; vapor pressures: physical states: boiling and melting points.
3. Contains the health hazards and risks, toxicological data, and first aid procedures?	Exposure routes and limits: signs and symptoms: target organs: and medical conditions aggravated by exposure.
4. Contains methods for the safe handling and use of the chemical, and emergency response?	Identifies the equipment, clothing and procedures required.
5. Indicates if notification requirements apply to the chemical released?	Identifies notification requirements for release of reportable quantities of chemicals (e.g., CERCLA, SARA).

VULNERABILITY ANALYSIS

Objective: Identify geographic zone of the community that may be affected by an airborne release and populations that may be subject to harm.

Criteria	Explanation/Examples
1. Accepts information on critical areas around facilities and routes?	Drinking water supplies: cropland; livestock: sensitive natural areas.
2. Accepts information on the characteristics of populations located in areas that could be in the vulnerable zone?	Location of special populations (e.g., elderly: handicapped: hospitals: prisons; schools) and population density.
3. Calculates the vulnerability zone based on the maximum quantity present for screening?	Calculations are based on credible worst case assumptions identified in this technical guidance document.
4. Allows site-specific inputs to the calculation of vulnerability zones and provides release scenarios?	Calculations are based on site-specific planning factors such as wind speed, stability class, and chemical toxicity.

Modeling the Release of Chemicals (predicting the path, the effect, and the area of impact of the chemical release using mathematical analysis)

Inputs (information that drives the model)

1. Accommodates physical characteristics of the chemical?	Liquids at boiling point or ambient temperature;. powdered solids: solids in solution: molten solids: gas density.
2. Addresses different types of releases?	Instantaneous and continuous releases including spills, leaks, fires, explosions, and BLEVEs.
3. Supports multiple point sources?	Several release sources operating concurrently.
4. Address releases from any source or only pre-selected sources?	Modeling ability may be limited to a specific set of pre-established sites or may be capable of representing releases from any possible location (e. g., transportation accident).

VULNERABILITY ANALYSIS (Continued)

Criteria	Explanation/Examples
5. Accepts data on meteorological conditions?	Wind velocity and direction: temperature: stability class: precipitation.
a. Allows observed data to be manually input?	Data are typed into the system using the keyboard.
b. Allows a modem link for direct data entry?	Accepts data directly from laboratories or weather stations.
c. Requires a meteorological tower for data input?	Facility or community meteorologic tower is required for data collection.
6. Accepts data input for the level of concern?	Uses the data entered to calculate the vulnerable zones.

Algorithms (equation(s) and assumptions used to calculate the results such as the concentration of the plume of released chemicals)

1. Employs dispersion models that are consistent with those used in this technical guidance document?	Gaussian dispersion models based on Turner's Workbook of Atmospheric Dispersion Estimates, PHS Pub. No. 999-AP-26. Different air stabilities and wind speeds are used.
2. Identifies the types of assumptions used?	Some models are not documented to provide information on the assumptions used to perform calculations and their effect on the model's results, or the limits of the model's ability.
3. Calculates chemical dispersion rates and routes?	Provides information on the plume size, motion, and concentration over time: and predicts toxic corridors.
4. Supports terrain modeling and considers complex terrain?	The ability to accommodate site-specific effects of terrain can be significant under some circumstances.

Outputs (the results of the calculations performed)

1. Presents pictorial representation of dispersion plumes?	Presents model output as dispersion plume overlaid on a map of the area.

2. Produces line, bar, or pie graphs?	Presents model output in graphical format (e.g., concentrations experienced at a location over time).
3. Retains the results of calculations in final form for future review or stores the input parameters to allow the results to be reproduced?	Systems differ in their ability to re-enact a series of calculations or to reproduce a specific output.

RISK ANALYSIS

Objective: Provide a basis to judge the relative likelihood (probability) and severity of various possible events. Risks can be expressed in qualitative terms (high, medium, low) based on subjective, common-sense evaluations, or in quantitative terms (numerical and statistical calculations).

Criteria	Explanation/Examples
1. Allows judgement to be made concerning facilities and routes, for probable hazard and severity of consequences?	Judgement may be based on the accident history, type of facility, storage conditions, control technologies in place, and other factors.
2. Assembles quantitative facility information concerning possible release scenarios?	Recognized systematic approaches include: hazard operability study (HAZOP): event tree analysis: fault tree analysis.
3. Allows priorities to be recorded according to community concerns and opinions?	Judgement and concerns of the community can be entered into the ranking and prioritization for community hazards.

EMERGENCY RESPONSE PLANNING

Objective: Assemble detailed information concerning hazards, vulnerability, and risk; provide action outlines for responders and criteria for plan review; present maps of the local area; and provide simulation capabilities for training.

Criteria	Explanation/Examples
1. Provides detailed methods for promptly identifying the affected area and population based on release information?	Mapping: modeling; demographical statistics: worst case release.
a. Maps facility locations and transportation routes?	Provides details of relative locations of hazards and vulnerable zones.
b. Plans routes for hazardous chemical shipments?	Based on characteristics of routes available, selects the least dangerous route.
2. Accepts emergency information and plans provided by chemical facilities?	Plans; procedures: site diagrams: emergency checklists.
a. Records facility emergency contacts?	Provides names, titles, and 24-hr. phone numbers for emergency purposes.
b. Generates floor plans of facility storage sites?	Shows building layout and chemical locations graphically.
c. Indicates location of engineering controls/safeguards?	Identifies safeguards such as emergency shut-offs graphically, or by detailed description of the location.
3. Provides an action outline for emergency responders?	Provides a chain of events or considerations that is based on the site-specific conditions involved.
4. Identifies the needed emergency response equipment for various types of emergencies?	Provides a decision aid for choosing proper equipment and required medical supplies based on the chemicals involved.
5. Stores the inventory of local response equipment and provides location and availability information?	Assists in the identification of equipment available from chemical facilities, local emergency responders, hospitals, other communities, and private contractors.

EMERGENCY RESPONSE PLANNING (Continued)

Criteria	Explanation/Examples
6. Stores information on community emergency procedures and plans?	Direction and control; communications: evacuation and sheltering: medical treatment facilities: resource management: cleanup and disposal: decontamination: and documentation.
7. Provides criteria for evaluating existing emergency response functions?	Identifies the essential elements that should be present in the plans based on regulatory requirements and local community priorities.
8. Prompts for information to update emergency response plans?	Flags information that changes frequently (e.g., emergency contacts, telephone numbers, and addresses).
9. Identifies hazardous material training program requirements and stores training information and schedules?	Provides criteria for evaluation of training programs and stores information on training completed per regulatory requirements.
10. Provides simulation capabilities for training?	Provides example test emergencies to exercise the plan and train response personnel.

IDENTIFICATION OF REGULATORY REQUIREMENTS

Objective: Track regulatory deadlines and assist in the assessment of compliance with reporting requirements, as well as record the status of required information and log requests for information.

NOTE: These criteria concentrate on planning and response requirements of Title Ill of SARA. The following is only a partial list of the possible capabilities that computer applications may possess with regard to the identification of regulatory requirements.

Criteria	Explanation/Examples
1. Tracks deadlines for reporting requirements under Title Ill of SARA?	Deadlines for reporting as required under Title 111 of SARA Sections 302, 304, 311-312, and 313.
2. Provides a means to respond to information reporting requirements of Title III of SARA?	Report capabilities may include production of the submission forms or letters or partial assembly of the needed information.
3. Has the capability to store and manage MSDS and chemical inventory form data?	Data manipulation including cross indexing lists to identify all facilities using a particular chemical.
4. Addresses public requests for information under Title Ill of SARA?	Record type and number of requests and provide information to answer them.
5. Tracks the status of planning in the local districts?	Identify when a plan was developed and when it was last updated.

APPENDIX L

SELECTED BIBLIOGRAPHY

This appendix lists some other documents that may prove helpful to anyone organizing a community awareness and preparedness program for responding to releases of extremely hazardous substances (EHSs).

1. *Hazardous Materials Emergency Planning Guide (NRT-1).* Washington, D.C.: National Response Team: prepared by ICF Incorporated, 1987.

NRT-1 was prepared to comply with the requirement in Section 303(f) of SARA. It contains general guidance on selecting and organizing the planning team, and describes how to carry out fundamental planning tasks (e.g., review existing plans, assess response capabilities, conduct a hazards analysis). The guide describes in detail what should be included in a hazardous materials emergency plan and suggests how this material could be organized.

NRT-1 can be obtained free of charge from:.

Hazmat Planning Guide WH-562A
401 M Street, S.W.
Washington, D.C. 20460

2. *Community Teamwork: Working Together to Promote Hazardous Materials Transportation Safety.* Washington, D.C.: U.S. Department of Transportation (DOT), Research and Special Programs Administration; prepared by Cambridge Systematics, Inc. 1983.

This publication provides State and local (i.e., fire, police, emergency service/civil defense, transportation, public safety, and environmental protection) officials with guidance on the most efficient use of their resources to develop effective hazardous materials programs. The bulk of the guide describes how one can, with a limited budget (1) perform a risk analysis: (2) obtain and mobilize emergency response services: (3) perform hazardous materials inspections: and (4) obtain hazardous materials training.

Deliberate and detailed attention to minimizing costs is a- consistent aspect of DOT's *Community Teamwork.* Because most communities must take into consideration strict budget limitations when devising preparedness plans, *Community Teamwork* should be of interest for this reason alone. *Community Teamwork* will also prove helpful to those planning to provide personnel safety equipment and clothing. Copies of *Community Teamwork* can be obtained by calling (202) 426-2301 or writing to:

Office of Hazardous Materials Transportation, Attn.: DHM-50
Research and Special Programs Administration
Department of Transportation
400 7th Street, S.W.
Washington, D.C. 20590

3. *Hazardous Materials Management System: A Guide for Local Emergency Managers.* Portland: Multnomah County Office of Emergency Management, 1983.

This handbook is a detailed guidance document prepared at the local level and published by the Multnomah County Office of Emergency Management in Portland, Oregon. This handbook guides the local emergency manager in the development and implementation of a comprehensive system approach for dealing with hazardous materials incidents within a specific geographic area. It is written from the perspective that such a system is multi-disciplinary and requires a team effort under the leadership of a local "emergency manager."

Information on availability of the Multnomah County guide can be obtained by calling (503) 255-3600 or writing to:

Multnomah County Emergency Management
12240 N.E. Glizan
Portland, Oregon 97230

4. *Community Awareness and Emergency Response Program Handbook.* Washington, D.C.: Chemical Manufacturers Association (CMA), 1985.

This private sector planning document is similar to those prepared by government agencies. However, the CMA document addresses two areas of chemical plant management:

- Community awareness: developing a community outreach program and providing the public with information on chemicals manufactured or used at local chemical plants: and

- Emergency response planning: combining chemical plant emergency plans with other local planning.

This CMA document presumes that the key organizing person might have no experience in contingency planning; hence, the information is provided in elementary detail to help just such an organizer. Pages 1-40 will prove helpful to any community preparing to develop an emergency plan to respond to EHS incidents. Appendix 1 lists typical components of a chemical plant emergency response plan: Appendix 2 provides highlights of interrelated plant, community, and State plans.

Copies of the CMA guide are available for $10.00 and can be obtained by calling (202) 887-1100 or writing to:

Chemical Manufacturers Association
2501 M Street, N.W.
Washington, D.C. 20037

5. An Unconstrained *Overview* of *the Critical Elements in a Model* Stare *System* for *Emergency Responses to Radiological Transportation Incidents.* Washington, D.C.: U.S. Nuclear Regulatory Commission and U.S. Environmental Protection Agency; prepared by Rockwell International, 1981.

6. *Atmospheric Emergencies: Existing Capabilities and Future Needs.* Washington, D.C.: Transportation Research Board, 1983.

7. *Chemical Hazards Response Information System (CHRIS), Manual II: Hazardous Chemical Data.* Washington, D.C.: United States Coast Guard, Department of Transportation, 1984.

8. *Criteria and Methods for Preparing Emergency Exposure Guidance Level (EEGL) Documents.* Washington, D.C.: National Research Council, May 1985.

9. *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support* of *Nuclear Power Plants.* Washington, D. C. : U.S. Nuclear Regulatory Commission and Federal Emergency Management Agency, 1980. (NUREG 0654/FEMA-REP-1).

10. *Emergency Planning, Student Manual.* Washington, D.C.: Federal Emergency Management Agency, August 1983.

11. *Disaster Operations: A Handbook* for *Local Governments.* Washington, D.C.: Federal Emergency Management Agency, 1981.

12. *1987 Emergency Response Guidebook.* Washington, D.C.: U.S. Department of Transportation, 1987. This guidebook is available at:

Office of Hazardous Materials Transportation, Attn. : DHM-50
Research and Special Programs Administration
Department of Transportation
400 7th Street, S.W.
Washington, D.C. 20590

13. *Guidance for Developing State and Local Radiological Emergency Response Plans and Preparedness for Transportation Accidents.* Washington, D.C.: Federal Emergency Management Agency, 1983. (FEMA-REP-5)

14. *Guide and Checklist for the Development and Evaluation of State and Local Government Radiological Emergency Response Plans in Support of Fixed Nuclear Facilities.* Washington, D.C.: U.S. Nuclear Regulatory Commission, Office of International and State Programs, 1974.

15. *Guide for Development of State and Local Emergency Operations Plans,* CPG 1-8. Washington, D.C.: Federal Emergency Management Agency, October 1985.

16. *Multi-Media Compliance Inspection: Union Carbide Corporation, Institute,* WV. Philadelphia: Environmental Protection Agency, Region Ill, 1985.

17. *The National Oil and Hazardous Substances Pollution Contingency Plan.* Washington, D.C.: U.S. Environmental Protection Agency, 40 CFR Part 300. (Usually referred to as the National Contingency Plan).

18. *Objectives for Local Emergency Management,* CPG 1-5. Washington, D.C.: Federal Emergency Management Agency, July 1984.

19. *Risk Assessment/Vulnerability Users Manual for Small Communities and Rural Areas.* Washington, D.C.: U.S. Department of Transportation, Research and Special Programs Administration; Prepared by Department of Civil Engineering, Kansas State University, 1981.

20. *Emergency Handling* of *Hazardous Materials in Surface Transportation,* Student, Patrick J. (ed). Washington, D.C.: Association of American Railroads, Bureau of Explosives, 1981,

21. *Overview of Environmental Pollution in the Kanawha Valley,* Vincent, James R,. Denver: EPA Office of Enforcement and Compliance Monitoring, 1984.

22. *Highly Hazardous Materials Spills and Emergency Planning,* Zajic, J.E., and Himmelman, N.A. New York: Marcel Dekker, Inc., 1978.

23. *Hazardous Materials Transportation: A Synthesis of Lessons Learned from the DOT Demonstration Projects.* Washington, D.C.: ICF Incorporated. This report summarizes seven DOT-sponsored demonstration projects on prevention and preparedness planning. Appendix F contains a discussion of the lessons learned so that other communities can benefit from the experience.

24. *Hazardous Materials Response Guide, Kelty, J.* Emergency Response Unit, Illinois Environmental Protection Agency. This guide is designed to provide rapid access to information on hazardous properties of chemicals involved in emergency incidents.

25. *Safeguards Report.* University of Charleston, Charleston, West Virginia: National Institute for Chemical Studies, November 1986. A Community Hazard Assessment for the Kanawha Valley of West Virginia.

26. *Criteria and Methods for Preparing Emergency Exposure Guidance Level (EEGL), Short-Term Public Emergency Guidance Level (SPEGL), and Continuous Exposure Guidance Level (CEGL) Documents.* Washington, D.C.: National Academy Press, 1986. This document was developed by the Board on Toxicology and Environmental Health Hazards of the National Research Council. It is designed exclusively for the use of the Department of Defense (DoD) for the chemicals of interest to it.

27. *The Workbook of Atmospheric Dispersion Estimates,* Turner, B., Public Health Service Publication No. 999-AP-26, 1970.

28. *Analysis of Hazardous Materials Emergencies for Emergency Program Managers: Student Manual.* FEMA SM-110.

29. *DOT Hazardous Materials Table.* 49 CFR 172.101.

30. *Fire Protection Guide on Hazardous Materials.* Quincy, MA.: National Fire Protection Association, 1986.

APPENDIX M

EPA AND FEMA REGIONAL CONTACTS

A. EPA Regional Preparedness Contacts

Region I
(Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut)
60 Westview Street
Lexington, MA 02173

Environmental Services Division
(617) 861-6700, ext. 221

Region II
(New York, New Jersey, Puerto Rico, Virgin Islands)
26 Federal Plaza
Room 900
New York, NY 10278

Response and Prevention Branch
New Jersey: (201) 321-6657
New York: *(212) 264-2525*

Region III
(Pennsylvania, Maryland, D.C., Delaware, Virginia, West Virginia)
841 Chestnut Street
Philadelphia, PA 19107

Office of Emergency Response
(215) 597-8907

Region IV
(North Carolina, South Carolina, Georgia, Florida, Mississippi, Alabama, Tennessee, Kentucky)
345 Courtland Street, N.E.
Atlanta, GA 30365

Emergency Response and Control Section
(404) 347-3931

Region V
(Wisconsin, Illinois, Indiana, Michigan, Ohio, Minnesota)
230 South Dearborn Street
Chicago, IL 60604

Emergency Response Section
(312) 886-1964

Region VI
(New Mexico, Texas, Oklahoma, Louisiana, Arkansas)
1445 Ross Avenue
Allied Bank Tower at Fountain Place
Dallas, TX 75202

Regional Information Center
(214) 655-2270

Region VII
(Nebraska, Kansas, Iowa, Missouri)
726 Minnesota Avenue
Kansas City, KS 66101

Preparedness Coordinator
(9 13) 236-2806

Region VIII
(Montana, Wyoming, Utah, Colorado,
North Dakota, South Dakota)
One Denver Place
999 18th Street
Suite 500 Denver, CO 80202

Emergency Response Branch
(303) 293-1723

Region IX
(California, Nevada, Arizona, Hawaii,
American Samoa, Guam)
215 Fremont Street
San Francisco, CA 94105

Toxics Division
(415) 974-7460

Region X
(Washington, Oregon, Idaho, Alaska)
1200 Sixth Avenue
Seattle, WA 98101

Hazardous Waste Division
Emergency Response Team
(206) 442-1263

Title III/CEPP Information **HOTLINE NUMBER**

1-800-535-0202 (in Washington, D.C.: (202) 479-2449)

B. FEMA Regional Offices

(Note: Direct all requests to the "Hazmat Program Staff" of the appropriate FEMA Regional office.)

Region I

(Connecticut, Maine, Massachusettes, New Hampshire, Rhode Island, Vermont)
442 J. W. McCormack POCH
Boston, MA 02109
(617) 223-9540

Region II

(New Jersey, New York, Puerto Rico, Virgin Islands)
Room 1337
26 Federal Plaza
New York, NY 10278
(212) 238-8208

Region III

(Delaware, Washington DC, Maryland, Pennsylvania, Virginia, West Virginia)
Liberty Square Building
105 S. 7th Street
Philadelphia, PA 19106
(215) 597-9416

Region IV

(Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee)
Suite 700
1371 Peachtree Street, N.E.
Atlanta, GA 30309
(404) 347-2400

Region V

(Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin)
4th Floor
175 W. Jackson Blvd.
Chicago, IL 60604
(312) 431-5501

Region VI

(Arkansas, Louisiana, New Mexico, Oklahoma, Texas)
Federal Regional Center, Room 206
800 N. Loop 288
Denton, TX 76201-3698
(817) 898-9399

Region VII

(Iowa, Kansas, Missouri, Nebraska)
911 Walnut Street, Room 300
Kansas City, MO 64106
(816) 283-7060

Region VIII

(Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming)
Denver Federal Center, Building 710
Box 25267
Denver, CO 80225-0267
(303) 235-4811

Region IX

(Arizona, California, Hawaii, Nevada, American Samoa, Guam)
Building 105
Presidio of San Francisco, CA 94129
(415) 923-7100

Region X

(Alaska, Idaho, Oregon, Washington)
Federal Regional Center
130 228th St., S.W.
Bothell, WA 98021-9796
(206) 481-8800

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