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Technical Compliance Guide for Clean Air Act Section 112(r) Risk Management Plan Program

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Prepared by:
U.S. Army
Center for Health Promotion and Preventive Medicine
Directorate of Environmental Health Engineering
Air Quality Programs

David A. Reed, Ph.D.
CPT Jeanne Pricer

Prepared for:
U.S. Army Environmental Center
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EXECUTIVE SUMMARY
TECHNICAL COMPLIANCE GUIDE FOR
CLEAN AIR ACT SECTION 112(r)
RISK MANAGEMENT PLAN PROGRAM
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

1. Background: Section 112(r) of the Clean Air Act (CAA) requires facilities that have threshold amounts of certain materials on hand to prepare a risk management plan (RMP.) The regulations implementing this requirement contain a specific list of chemicals and associated thresholds. The U.S. Environmental Protection Agency (EPA) established the RMP requirements in two parts. Part 1, the list of regulated chemicals and their thresholds, was promulgated 31 January 1994. Part 2, which describes the content of an RMP, was promulgated 20 June 1996. Installations have until 20 June 1999 to develop and submit plans. Results of a checklist survey found that about one-third of Army installations are subject to these rules.

2. Discussion.

a. The EPA stated purpose for the promulgation of these rules is to prevent catastrophic accidental releases, such as that which occurred in Bhopal, India in the early 1980's. Consequently, these rules deal with specific toxic and flammable substances that could be involved in a single incident in a significant amount. There are few materials listed in the rule that would be found above listed threshold quantities on a typical Army installation. However, many installations are expected to be subject to planning for at least one of these chemicals. Additionally, impacts may be determined by what is in proximity to the subject site (i.e. if there is a release at building A, will it involve the material in building B as well). A RMP can be very simple or complex, depending on such factors as accident history, amount of material, and proximity to off-post communities.

b. The RMP describes four major components of a risk management program on an installation: a hazard assessment, a management program, a prevention program, and an emergency response program. The hazard assessment describes how a release could occur and who would be impacted by the release. The management program is demonstration of involvement and knowledge by upper level management (i.e. installation commander) of how certain substances are managed on their facility. The prevention program shows how a catastrophic release is being prevented. The emergency response program describes what the facility will do in case a release occurs.

3. Special Issues.

a. The EPA's current proposal would have submittal of the RMPs occur over the Internet. There is currently a workgroup including a Department of Defense representative to insure concerns about security and information access are properly addressed.

b. The RMP describes potential consequences of an accidental release. Industry sources have advised that they are putting as many resources into the public affairs aspect as the technical compliance portion.

c. The application of Occupational Safety and Health Administration Process Safety Management (PSM) is a criteria for determining whether the RMP rule applies to certain sources. The Army Environmental Law Division has established that PSM rules do apply on installations. A copy of that memorandum is provided in this technical compliance guide.

d. While the RMP rules require analysis of off-site impacts, Army policy requires a similar but separate analysis of impacts that an accidental release might have on the soldier housing areas. These areas would be ignored under the rule. This requirement is stated in memorandum, DAIM-ED-C, subject: Risk Management Plans Under the Clean Air Act--Checklist for Determining Applicability and Impact, 16 October 1996.

Table of Contents

1.0 INTRODUCTION

1.1 Background. Section 112(r) of the Clean Air Act Amendments of 1990 (CAAA-90) is entitled "Accidental Release Prevention". Commonly referred to as the "Risk Management Plan" (RMP), Section 112(r) is designed to both prevent and prepare for releases of chemicals or flammable substances that would have a serious impact on the surrounding public. The Bhopal, India release of methyl isocyanate is an example of such a catastrophic event. Under the regulation, certain facilities would be required to submit to the U.S. Environmental Protection Agency (EPA) an RMP that summarizes their Risk Management Program

The scope and impact of the regulation caused the EPA to declare it a Tier I rulemaking, which requires oversight and review by the Administrator's office. The EPA expects the regulation to apply to two to three times more facilities than the CAAA-90 Title V permitting provisions. The regulation also has a significant public affairs aspect since the RMP details the radius of impact for a serious release, generally referred to as a "footprint". It also identifies receptors that would be affected by the release such as census population and sensitive areas (e.g., schools, hospitals, public arenas, large commercial and residential areas, etc.). This information is to be submitted electronically and then made accessible to the public, presumably via the Internet.

Installation personnel responsible for the Risk Management Program implementation must understand that the regulation has a unique chemical list and threshold methodology, and focuses on individual processes. Neither the CAAA-90 Hazardous Air Pollutant (HAP) nor the Emergency Planning and Community Right-to-Know Act (EPCRA) chemical lists apply to this regulation. The RMP regulated substances include 77 toxic chemicals and 63 flammables. Additionally, Section 112(r) incorporates a general duty clause which covers any substance which could have an offsite impact regardless of the quantity. Toxic chemicals such as chlorine, sulfur dioxide, ammonia, hydrochloric acid, and nitric acid are expected to exist in reportable quantities at Army installations. Chlorine is expected to be the most widely reported by installations due to its low threshold and its common use in water and wastewater treatment. Flammables such as butane or propane are also expected to be found in reportable quantities at many installations. Since Risk Management Program thresholds apply to individual processes, the EPCRA threshold principles, which apply to entire facilities, are not used with RMP compliance procedures.

1.2 Purpose of this Document. The development of an installation Risk Management Program may require a significant expenditure of human and fiscal resources and careful planning. This document is intended to be a technical reference guide for what is expected of an installation's comprehensive Risk Management Program. It will also serve as a template for installation and command elements to assess the quality of final documentation.

A description of the Risk Management Program regulation and specific compliance steps are included as the body of this document. Technical sections which follow, cover each element of the regulation. The document is arranged such that specific and applicable technical sections can be referenced in developing a comprehensive program. Experience gained by the U.S. Army

Center for Health Promotion and Preventive Medicine (USACHPPM) indicates that multiple installation points of contact (POCs) will be developing and will be responsible for the full implementation of the Risk Management Program. The technical sections can be referenced as stand alone requirement descriptions for the POCs.

This document will be updated as experience warrants. The USACHPPM will be preparing Risk Management Programs and Plans for several installations. Lessons learned will be the basis of the document update along with any additional guidance from the EPA.

2.0 REGULATION EXPLANATION

2.1 Overview. Figure 1 explains the more global aspects of Section 112(r) as follows:

- A Risk Management Plan (RMP) is submitted to the EPA and is a summary of the installation's Risk Management Program.

- ***The above point needs to be stressed as it frequently leads to confusion***. An adequate Risk Management *Program* is the comprehensive requirement of this regulation. The Program is developed by the installation to reflect the Section 112(r) requirements for the prevention of catastrophic chemical releases. The Risk Management *Plan* is what is submitted to the EPA, as required by the Section 112(r) regulation. This Guide discusses what is needed to create an installation Risk Management Program and/or evaluate documentation for the Program.

- The installation's Risk Management Program consists of 4 major components: Hazard Assessment, Management Program, Prevention Program, and Emergency Response Program.

- The 4 major components consist of distinct requirements. The specific requirements to be performed for any given covered process depend on whether the covered process is a Program Level 1, 2, or 3 process.

- Finally, the reader should note that the term "components" is the authors'. In numerous cases the Section 112(r) regulation uses the word "program" to refer to these, as well as to the overall Risk Management Program. Compliance personnel are cautioned to understand the context in which "program" is used in any given situation.

2.2 Key Concepts. Concepts that should be understood include *regulated substances, listed toxic chemical, listed flammable,* and *covered process*. These terms are discussed throughout this guide and below.

The term *regulated substances* can refer to either a *listed toxic chemical* or a *listed flammable.* The EPA has divided the Section 112(r) *regulated substances* into these two major groupings.

There are 77 toxics and 63 flammables. The listed toxic chemicals have unique thresholds. For example, chlorine has a threshold of 2,500 pounds while sulfur dioxide has a threshold of 5,000 pounds. Flammables all have the same threshold of 10,000 pounds. The method for determining the impact of a catastrophic release of listed toxic chemicals differs from that used for listed flammables. Mixture considerations are also treated differently. Finally, reporting requirements for these in the RMP will vary depending on whether the *regulated substance* is a toxic chemical or flammable.

Another concept which requires clarification is *covered process.* A *covered process* is a process which has a *regulated substance* onsite in greater than threshold quantities. For instance, 4,000 pounds of chlorine at a wastewater treatment plant would cause the wastewater treatment plant to be considered the covered process. (Chlorine is a regulated substance and 4,000 pounds is greater than the 2,500 pound threshold for chlorine as stated in the regulation.) The covered process is where an accident is most likely to occur or be prevented and likewise, where accident prevention measures are focused. In contrast, a 150 pound cylinder of chlorine at an installation swimming pool or drinking water well would not trigger Section 112(r) compliance requirements because the quantity at that particular site is below threshold, *even if chlorine is triggered elsewhere on the installation.*

The installation Risk Management Program will reflect these varying concepts and users of this guide should understand how they interact. The USACHPPM is recommending (via this Guide) that ***Risk Management Program documentation reflect the covered processes***, not the listed substances. This may result in certain information being duplicated within a single program document since two or more processes may have the same regulated substances. Duplication would provide a stand alone document for each covered process which may be "pulled out" from the main document and a copy maintained at the covered process facility. Program documentation is discussed further on page 12, and the recommended report format is shown in Table 3.

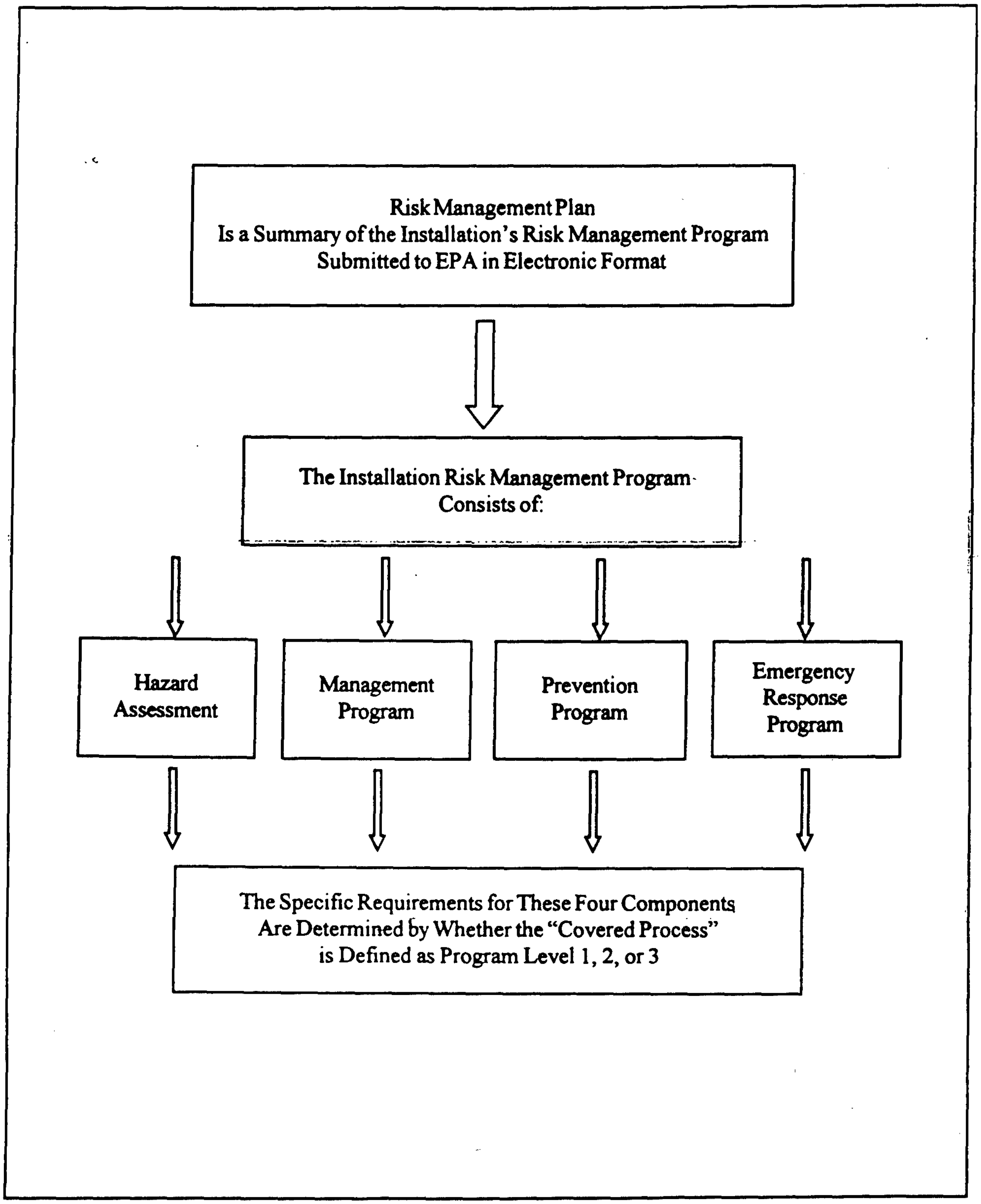

Figure 1 - Major Compliance Concepts with Section 112(r) Regulation

2.3 Major Components of a Risk Management Program.

2.3.1 Hazard Assessment. At least a portion of the Hazard Assessment must be completed for each covered process. The Hazard Assessment is designed to determine previous accident history of an installation, potential impact of an accidental release, and the Program Level applicable to a covered process. A five-year accident history and a worst-case release scenario analysis are criteria for Program Level determination. In performing the latter, air dispersion modeling or tables can be used to determine the potential footprint of the resulting explosion or toxic gas cloud. A process is Program Level 1 eligible if there have been no accidents in the previous 5 years, and modeling of a worst-case release indicates no impact to public receptors. Table 1 shows the Program Levels, with major components and corresponding individual requirements for the regulation. As seen in Table 1, very few compliance requirements apply to a Program Level 1 process. Program Levels 2 or 3 require the installation to perform further modeling to determine alternative (and more realistic) release scenarios. For installations with multiple covered processes, the number of release scenarios reported in the RMP may not be equal to the number of covered processes. This is because EPA has determined that one release scenario may be representative of all cases (especially true with flammable releases), or one covered process may require more than one release scenario.

When a hazard assessment indicates that public receptors fall within the footprint of the release, then populations must be identified from census data. Additionally, the presence of schools, hospitals, other institutions, public arenas, recreational areas, and large commercial and industrial developments within this footprint which can be identified on street maps must be noted in the RMP.

The public affairs ramifications of this information should not be underestimated. The data described above, including the catastrophic release footprint will be available to the public. Public affairs personnel should be involved in the Risk Management Program development as soon as definitive determinations have been made.

2.3.2 Management Program. Section 112(r) emphasizes that Command awareness and support is essential for a successful Risk Management Program. The Management Program requirements help secure this top level support. Current procedures that are already used to inform Command of environmental issues can be utilized to help meet this requirement.

2.3.3 Prevention Program. This program addresses installation practices which must exist (and be documented, maintained, updated, and recorded) to help prevent catastrophic releases. The most resource intensive requirements under Section 112(r) for Program Level 2 and 3 covered processes are in the Prevention Program. As seen in Table 1, a Program Level 3 process will involve performing and documenting up to 12 separate requirements. Tasking ranges from formal procedures for incident investigation to a Process Hazard Analysis (PHA). The PHA itself can be as simple as a what-if scenario question and answer document, or as complex as a full blown Failure Mode Effects Analysis (FMEA) or Fault Tree Analysis (FTA).

Installations should be aware of the U.S. Occupational Safety and Health Administration (OSHA) Process Safety Management (PSM) Standard and how it's tied in with Section 112(r). The OSHA PSM Standard applies to workers as the Risk Management Program applies to the public. Prevention Program requirements mirror the OSHA PSM requirements to the point that one can be used for the other. ***The EPA has stated that OSHA PSM compliance is equivalent to the Risk Management Program - Prevention Program requirements.*** Installations should coordinate with their safety or occupational health directorates to determine whether the OSHA PSM plan is complete. Combining resources to perform the requirements of the RMP and PSM would benefit both parties.

2.3.4 Emergency Response Program. The Emergency Response Program requires installations to prepare for possible catastrophic releases and thereby reduce risk to the public by having better prepared responders. No *specific* requirements have been promulgated. The EPA has relied on compliance with other regulations to serve the purpose of this program. Although EPA has acknowledged the Presidential report which stated that there is seldom harmony with differing Federal emergency response requirements, it has endorsed the Federal "One-Plan" approach. Subsequent guidance on this aspect of Section 112(r) will be distributed by Service elements as information becomes available.

2.4 Risk Management Plan Contents. The regulation requires that installations submit an RMP to the EPA. As previously stated, this is a summary of an installation's Risk Management *Program*. Appendix A contains the EPA RMP data elements and instructions.

Program 1	Program 2	Program 3
Hazard Assessment		
Worst-case analysis	Worst-case analysis	Worst-case analysis
	Alternative releases	Alternative releases
5-year accident history	5-year accident history	5-year accident history
Management Program		
	Document management system	Document management system
Prevention Program		
Certify no additional steps needed	Safety Information	Process Safety Information
	Hazard Review	Process Hazard Analysis
	Operating Procedures	Operating Procedures
	Training	Training
	Maintenance	Mechanical Integrity
	Incident Investigation	Incident Investigation
	Compliance Audit	Compliance Audit
		Management of Change
		Pre-startup Review
		Contractors
		Employee Participation
		Hot Work Permits
Emergency Response Program		
Coordinate with local responders	Develop plan and program	Develop plan and program
Risk Management Plan Contents		
Executive Summary	Executive Summary	Executive Summary
Registration	Registration	Registration
Worst-case data	Worst-case data	Worst-case data
5-year accident history	Alternative release data	Alternative release data
Certification	5-year accident history	5-year accident history
	Prevention program data	Prevention program data
	Emergency response data	Emergency response data
	Certification	Certification

Table 1 - List of Section 112(r) Program Levels, Major Components, and Requirements

3.0 STEPS FOR RISK MANAGEMENT COMPLIANCE

Fundamentally, there are four steps required to develop a Risk Management Program. The first step is applicability determination. Is Section 112(r) even applicable at the installation? If so, the second step is to determine which Program Level applies to the covered processes. As seen in Table 1, compliance requirements vary significantly. The third step is to develop, document, and implement the installation Risk Management Program. Step four involves preparation of the RMP and submittal to the EPA. The EPA is currently developing an electronic submission process.

3.1 Applicability Determination. Appendix B contains a Compliance Assessment Checklist to be used as a screening tool for applicability. All Army installations should have received this through their Chain of Command. Completion of the checklist provides installations with a list of their covered processes. Remember, the regulation is applicable only to installations which are expected to have listed substances at greater than threshold quantities by 20 June 1999 (the compliance date). If all listed substances at an installation do not exceed threshold quantities after 20 June 1999, then no specific requirements apply and this document requires no further reading! However, should a regulated substance at a covered process exceed the threshold quantity at any time after 20 June 1999, an RMP must be in place at that time. Appendix C contains the final regulation which lists the regulated substances and their corresponding thresholds which trigger compliance requirements. It is critical to note that a threshold quantity of a listed toxic or flammable must be present in one location, or multiple quantities be connected, such that the entire amount could conceivably be involved in a single catastrophic accident. An installation-wide accountability of all quantities of toxic chemicals and flammables on the list is not required.

3.2 Program Level (s) Determination. Covered processes must comply with one of three sets of requirements termed by EPA as "Program 1, Program 2, or Program 3". To avoid confusion, this document will use the term Program Level when referring to these compliance requirements. The criteria for determining Program Level eligibility are a five-year accident history analysis, a determination of whether the regulated substance will impact public receptors, the Standard Industrial Classification (SIC) code for the covered process, and determination of whether the covered process is subject to the OSHA PSM Standard.

It should be understood that the compliance requirements of Section 112(r) can apply to either the entire installation, a *listed toxic chemical or flammable,* or to a *covered process*. For the most part, however, the regulation requirements address the covered process and, as discussed below, the USACHPPM recommends that Risk Management Program documentation reflect this.

3.2.1 Program Level 1 Covered Process Determination. A covered process is eligible for Program Level 1 if it has *no history of accidents for the past 5 years and would have no offsite impact* as determined from the worst-case release analysis (performed in Hazard Assessment). Table 2 lists Program Level 1 requirements for a covered process. Each of the requirements in this table are explained in detail in the Technical Sections of this guide. Table 2 can be viewed as a representative Table of Contents for Risk Management documentation which contains compliance information for a Program Level 1 covered process.

	Technical Section
1. Five-Year Accident History	2
2. Worst-Case Release Scenario Analysis	3
3. Coordination With Local Emergency Planners	4
4. Certification Statement	5

Table 2 - Program Level 1 Covered Process Documentation and Associated Technical Sections

A covered process that would have an impact on a public receptor will be either Program Level 2 or 3.

3.2.2 Program Level 2 vs. Program Level 3 Covered Process Determination. Covered processes which are not Program Level 1 are either Program Level 2 or 3. The EPA has stated that a covered process is Program Level 3 if it meets either one of the two conditions described below; all other covered processes are Program Level 2.

A covered process is a Program Level 3 process if:

The process (not the installation) is in SIC code:

- 2611 (pulp mills)
- 2812 (chlor-alkali)
- 2819 (industrial inorganics)
- 2821 (plastics and resins)
- 2865 (cyclic crudes)
- 2869 (industrial organics)
- 2873 (nitrogen fertilizers)
- 2879 (agricultural chemicals)
- 2911 (petroleum refineries)

\- or -

The process is subject to the OSHA PSM regulation.

Processes on military installations are subject to OSHA PSM. This legal determination was made by The Army Office of The Judge Advocate General (TJAG), in coordination with the other military services. Therefore all processes which meet the OSHA PSM threshold and the EPA RMP threshold, and do not qualify for Program Level 1, must comply with Program Level 3. Appendix D is a reproduction of TJAG letter which documents this determination.

Most of the Section 112(r) regulated chemicals are found on the OSHA PSM list. The only OSHA PSM listed chemical which has a higher threshold than the EPA RMP value is methyl chloride (PSM at 15,000 pounds, and RMP at 10,000 pounds). Based on the legal interpretation, only the chemicals which are not on the PSM list but are on the RMP list would be eligible for Program Level 2.

It should be noted that the OSHA PSM Standard exempts flammables which are used as fuels such as propane, methane, butane, etc., while the EPA rule does not. As such, installation flammables may not be subject to the OSHA PSM Standard but subject to RMP.

3.3 Develop Program. Installations with a covered process can use the applicable Technical Sections of this guide. They are designed to bridge the gap between the complex Section 112(r) regulation and a comprehensive installation Risk Management Program and explain all the requirements for the development of a Program Level 1 or 3 Risk Management Program. The Technical Sections are intended to aid the installation in determining report completeness and in understanding regulation requirements. Each Technical Section includes a checklist at the beginning to act as a table of contents and a final quality assurance (QA) review. Subsections are also included which detail required elements to the final report and give guidance and recommendations where appropriate.

The installation POCs should assign program responsibility and authority early, since interaction with other installation components will be required in most cases. The RMP will not be a "turn-key" document. Maintenance of records will be critical, and ongoing development will be necessary in many cases. While contracting the initial development of the Risk Management Program is likely, the installation should assume responsibility that all requirements are understood and, most importantly, *workable*.

3.4 Document Program. Documentation of the installation Risk Management Program is critical since it will indicate adherence to regulation requirements and dedication to public safety. Table 3 shows a recommended report outline. Risk Management Program documentation for each covered process is recommended to be contained in the appendices of the final Risk Management Program document. Additionally, the RMP should be included as an appendix. This is the only part of the document to be submitted to the EPA. Table 2 shows a recommended Table of Contents outline for the Program Level 1 appendix, in which applicable Technical Sections are referenced. The same outline format may be used for the Table of Contents for a Program Level 3 appendix with the additional applicable Technical Sections added. The main body of the report includes information submitted to the installation by the RMP service provider (either contractor or onsite personnel). It is suggested that the body of the report include a general introduction to the installation and the Risk Management Program, a brief summary of the covered processes addressed in the RMP, and results/conclusions that are of interest to the installation.

Note that the appendices are arranged to focus on the covered process rather than the listed chemical. The USACHPPM finds this to be the best approach for most situations. *A notable exception, however, occurs for chlorine used at a wastewater treatment and drinking water plant.*

Because of the similarity in equipment, operations, and organizational structure, it may be appropriate to combine these two covered processes into a single appendix.

The USACHPPM recognizes some duplication may occur in using the recommended report outline (Table 3). For example, a single Management Program will meet the requirements for all Program 2 and 3 covered processes. Yet this would be reproduced in each Program Level 2 and 3 Appendix.

The USACHPPM recommends that the reports be formatted as given in the Tables, with the focus remaining on the covered process. This will allow installation personnel, Command, and USACHPPM to perform QA tasks in an orderly fashion. This in turn will ensure that each installation obtains a plan which meets regulatory requirements and alleviates public concern. To assist workers with the Risk Management regulation, appendices listed in the Table of Contents of this guide apply.

Table of Contents

1. Introduction
   - 1.1 Installation Background Information
   - 1.2 RMP Background Information
     - 1.2.1 RMP Team
     - 1.2.2 Personnel Contacted
2. Installation Covered Processes and Corresponding Chemicals
3. Circles of Concern and Public Receptors
4. Risk Management Program Current Status and Future Work

APPENDICES

A. Risk Management Program for Covered Process XXX
   (See Table 2 for example Program Level 1 template)

B. Risk Management Program for Covered Process YYY
   (Table 2 with additional applicable Technical Sections may be an example Program Level 2 or 3 template)

C. Installation Risk Management Plan

Table 3 - Schematic of an Installation Risk Management Program Document

Technical Sections

Technical Section 1 - Introduction and RMP Executive Summary

Installations must prepare an introduction to be submitted with the Risk Management Plan (RMP) which presents a general description of the installation, summarizes the RMP preparation and contents, and contains the Section 112(r) required Executive Summary and Registration. The following topics must be covered in paragraph form:

Checklist for Determining Report Completeness
Introduction and RMP Executive Summary

_____ 1.1 Background

_____ 1.2 RMP team

_____ 1.3 Executive Summary

- _____ 1.3.1 Prevention and emergency response policies
- _____ 1.3.2 Process and chemicals description
  - _____ 1.3.2.1 Primary activities
  - _____ 1.3.2.2 Reason process is covered
  - _____ 1.3.2.3 Quantity of chemical
  - _____ 1.3.2.4 Program level of chemical and reason
  - _____ 1.3.2.5 Use of chemical
  - _____ 1.3.2.6 Use of product and product turnaround
  - _____ 1.3.2.7 How chemical is stored and in what quantity
- _____ 1.3.3 Description of worst-case scenario and alternative release scenario(s)
- _____ 1.3.4 General prevention program and chemical-specific prevention steps
- _____ 1.3.5 Five-year accident history
- _____ 1.3.6 Emergency response program
- _____ 1.3.7 Any planned changes to improve safety

_____ 1.4 Registration

- _____ 1.4.1 Source identification
- _____ 1.4.2 Installation information
- _____ 1.4.3 Name and title of person with RMP implementation responsibility
- _____ 1.4.4 Emergency contact: name, title, phone, 24 hour phone
- _____ 1.4.5 Information for each process

_____ 1.4.5.1 RMP listed chemical(s) at threshold
_____ 1.4.5.2 CAS number for each chemical
_____ 1.4.5.3 Maximum quantity of each chemical
_____ 1.4.5.4 SIC code for each process
_____ 1.4.5.5 Program level of each chemical
_____ 1.4.6 EPA identifier of the process
_____ 1.4.7 Number of full-time employees at the process
_____ 1.4.8 Statement identifying process coverage by:
_____ 1.4.8.1 OSHA PSM (29 CFR 1910.119)
_____ 1.4.8.2 EPCRA Section 302 (40 CFR Part 355)
_____ 1.4.8.3 CAA Title V Operating Permit (40 CFR Part 70)
_____ 1.4.9 Date of last safety inspection of the process, and inspecting agency

1.1 Background. A basic description of the installation including location (county, nearby cities, associated geographic landmarks), size (acreage), mission (including principal activity(ies) and tenants, important support activities, government agencies or contractors) number of personnel employed, and facilities and plants.

1.2 RMP team. Names and titles of individuals who participated in the RMP survey, prepared the data, and completed the RMP report.

1.3 Executive Summary. A Section 112(r) requirement for installations which have Program Level 2 or 3 processes. This basically provides an introduction to the processes which involve chemicals on the RMP checklist, and to various related topics which will be covered in the installation's RMP report. This must be brief (no more than four pages long per process) and must include the following, for each covered process:

1.3.1 Prevention and emergency response policies.

1.3.2 Description of the covered process and associated chemicals. This is a brief summary which includes the following:

1.3.2.1 Primary activities (ex: water treatment, pulp mill, etc.).
1.3.2.2 Reason the process is covered.
1.3.2.3 Quantity of each chemical involved.
1.3.2.4 Program level of each listed chemical and reason for that program level assignment.
1.3.2.5 Use of the chemical in the process.

1.3.2.6 Use of the process product and product turnaround (ex: gallons of water processed per day in water treatment plant).

1.3.2.7 How each process chemical is stored and in what quantity.

1.3.3 Description of the worst-case and alternative release scenario (s), including any administrative controls and passive mitigation measures. This would include the scenario and distance to the endpoint. The defined endpoints for each toxic chemical or flammable can be found in the EPA guidance and reference is made to endpoints in Table 2.

1.3.4 Description of the general prevention program and chemical-specific prevention steps. This would include the statement that the installation is in compliance with the OSHA PSM regulation and therefore, the RMP regulation. Any general or specific steps key to the prevention program (technological or procedural) may be mentioned.

1.3.5 Description of the five-year accident history. This is a paragraph summary of the accidents, if any, which occurred within the last five years. It includes the dates of the releases, the chemical released, the greatest quantity released out of all the accidents, and whether injury occurred or evacuation was required.

1.3.6 Description of the emergency response program. This includes a statement certifying that the process has such a plan, and whether the plan has been coordinated with the local community plan. Any joint training with local officials or agencies, and any use of public notification and alert systems may be mentioned.

1.3.7 Description of any planned changes which would improve safety.

1.4 Registration. A single registration form for all covered processes is required and must be included in the RMP. Refer to the enclosed RMP registration data elements. Note that Dun and Bradstreet number of the process and corporate parent company is included as a data element. Neither the Department of Defense nor installations should have a Dun and Bradstreet number; therefore, this data element would not apply. The following information must be included:

1.4.1 Source identification, which includes process name, address (street, city, county, state, zip code), and latitude and longitude (available from U.S. Geological Survey maps).

1.4.2 Owner/operator information, as defined in the regulation. This includes name, business telephone number, and business mailing address. The owner/operator is defined by the regulation as any person who owns, leases, operates, or controls a process. He/she is the highest ranking executive onsite. In the case of unmanned operations, the owner/operator would be the person responsible for the process.

USACHPPM Recommends

The signature requirements for the RMP differ from the Clean Air Act Title V signature requirements. However, Section 112(r) is an applicable Clean Air Act requirement. It is recommended that if a Clean Air Act Permit has been submitted, then the person or position who signed the permit application be the signator of the RMP. Otherwise, the highest ranking person (civilian or officer) *who has responsibility for the operators of a covered process* signs the Risk Management Plan Submission. This recommendation is tentative pending clarification. Installation personnel are encouraged to check with their chain of command to determine signatory responsibilities.

1.4.3 Name and title of person or position with overall responsibility for RMP elements and implementation.

1.4.4 Emergency contact, including name, title, telephone number (usually the telephone number at the process, or the contact's business telephone number, the dispatcher's telephone number, or customer service), 24-hour telephone number (where the emergency contact may be reached after hours or: a home telephone number, beeper, etc.). The emergency contact should be a process employee or the owner/operator, and be knowledgeable about the site, and any emergency plans. This person must be able to mitigate a release, fight a fire, or direct response personnel conducting such tasks.

1.4.5 Information for each covered process:

1.4.5.1 Name of each RMP listed chemical at or above threshold quantity.
1.4.5.2 Chemical Abstract Service (CAS) number for each chemical.
1.4.5.3 Total maximum quantity in pounds of each regulated chemical or mixture (two significant digits) at the process.
1.4.5.4 SIC code for each process. This is a federal government business activity category and may be found in the SIC Manual, Office of Management and Budget, U.S. Government Printing Office, Washington, D.C.
1.4.5.5 Program Level (1,2, or 3) of each listed chemical.

1.4.6 The EPA identifier of the process.

1.4.7 Number of full-time employees at the process. Part-time and seasonal workers may be added together to approximate a full-time worker (ex: 30 hours per week equals 3/4 of a full-time worker, 3 months of a year equals 1/4 of a full-time worker. Together, both equal one full-time worker.)

1.4.8 Statement identifying whether each covered process on the installation is covered by the following:

1.4.8.1 The OSHA PSM (29 CFR 1910.119). All DOD installations must comply with the OSHA PSM or equivalent.

1.4.8.2 The EPCRA Section 302. This requires that local authorities be notified of the presence of certain hazardous substances, including the toxic chemicals listed in Section 112(r).

1.4.8.3 The CAA Title V Operating Permit (40 CFR Part 70). Title V requires certain state and local operating permit programs for major sources of air pollution.

1.4.9 Date of last safety inspection of each process. The applicable inspection agency must also be indicated.

Technical Section 2 - Five-Year Accident History

All installations that maintain one or more covered processes must prepare a five-year accident history.

Checklist for Determining Report Completeness Five-Year Accident History
_____ 2.1 Five-year accident history

2.1 Five-year accident history. This is an identification of all accidental releases from all covered processes that resulted in deaths, injuries, or significant property or environmental damage on or off site. Any evacuating or sheltering in place that occurred off site must also be identified. For each applicable release in the last five years, the installation must prepare a report which includes the information detailed on the form on the following page.

Accident Report

Release Date ______________________ Time ______________________

Approximate Duration of the Release ______________________

Chemical(s) released ______________________

Estimated quantity released in pounds ______________________

Type of release event and its source ______________________

____

____

____

Weather conditions, if known ______________________

____

Onsite impacts ______________________

____

____

____

Known off site impacts ______________________

____

____

____

Initiating event and contributing factors, if known ______________________

____

____

Which off site responders were notified, if known ______________________

____

Operational or process changes that resulted from investigation of the release ______________________

____

____

____

Technical Section - 3 Worst-Case Release Scenario Analysis

For each covered process, installations must complete a worst-case release scenario analysis to determine if a worst-case accidental release will result in an impact to a public receptor. A public receptor is defined as an off site residence, institution (e.g., school, hospital), industrial, commercial, or office building, park, or recreational area inhabited by the public at any time without restriction by the stationary source, where members of the public could be exposed to toxic concentrations, radiant heat, or overpressure, as a result of an accidental release. RMP Off site Consequence Analysis (EPA, 24 May 1996) provides a comprehensive review for performing a worst-case or alternative (discussed later) release scenario analysis. According to EPA guidance, a worst-case release analysis is performed with the steps outlined in this guidance.

Checklist for determining Report Completeness
Worst-Case Release Scenario Analysis

_____ 3.1 Define worst-case

- _____ 3.1.1 Define worst-case event
- _____ 3.1.2 Define endpoints
- _____ 3.1.3 Define meteorological conditions
- _____ 3.1.4 Define quantities released

_____ 3.2 Select scenario for RMP submission

_____ 3.3 Calculate release rate

_____ 3.4 Determine distance to endpoint

- _____ 3.4.1 Flammables
- _____ 3.4.2 Toxic chemicals

_____ 3.5 Results

- _____ 3.5.1 Distance to endpoint
- _____ 3.5.2 Population affected
- _____ 3.5.3 Public receptors
- _____ 3.5.4 Environmental receptors

Interpretation for Installations

The definition for "public" in the regulation includes all persons who are not an employee or contractor.

The definition for "off site" includes any area where the "public" has routine and unrestricted access.

As such only installations or portions of an installation which have secure boundaries can use the fenceline definition for off site. Public access applies to military dependants, retirees, and the public on many Army installations. Included as "off site" would be military (AAFES) and non-military shopping centers, military family housing, schools, museums, recreation areas, hospitals, etc.

The Department of the Army (DA) has determined as policy that soldier housing will also be treated as off site.

When determining whether an off site impact occurs under Section 112(r) these areas should be considered.

3.1 Define worst-case. Defining the worst-case conditions will require that the worst case event and modeling parameters be determined. These parameters are then used to determine release rates and model conditions to determine the distance to the off site receptors.

3.1.1 Define worst-case event. The EPA has defined the worst-case release as the one that releases the largest quantity of a regulated substance (toxic or flammable) and gives the greatest distance to a specified endpoint. Table 1 lists dominating release events. The storage conditions and physical state of the toxic chemical or flammable are used to determine the worst possible release.

3.1.2 Define endpoints. The defined endpoints for each toxic chemical or flammable can be found in the EPA guidance. Endpoint references are shown below in Table 2.

TABLE 1. Worst-Case Release Events.

Substance	**Storage**	**Worst-Case Release Scenario**	**Release Rate**
Toxic Gas	Regulated substances that are normally gases at ambient temperature and handled as a gas or as a liquid under pressure	Worst-Case Release Quantity released as a gas in 10 minutes	Worst-Case Release Quantity divided by 10 *
Toxic Gas	Gases handled as refrigerated liquids at ambient pressure †	Worst-Case Release Quantity released as a gas in 10 minutes	
Toxic Gas	Gases handled as refrigerated liquids at ambient pressure ††	Worst-Case Release Quantity is spilled instantaneously to form a liquid pool	Calculated at the boiling point of the substance ∮
Toxic Liquids ‡‡	For regulated toxic substances that are normally liquids at ambient temperature (no passive mitigation in place).	Worst-Case Release Quantity is spilled instantaneously to form a liquid pool.	‡
Toxic Liquids ‡‡	For regulated toxic substances that are normally liquids at ambient temperature (passive mitigation in place).	Worst-Case Release Quantity is spilled instantaneously to form a liquid pool.	∮
Flammables	All container types	Worst-Case Release Quantity vaporizes resulting in a vapor cloud explosion	

* Unless passive mitigation systems are in place.

† This scenario assumes that the released substance is not contained by passive mitigation systems or that the contained pool would have a depth of 1 centimeter or less.

†† This scenario assumes that the released substance is contained by passive mitigation systems in a pool with a depth greater than 1 centimeter.

∮ Calculated using the surface area of the contained liquid. Must take into account the highest daily maximum temperature occurring in the past three years, the temperature of the substance in the vessel, and the concentration of the substance if the liquid spilled is a mixture or solution.

‡ The surface area of the pool shall be determined by assuming the liquid spreads to 1 centimeter deep.

‡‡ If release occurs onto a surface that is not paved or smooth, actual surface characteristics should be considered.

TABLE 2. Distance to Endpoints.

Substance	Distance to Endpoint
Toxic	See Appendix E
Flammable	Varies according to scenario
Explosion	Overpressure of 1 psi *
Radiant Heat/Explosion Time	5 kilowatt per square meter for 40 seconds
Lower Flammability Limit	†

* A yield factor of 10 percent of the available energy released in the explosion shall be used to determine the distance to the explosion endpoint if the model used is based on TNT-equivalent methods.

† As provided in National Fire Protection Association documents or other generally recognized sources.

3.1.3 Define meteorological conditions. The EPA has defined default conditions for meteorological modeling parameters. These should be used unless a valid reason for using other values is documented. Table 3 lists the EPA default conditions.

TABLE 3. Modeling Parameters

Parameter	Value
Wind Speed	1.5 meters per second *
Atmospheric Stability Class	F *
Ambient Temperature †	Highest Daily Maximum Temperature in the previous three years ††
Humidity †	Average ††
Height of Release	Ground Level (0 feet)
Surface Roughness	∮
Gas Density	‡
Release Temperature	Ambient or process (whichever is higher)

* If the installation can demonstrate that local meteorological data applicable to the stationary source show a higher minimum wind speed or less stable atmosphere at all times during the previous three years, those minimums may be used.

† Based on temperature/humidity data gathered at the stationary source or at a local meteorological station.

†† If installations are using the RMP Off site Consequence Analysis Guidance, temperature and humidity of 25 degrees Celsius and 50 percent, respectively, can be used.

∮ Use urban or rural as appropriate.

‡ Models/tables need to account for gas density.

3.1.4 Define quantities released. The worst-case release quantity of the flammable or toxic chemical is determined based on the amount present which could be involved in a single catastrophic release. This includes the greatest amount in process piping and storage vessels.

3.2 Select scenario for RMP submission. In addition to providing emergency planning and response information, the worst-case release scenario is used to determine the compliance requirements for the individual covered processes at an installation. A "no-impact" worst-case release scenario for a covered process which has had no accidents within the previous 5 years would be termed a "Program Level 1" process and compliance requirements would be minimal. The EPA does not require that a worst-case analysis be submitted in the RMP for every covered process and listed chemical that exceeds a threshold. The EPA requires the following scenarios be submitted:

For Program Level 1:
- One worst-case release scenario for each covered process.

For Program Levels 2 and 3:
- One worst-case release scenario for the listed toxic chemical having the greatest radius of impact on the public. (This can be viewed as the "worst"-worst-case.)
- One worst-case release scenario for the listed flammable substance having the greatest radius of impact on the public.
- Additional worst-case release scenarios for any toxic chemical or flammable which has a radius of impact affecting different populations.

3.3. Calculate the release rate. The actual release rate for the worst-case analysis is determined while taking into account passive mitigation (such as the case in which a chemical is stored inside a building, which would reduce the rate of release to the environment). Factors such as temperature of the release and whether the substance is a liquid or gas are taken into account.

3.4 Determine distance to endpoint (modeling). Distances to the endpoint will determine the worst-case "area of concern." This can be visualized as a circle drawn on a map with the release point at the center of the circle. The parameters determined above are used as inputs to equations, look-up tables, or computer models to determine the distance.

USACHPPM Recommends

Because the worst-case release scenario is used to determine Program Level eligibility, and;

Because worst-case analysis costs are not critically dependant on the number of scenarios analyzed, and;

Because flammable worst-case analysis is a matter of a few mathematical equations rather than computer modeling using topographic and meteorological data,

USACHPPM recommends that, in most cases, all toxic chemicals and flammables in all covered process be analyzed for worst-case releases for the purposes of the installation Risk Management Program documentation. However, USACHPPM recommends that only the required scenarios be submitted to the EPA in the RMP, since multiple worst-case analyses will not provide any further emergency planning information. Determination of the scenario (s) to be submitted to EPA can be made after determining what relevant information should be provided to the emergency planning and response authorities. Also, decisions may be made as to whether submission of additional analyses is necessary .

Some situations may exist which do not require comprehensive analysis (such as tank farms). Such situations should be clearly documented in the installation's Risk Management Program documentation.

3.4.1 Flammables. The area of concern for flammables is determined using a set of equations. The EPA guidance shows how this is done in a step-by-step fashion for flammable releases.

3.4.2 Toxic chemicals. There are two methods of determining the distance to the endpoint for toxic chemicals. The EPA guidance has look-up tables which can be used to determine distance. These tables are conservative and will most likely give larger areas of concern than air dispersion computer models. The EPA has not proscribed computer models for determining distance. Instead, they have allowed use of any model which is publicly available and generally accepted for use.

USACHPPM Recommends

Air dispersion modeling is a complex task in which experience and expertise are advisable. The results from model to model can vary significantly depending on the parameters and data used to develop and validate the model. As such, USACHPPM recommends the following approach for the air dispersion modeling:

1) The EPA look-up tables provided in the Off site Consequence Analysis Guidance (Appendix E) should be used as a screening tool. If the tables show that there is no offsite impact, then further distance determination is not required.

2) For cases where the look-up tables indicate an off site impact, air dispersion modeling should be used. The USACHPPM recommends "ALOHA", an emergency response model developed by the EPA for determining release footprints. Since this model is familiar to the emergency planners, results would be easily accepted. A limitation to ALOHA is that it models impact radii of no greater than 10 kilometers. Therefore ALOHA would not apply when a greater radius is anticipated. For alternative models, it is recommended that installations require EPA approved air dispersion models. These models can be found on the EPA Technology Transfer Bulletin Board System and are available free of charge.

NOTE: Some technical service providers recommend that dispersion or emergency response computer models be developed for complying with the Section 112(r) regulation. The USACHPPM is unaware of any situations which require model development. Installations should contact the USACHPPM or AEC if they believe new modeling is required.

3.5 Results. The results from the worst-case release analysis should include all required information for the RMP submission. Appendix A contains the required data elements for a toxic chemical and flammable worst-case release. Most of the information required for the RMP submission has been discussed above. Only the results from the modeling need to be discussed in the results section. This includes the distance, population, and receptor information.

3.5.1 Distance to endpoint. The modeling distance determined to the endpoint must be described and explained. It is strongly recommended that a map of the area be included, with shaded areas of concern. The map should be of sufficient scale so that the area of concern is easily discernable.

3.5.2 Population affected. The populations affected are those within the area of concern. Census data can be used to define this population. The EPA suggests, and USACHPPM concurs, that LandView be used to determine population affected. LandView is an electronic publication of environmental, geographic and demographic information which is available free of charge on the Internet.

3.5.3 Public receptors. The presence of schools, hospitals, other institutions, public arenas, recreational areas, and large commercial and industrial developments located within this circle must be noted in the RMP. However, the number of people occupying these locations need not be determined. Street maps depicting the appropriate areas will identify these receptors and can usually be obtained from the local library.

3.5.4 Environmental receptors. The presence of environmental receptors within the area of concern must also be noted in the RMP. Maps depicting the area will help identify these receptors. The EPA has defined environmental receptors as natural areas such as national or state parks, forests, or monuments, officially designated wildlife sanctuaries, preserves, or refuges, and federal wilderness areas that can be exposed to an accidental release. All of these can be identified on local U.S. Geological Survey (USGS) maps or maps based on USGS data.

Technical Section 4 - Coordination with Local Emergency Planning and Response Agencies

Installations which perform Program Level 1 requirements for a covered process must coordinate with Local Emergency Planning and Response Agencies.

Checklist for Determining Report Completeness Coordination with Local Emergency Planning and Response Agencies.
_____ 4.1 Coordination with Local Emergency Planning and Response Agencies.

4.1 Coordination with Local Emergency Planning and Response Agencies. The EPA did not proscribe specific actions to meet this requirement but is instead relying on the National Response Team's Integrated Contingency Plan Guidance. This would ensure that emergency planning is performed in a manner which will satisfy the requirements of Section 112(r) and not cause overlapping or duplicated requirements. The USACHPPM is currently investigating Army response and actions intended for the one-plan requirements and will update any specific Section 112(r) guidance with the final version of this document.

USACHPPM Recommends

Although higher headquarters will offer guidance to Army emergency responders (e.g., fire department personnel), USACHPPM recommends that installations write a letter to their Local Emergency Planning Committee (LEPC) informing them that they have Section 112(r) listed chemicals above threshold amounts and will be complying with Program Level 1 requirements. Installations should indicate their willingness to coordinate with the local emergency responders. It is strongly advised that this letter be coordinated, or even sent by, the onsite fire department. Inclusion of this letter in the final Risk Management documentation will be sufficient to satisfy the requirement in this section.

Technical Section 5 - Certification Statement

Installations which perform Program Level 1 requirements for a covered process must submit a certification statement with the RMP.

Checklist for Determining Report Completeness Certification Statement
_____ 5.1 Certification Statement for a Program Level 1 process.

5.1 Certification Statement. According to the regulation (§68.12(b)(4)) this statement is:

> *"Based on the criteria in 40 CFR 68.10, the distance to the specified endpoint for the worst-case accidental release scenario for the following process(es) is less than the distance to the nearest public receptor: [list process(es)]. Within the past five years, the process(es) has (have) had no accidental release that caused offsite impacts provided in the Risk Management Program Rule (40 CFR 68.10(b)(1)). No additional measures are necessary to prevent offsite impacts from accidental releases. In the event of fire, explosion, or a release of a regulated substance from the process(es), entry within the distance to the specified endpoints may pose a danger to public emergency responders. Therefore, public emergency responders should not enter this area except as arranged with the emergency contact indicated in the RMP. The undersigned certifies that, to the best of my knowledge, information, and belief, formed after reasonable inquiry, the information submitted is true, accurate, and complete. [Signature, title, date signed]."*

Technical Section 6 - Management System

The EPA stresses that successful accident prevention must begin with top management awareness. A comprehensive management system must be demonstrated which shows that preventing accidents is a command priority.

Checklist for Determining Report Completeness Management System
_____ 6.1 Management system has been documented.
_____ 6.2 Qualified person or position is identified to implement Section 112(r).
_____ 6.3 All elements of Section 112(r) program are assigned to persons or positions.

6.1 Management system has been documented. The regulation requires that a management system be developed to oversee the implementation of the Risk Management Program elements. The EPA does not define the term "management system"; however, in the preamble to the Section 112(r) regulation, EPA defined their approach to a comprehensive management system as follows:

> *"[The EPA] emphasizes the importance of management and management commitment for two reasons. First, without management commitment and an integrated system for managing process safety, it is unlikely that safety will be consistently recognized as a priority. Second, although for some facilities better or different technologies may be the most effective methods of addressing hazards, the technologies, by themselves, cannot ensure safety. Equipment must be maintained and workers trained in its proper uses. Changes in the process or procedures may affect the safe operation of technologies. Only with an integrated management system that continually evaluates the safety of a facility can the hazards posed by regulated substances be managed to minimize the likelihood of accidental releases."*

6.2 A Qualified person or position is identified to implement Section 112(r). A qualified person or position must be assigned that has the overall responsibility for development, implementation, and integration of the program.

6.3 All elements of Section 112(r) program are assigned to certain persons or positions. Individuals or positions responsible for implementation of specific parts of the regulation must be documented and lines of authority defined through an organizational chart or similar document.

USACHPPM Recommends

To meet the requirements of a management system, USACHPPM recommends that:

1) Installations document existing accident prevention mechanisms and practices to ensure that the command is aware of environmental and safety issues. (In many cases command awareness would involve the Environmental Quality Control Committee (EQCC)). Safety regulations do not need to be reproduced in the document but should be incorporated by reference. Safety meetings involving employees who operate the covered process should also be noted in this section. If possible, examples of minutes from the safety meetings should be included.

2) A memorandum or charter be created with the EQCC Chairman's signature authorizing the office with responsibility for RMP implementation.

3) An RMP organization chart be created to define roles and responsibilities for implementation. This chart should be accompanied with explanatory text.

Technical Section 7 - Alternative Release Scenario Analysis

The alternative release scenario analysis allows preparation and planning for release events which are more likely to occur. Requirements for modeling and for results are the same as those for worst-case analysis, except that active mitigation and reduced release rates are taken into account. Reference to the worst-case modeling and results section of the report may be made, and only any deviations and justifications as required, need be listed in this section. For example, justification of the air dispersion model selected for the alternative release scenario would be unnecessary if it is the same justification made for the worst-case release analysis.

Checklist for determining Report Completeness
Alternative Release Scenario Analysis

_____ 7.1 Define alternative release case(s)

- _____ 7.1.1 Define alternative release event(s)
- _____ 7.1.2 Define endpoints
- _____ 7.1.3 Define meteorological conditions
- _____ 7.1.4 Define quantities released

_____ 7.2 Select scenario for RMP submission

_____ 7.3 Calculate release rate

_____ 7.4 Determine distance to endpoint

- _____ 7.4.1 Flammables
- _____ 7.4.2 Toxic chemicals

_____ 7.5 Results

- _____ 7.5.1 Distance to endpoint
- _____ 7.5.2 Population affected
- _____ 7.5.3 Public receptors
- _____ 7.5.4 Environmental receptors

7.1 Define alternative release case.

7.1.1 Define alternative release event. The EPA has mandated that the following conditions be considered *at a minimum* in determining the alternative case (note that some will not be applicable to all processes):

7.1.1.1 Transfer hose releases due to splits or sudden hose uncoupling.
7.1.1.2 Process piping releases from failures at flanges, joints, welds, valves and valve seals, and drains or bleeds.
7.1.1.3 Process vessel or pump releases due to cracks, seal failure, or drain bleed, or plug failure.
7.1.1.4 Vessel overfilling and spill, or overpessurization and venting through relief valves or rupture disks.
7.1.1.5 Shipping container mishandling and breakage or puncturing leading to a spill.

7.1.2 Define endpoints. As determined for the worst-case release.

7.1.3 Define meteorological conditions. The EPA defaults used for the worst-case release analysis can be used. If different, more prevalent, conditions are selected then they should be justified.

7.1.4 Define quantities released. The release quantity from the alternative release analysis should be justified here. The alternative release quantity should be less than or equal to the worst-case value. Note that active mitigation systems will reduce the quantity released, provided that the system can withstand the event which triggered the accident in the first place.

7.2 Select scenario for RMP submission. The following scenarios are required for submission to EPA in the RMP:

- One alternative case release scenario to represent all flammables
- One alternative case release scenario for each toxic chemical at the installation.
- Additional worst-case release scenarios for any toxic chemical or flammable which has a radius of impact different from the one listed above.

7.3. Calculate the release rate. As discussed for the worst-case release.

7.4 Determine distance to endpoint (modeling). As discussed for worst-case.

7.5 Results. The results from the alternative case release analysis should include all required information for the RMP submission. As with the worst-case release results section, only the results from the modeling need to be discussed. This includes the following:

7.5.1 Distance to endpoint.
7.5.2 Population affected.
7.5.3 Public receptors.
7.5.4 Environmental receptors.

Large military installations usually have a comprehensive community and emergency service system. Because of this, compliance with the RMP Emergency Response Program is most likely a matter of coordination and documentation rather than of program development. Post Fire Departments are usually (if not always) a member of the local community response network with mutual aid agreements in place to assist or be assisted by other fire departments. Emergency response personnel comply with major regulations (such as the Risk Management Program) and with other Directorates/Divisions that require emergency service planning. Emergency response procedures for Army fire departments follow the guidelines published by the U.S. Department of Transportation: 1996 North American Emergency Response Guidebook. Requirements for the Army fire departments are defined by Army Regulation (AR) 420-90 which itself adopts the National Fire Protection Association (NFPA) codes for operation. Other guidelines are listed in Appendix F.

Military installations are usually required to develop Installation Spill Contingency Plans (ISCPs) and Spill Prevention, Control, and Countermeasures Plans (SPCCPs). These plans are legal requirements as installation regulations and may be used to satisfy RMP requirements.

Checklist for determining Report Completeness
Emergency Response Program

_____ 8.1 Emergency Response Plan is in Place

- _____ 8.1.1 Notification of public and local emergency response agencies
- _____ 8.1.2 Documentation of first-aid and emergency medical treatment
- _____ 8.1.3 Procedures and measures for response after release

_____ 8.2 Inspection, testing, and maintenance of emergency response equipment
_____ 8.3 Training for all employees in relevant procedures
_____ 8.4 Procedures to review emergency response plan

8.1 Emergency Response Plan is in Place.

8.1.1 Notification of public and local emergency response agencies. Fire department procedures contain notification requirements and practices to be followed in the case of a release of hazardous materials.

8.1.2 Documentation of first-aid and emergency medical treatment.

8.1.3 Procedures and measures for response after release. The procedures used by on-post personnel concerning measures taken after a release must be documented.

8.2 Inspection, testing, and maintenance of emergency response equipment. The NFPA codes and AR 420-90 list activities involved with the proper care of response equipment.

8.3 Training for all employees in relevant procedures. To be determined later. The USACHPPM has not yet determined the meaning of the regulatory requirement for **ALL** employees to be trained.

8.4 Procedures to review emergency response plan. Emergency response plans are reviewed by the Emergency Service and other personnel on an as needed or as required basis. Specifically, the ISCP/SPCCP is updated every three years as required under 40 CFR 112.

Technical Section 9 - Process Safety Information

The installation must compile up-to-date safety information for each covered process so that operators can identify and understand the hazards which may be associated with the substances used or produced by the process.

Checklist for Determining Report Completeness
Process Safety Information

______ 9.1 Hazards of the regulated substance

- ______ 9.1.1 Toxicity of Substance
- ______ 9.1.2 Permissible exposure limits
- ______ 9.1.3 Physical data
- ______ 9.1.4 Reactivity data
- ______ 9.1.5 Corrosivity data
- ______ 9.1.6 Thermal and chemical stability data
- ______ 9.1.7 Effects of inadvertent mixing

______ 9.2 Technology of the process

- ______ 9.2.1 Technology information
- ______ 9.2.2 Process chemistry
- ______ 9.2.3 Inventory information
- ______ 9.2.4 Safe operating limits and consequences of deviation

______ 9.3 Process equipment

- ______ 9.3.1 Process equipment description and materials of construction
  - ______ 9.3.1.1 Piping and instrumentaion diagrams (P&ID's)
  - ______ 9.3.1.2 Electrical classification
- ______ 9.3.2 Relief system design
- ______ 9.3.3 Ventilation system design
- ______ 9.3.4 Design codes and standards
- ______ 9.3.5 Material and energy balances
- ______ 9.3.6 Safety system information
- ______ 9.3.7 Documentation

9.1 Hazards of the regulated substance. Concise paragraph or outline form must include detailed information regarding chemical hazards. Much of the information may be obtained from Material Safety Data Sheets (MSDSs) which meet the requirements of 29 CFR 1910.1200(g).

9.1.1 Toxicity of substance. The effects its vapors or liquid would have on the body, including effects on the skin, eyes, nose, throat, mucous membranes and any internal organs. Both short-term and possible long-term symptoms associated with chronic low level exposure, as well as acute exposure must be described. (Ex. "Chlorine gas is a severe irritant and will attack the eyes, skin.... exposure to a high concentration may cause burning of eyes, nose and mouth, coughing, choking...There does not appear to be any increase in risk of cancer...") Specific concentration values associated with symptoms must be included, if known, along with any known short or long-term environmental effects.

9.1.2. Permissible exposure limits. The current OSHA ceiling level in parts per million (ppm) of the substance over a given time period. The lowest concentration at which the substance can be detected by human senses, such as smell, must be included.

9.1.3 Physical data. A list which includes, but is not necessarily limited to boiling point (degrees F and C), freezing point (degrees F and C), solubility in water (g/100g water at 20° C), specific gravity (of gas and liquid at 32° F, 0° C), odor (pungent, sweet, etc.), vapor pressure (psig and kPa at 68° F, 20° C), vapor density (at 32° F, 0° C), appearance (color of liquid, vapors), molecular weight, flash point, flammable limits (upper and lower).

9.1.4 Reactivity data. A description of the extent of any reaction of the substance with other substances. All substances, solid, liquid, or gas, and applicable temperatures and other environmental conditions supporting reaction if available, must be listed. Any reaction with moisture must be included as well as how the substance may support reaction/combustion of other substances given certain conditions (ex. "Chlorine is not explosive but may support the combustion of acetone under certain conditions."). Any extreme conditions which may cause storage containers to burst must be mentioned, and any recommendations regarding care/cleaning materials which should or should not be used on equipment used with or around the substance must be made.

9.1.5 Corrosivity data. A list of materials, and under which environmental conditions, the substance may corrode. (Ex. "Dry chlorine, is highly corrosive in the presence of moisture.") The physical state(s) of the substance which would support corrosivity must be specified.

9.1.6 Thermal and chemical stability data. A description of the stability of each physical state of the substance is required. The conditions under which a given state will exist and the point at which the state of the substance will change as these conditions change, must be described. (Ex. "Liquid chlorine will evaporate rapidly if exposed to atmospheric conditions...") If applicable, number of volumes of gas (or liquid) which one volume of liquid (or solid) would produce upon such a change in conditions must be included. (Ex. "...and one volume of liquid will produce 460 volumes of gas.") Storage conditions in terms of how temperature affects density and pressure of the substance (i.e. does storage temperature directly affect pressure?) must be described, including any conditions (temperature, pressure, substance capacity, etc.) which may cause storage tanks to rupture.

9.1.7 Possible hazardous effects of inadvertent mixing with different materials. Effects involving all substances which will react with the given substance, including the rapidness and severity of the reaction, and the end product. Relevant quantities and ratios of substances and the state and stability of the end product must be included. (Ex. "Chlorine and hydrogen mixtures, composed of greater than 5 percent of either element, may violently react, forming hydrogen chloride.") The MSDS's may be used to comply with this requirement to the extent that they contain the required information.

9.2 Technology of the process. If original technical information no longer exists, such information may be developed in conjunction with the PHA described below. Concise paragraph form must include detailed information regarding the following:

9.2.1 Technology information. The main purpose/use of the substance and in what type of facility the associated process occurs must be documented. A comprehensive description of each step of the process operation and its end result must be provided. (Ex. "Chlorine is used at a waste or clean water treatment facility for disinfection. Gaseous chlorine is combined with treated water from the CO_2 stripping towers, using an eductor. The chlorine solution is then piped across to the entrance of the clear well distribution pumps where it is injected...") A block flow or simplified process flow diagram of the process must be included, with references made to it during the step-by-step process description.

9.2.2 Process chemistry. An equation detailing the reaction of the substance, including all its end products, along with a paragraph describing the reaction is stated here. Descriptions of any intermediate reactions and end products, or further reactions resulting from addition of excess substance must be included. (Ex. "When chlorine is mixed with water, it immediately dissolves to form hypochlorous acid and hypochlorites... if excess chlorine is added to the process, the reaction will continue with ammonia or other nitrogenous compounds to produce chloramines...") Any reaction conditions which enable the process to be most effective and efficient must be specified.

9.2.3 Maximum intended inventory. The maximum onsite storage capacity of the plant or facility for the given substance. Storage capacity of any storage rooms or buildings at the process site must be included, as well as the amount of substance or size tank which is normally operational (hooked up to the process) or on standby, ready to be placed on-line. The maximum amount of substance stored onsite at any time during normal operations must be stated.

9.2.4 Safe operating limits and consequences of deviation. Conditions based on temperature, pressure, flows, etc. (include specific values if possible) which allow for safe chemical storage and process operation, and the consequences if these specific conditions are not met. Daily substance usage amounts, ranges of normal operating flow rates, and maximum plant flow rate capacity, must be included, along with impacts on human safety and the environment should these amounts and rates change. (Ex. "Chlorine cylinders should never be stored in sunlight, and should the temperature exceed 130° F, there is the potential for explosive release. Maximum rated capacity of the chlorinators is 500 lbs/day. An increase in the chlorine amounts used for disinfection will not affect the safety of the employees, but will affect the quality of water discharged into the sound.")

9.3 Process equipment. Concise paragraph form must include detailed information regarding the following:

9.3.1 Equipment description and materials of construction. Description of basic pieces of equipment and materials crucial to operation of the process. Any standards and design codes according to which equipment and piping are installed must be specified. Weight, size, construction, configuration (any special valves, plugs, etc.) and storage position of storage containers must be described, along with any specific storage safety requirements. (Ex. "Chlorine storage cylinders are constructed of stainless steel, are approximately 80 inches long by 30 inches wide, and may weigh up to 3,700 lbs, when full. They contain openings for fusible plugs and valves. Care should be taken not to disturb the plugs... The cylinders are stored on their sides, above ground on concrete pads...") Any recommended procedures or tools for connection/disconnection of containers to/from the system must also be mentioned. The purpose, step-by-step function, and any if-then relationships of each piece of equipment must be described, including valves, gauges, gaskets, tubing etc., and any specific values of length, pressure, temperature, etc. This description would include situations in which certain pieces of equipment would not be used. Materials of which equipment is constructed (PVC, copper, etc.) must be specified. (Ex. "The vacuum regulator controls the flow of chlorine gas from the cylinder to the chlorinator... gas under pressure enters the stainless steel regulator...these valves will not open unless a minimum operating vacuum is introduced... If the second valve happens to fail, a pressure relief vent will allow the gas to flow out... the gas supply pressure is rated at 15 to 120 psi... flexible metal tubing connects the valve to the cylinder...")

9.3.1.1 P&ID's. Detailed process piping and instrumentation diagrams (P&ID's) which depict piping sizes and materials and the status of valve positions must be included.

9.3.1.2 Electrical classification. If applicable electrical classification must be included.

9.3.2 Relief system design and basis. Specific systems and their functions designed to handle excess pressure build up by controlling the release of the substance. The locations, interrelationships, and functions of any venting, piping, or valve systems must be described in detail, including the actual relief process, where the substance will be routed, and how any required neutralization of the substance is performed. This includes a description of any specific situations in which such relief systems may be utilized. (Ex. "The relief system consists of vent lines connected to the chlorinator units which will vent chlorine gas to the atmosphere in case the regulator vacuum valves fail to open.")

9.3.3 Ventilation system design. A depiction of the entire process ventilation system. The type, number, and location of each piece of ventilation equipment in each room or space of the facility, and the air exchange rate of the equipment must be described. An estimate of air exchange that would be necessary in the case of an emergency leak must also be included. Locations of switches and fresh air inlets must be described, and any opinions given regarding the efficiency of ventilation in any given areas. (Ex. "The chlorinator room contains two exhaust fans which are each rated at 105 cubic feet per minute and release into the chlorine cylinder storage area. The intake is located close to the floor by the door and does not provide good cross ventilation.")

9.3.4 Design codes and standards. Standards and design codes according to which equipment and systems are installed and operated. These standards and codes must be specified and documentation made that equipment complies with recognized and generally accepted good engineering practices.

9.3.5 Material and energy balances. For processes built after June 20, 1999. The relationship of turnover rate of the substance (amount per day) to amount of desired end product must be briefly described, including the amount or concentration of residual substance. (Ex. "Chlorine gas flows to the chlorinator at a rate of 40 lbs/day. The chlorine is then combined with water at a concentration of 1.25 ppm. The residual chlorine concentration is approximately 0.4ppm.")

9.3.6 Safety systems. In and around process plants and facilities. The following detailed list is necessary for each room or space in the facility: the number, locations of, and procedures and occasions for use of all safety related equipment such as substance sensors and alarms, distress alarms, general operator alarms, personal protective gear (goggles, coveralls, boots, gloves, self-contained breathing apparatus (SCBAs), etc.), eyewash and shower stations, and fire fighting equipment (including sprinkler systems). The protective gear required for use by operators must be specified, along with the safety equipment operations in which they are required to be trained. Certification must be made that MSDSs, hazardous chemical information stations, and first aid kits are available and accessible and their locations stated. The locations of all substance danger signs must be specified.

9.3.7 Documentation. The installation must prepare a document certifying that all equipment complies with recognized and generally accepted good engineering practices. For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, documentation must be made that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

Technical Section 10 - Process Hazard Analysis (PHA)

A designated team must perform this initial analysis on all covered processes to identify, and suggest control measures for potential process hazards. The order of priority for conducting the analyses is based on hazard severity or extent, number of potentially affected employees, process age, and process operating history. These analyses must be conducted by June 20, 1999. Analyses completed to comply with 29 CFR 1910.119(e) are acceptable and must be updated and revalidated, based on their completion date. PHA's must be retained for the life of the process.

Checklist for Determining Report Completeness
Process Hazard Analysis (PHA)

_____ 10.1 PHA methods

- _____ 10.1.1 What-if analysis
- _____ 10.1.2 Checklist
- _____ 10.1.3 What-if/checklist
- _____ 10.1.4 Hazop study
- _____ 10.1.5 Failure Mode and Effects Analysis (FMEA)
- _____ 10.1.6 Fault Tree analysis

_____ 10.2 PHA team

_____ 10.3 Content of a PHA

- _____ 10.3.1 Process hazards
- _____ 10.3.2 Previous incidents
- _____ 10.3.3 Engineering and administrative controls
- _____ 10.3.4 Consequences of failure
- _____ 10.3.5 Facility siting issues
- _____ 10.3.6 Human errors
- _____ 10.3.7 Control failure

_____ 10.4 PHA Update and revalidation

_____ 10.5 PHA Documentation system

- _____ 10.5.1 Findings and recommendations
- _____ 10.5.2 Resolution measures
- _____ 10.5.3 Future actions
- _____ 10.5.4 Actions communicated to employees

10.1 PHA methods. One or more of the following methods are applicable and must be used to perform PHA's:

10.1.1 What-if analysis. Consists of questions such as "what if pump X breaks down...".

10.1.2 Checklist. Includes a list of items which can go wrong in process operations or equipment.

10.1.3 What-if/checklist. Is a combination of the above two items.

10.1.4 Hazop study. Is the most popular method used by petroleum and chemical industries. A multi-disciplinary team is used to identify consequences of deviations of process parameters.

10.1.5 Failure Mode and Effects Analysis (FMEA). Tabulates each system or unit of equipment with its failure modes, its effects of failure on the whole system, and how critical is to the system. A ranking is then performed to determine which units are most likely to cause a serious accident.

10.1.6 Fault Tree analysis. A formalized deductive technique that works backward from an accident to identify the root cause of an accident.

10.2 PHA team. The PHA team must consist of individuals with expertise in process engineering and operations. It must include at least one employee who has experience and knowledge specific to the process being evaluated and one individual experienced in the analysis method being used.

10.3 Content of a PHA. A PHA must address the following in concise paragraph form:

10.3.1 Process hazards.

10.3.2 Previous incidents. Any previous incident which had a potential for catastrophic consequences.

10.3.3 Engineering and administrative controls.

10.3.4 Consequences of failure. Consequences of failure of the above controls.

10.3.5 Facility siting issues.

10.3.6 Potential for human errors.

10.3.7 Control failure. Possible safety and health effects of control failure.

10.4 PHA update and revalidation. A team, as described above, must update and revalidate the PHA every five years. This is to ensure that the analysis is consistent with the current process. Updated and revalidated PHA's to comply with 29 CFR 1910.119(e) are acceptable. All updates must be retained for the life of the process.

10.5 PHA documentation system. The installation must provide written documentation of a system which is in place and retained for the life of the process, which ensures the following:

10.5.1 Findings and recommendations are promptly addressed.

10.5.2 Resolution measures are recorded.

10.5.3 Future actions. Future actions are documented and scheduled for expedient completion.

10.5.4 Actions are communicated to employees. Such actions are communicated to applicable employees who may take part in, or be affected by these actions or recommendations.

Technical Section 11 - Operating Procedures

Written procedures must be documented which provide clear instructions for safely operating each covered process. These should be consistent with the information contained in the process safety section of the report. These operating procedures should be readily accessible to employees working at and around the process. Safe work practices must also be implemented for employees and contractor employees in order to control hazards. These include lockout/tagout, confined space entry, opening process equipment or piping, and control over entrance into a facility by regular employees, maintenance, contractor, laboratory, or other support personnel.

Checklist for Determining Report Completeness
Operating Procedures

_____ 11.1 Steps for each operating phase

- _____ 11.1.1 Initial startup
- _____ 11.1.2 Normal operations
- _____ 11.1.3 Temporary operations
- _____ 11.1.4 Emergency shutdown
  - _____ 11.1.4.1 Conditions under which emergency shutdown is required
  - _____ 11.1.4.2 Assignment of shutdown responsibility to qualified operators
- _____ 11.1.5 Emergency operations
- _____ 11.1.6 Normal shutdown
- _____ 11.1.7 Startup following a turnaround

_____ 11.2 Operating limits

_____ 11.3 Consequences of deviation and steps to prevent or correct

_____ 11.4 Safety and health considerations

_____ 11.5 Safety systems and their functions

11.1 Steps for each operating phase. Detailed steps for each operating phase of the process must be described in concise, numbered paragraphs and must be included for the following operating phases:

11.1.1 Initial startup. Each step must be detailed and must emphasize safety precautions pertinent to that step, such as ensuring the chemical tank/cylinder is properly hooked up, that inspection for potential leakage has been performed, that any other applicable pieces of equipment or configurations are in place, etc. Any potential results due to a step being improperly followed or a malfunction occurring, must be described. (Ex. "Check for chlorine leakage using an ammonia bottle. A white vapor will appear if chlorine is present in the atmosphere.") Cite any standing operating procedures (SOPs) or official instructions relevant to each step.

11.1.2 Normal Operations. All routine operations must be described in detail for each process. (Ex. Operations for the water treatment process: "Delivery and Hoist Operation Procedures, Procedure for Removal and Connection of Chlorine Cylinders, ...") Each step must be detailed such that an inexperienced worker could conceivably and competently complete the operation. Emphasis must be placed on safety precautions, including any necessary review of applicable SOPs, instructions, MSDSs, etc. Responsibilities of, and specific procedures performed by each involved employee, including contractor employees or outside employees (truck drivers etc.), must be included.

11.1.3 Temporary operations. These operations include those associated with non-routine events such as power failure, a shut down of a piece of machinery, any temporary change in procedure or materials, etc. Each step must be described in detail for each operation with emphasis on safety, and with appropriate references to relevant documents.

11.1.4 Emergency shutdown. These operations would occur in response to an unexpected situation which threatens the safety of employees or the public, or which threatens the environment or the integrity of equipment and the facility. All steps must be described in detail, to include situation assessment, preliminary precautions and steps, and "if-then" procedures, with emphasis on safety and clear warnings regarding actions not to be taken. (Ex. "The buddy system in which both operators are wearing SCBAs will be in effect... If the leak occurred at the cylinder, turn the gas discharge valve to the OFF position... Do not pour water on a leaking chlorine container because...") In the case of a crisis emergency situation, in which a large spill or leak has occurred as the result of an earthquake, fire, or other catastrophic event, specific steps regarding evacuation and notification of appropriate officials and agencies must be documented. Appropriate references to relevant documents must be made.

11.1.4.1 The conditions under which emergency shutdown is required, must be described.

11.1.4.2 Shutdown responsibility must be assigned to qualified operators to ensure that emergency shutdown is executed in a safe and timely manner.

11.1.5 Emergency operations. These operations include those associated with unexpected events during which a complete shut down of the process is unnecessary, such as those listed in 10.1.3 above. Each step must be described in detail for each operation with emphasis on safety, and with appropriate references to relevant documents.

11.1.6 Normal shutdown. These operations are associated with routine shutdown of equipment or the process. Each step must be described in detail for each operation with emphasis on safety, and with appropriate references to relevant documents.

11.1.7 Startup following a turnaround or after an emergency situation. These operations occur during non-routine startup of equipment or startup of the process following a non-routine, unexpected, or emergency event which required shutdown. Each step must be described in detail for each operation with emphasis on safety, and with appropriate references to relevant documents.

11.2 Operating limits. As in 8.2.4 of Process Safety Information, concise paragraph form must describe all operating limits for each covered process. Parameters such as maximum storage temperatures for chemicals, maximum daily flow rates, pressure values, concentration values, etc. must be included.

11.3 Consequences of deviation and steps to prevent or correct. As in 8.2.4 of Process Safety Information, a paragraph must describe the consequences of deviation from the operating limits, such as safety or environmental hazards, and steps to prevent or correct such consequences. (Ex. "Storage cylinders should never be stored in sunlight or in an area where the container temperature could exceed 130° F. Should the temperature exceed this value, there is potential for explosive release which could result in...")

11.4 Safety and health considerations. As in 9.1.1 of Process Safety Information, concise paragraph form must include detailed information regarding the effects of the substance vapors or liquid on the body, including effects on the skin, eyes, nose, throat, mucous membranes and any internal organs. Both short-term and possible long-term symptoms associated with chronic low level exposure, must be described, as well as acute high level exposure. (Ex. "Chlorine gas is a severe irritant and will attack the eyes, skin.... exposure to a high concentration may cause burning of eyes, nose and mouth, coughing, choking...") Specific concentration values associated with symptoms, if known, must be indicated. Also, detailed steps for the immediate treatment or mitigation of exposure symptoms for each possible exposure type, including specific actions not to be taken, must be provided, along with steps in the notification of appropriate emergency or health personnel. (Ex. "In the case of eye contact, immediately flush the exposed eye with low pressure water, continue flushing for 15 minutes... call for a physician... in the case of skin contact... do not apply lotions or oils to burned areas... in the case of inhalation...") In addition, precautions necessary to prevent exposure, including engineering and administrative controls, and personal protective equipment must be listed. Other considerations include a description of quality control for raw materials, control of hazardous chemical inventory levels, and any other special or unique hazards.

11.5 Safety systems and their functions. As in 8.3.6 of Process Safety Information, the following detailed list is necessary for each room or space in the facility: the number, locations of, and procedures and occasions for use of all safety related equipment such as substance sensors and alarms, distress alarms, general operator alarms, personal protective gear (goggles, coveralls, boots, gloves, SCBAs, etc.), eyewash and shower stations, and fire fighting equipment (including sprinkler systems). The protective gear required for wear by operators must be specified, along with the safety equipment operations in which they are required to be trained. Certification must be made that MSDSs, hazardous chemical information stations, and first aid kits are available and accessible and their locations stated. The locations of all substance danger signs must be specified.

Technical Section 12 - Training

Training of all employees involved in the process operations, including maintenance, must be performed and documented.

Checklist for Determining Report Completeness Training
_____ 12.1 Documentation of training
_____ 12.2 Initial training
_____ 12.3 Refresher training

12.1 Documentation of training. This must include the employee's name, the date of training, and the means used to verify that the employee understood the training (i.e., a practical test, observation, etc.)

12.2 Initial training. Each employee who is presently involved in process operations or who is newly assigned to a process must be trained in an overview of the system and system standing operating procedures. This training will emphasize health and safety hazards, emergency operations and shutdown procedures, and employee-specific safe work practices. Written certification in lieu of initial training may be prepared in the case of an employee already involved in process operations prior to June 20, 1999. This would state that the employee has the required knowledge, skills and abilities to safely carry out the duties and responsibilities as specified in the operating procedures.

12.3. Refresher training. This must be provided at least every three (3) years to ensure that employees involved in process operations understand and comply with the current operating procedures of the process. The installation, after consultation with the employee, must determine the appropriate frequency of refresher training.

Technical Section 13 - Mechanical Integrity

This section applies to all process pressure vessels and storage tanks, piping systems and components (including valves), relief devices and vent systems, emergency shutdown systems, controls (monitoring devices, sensors, alarms, interlocks, etc.), and pumps. The following requirements apply to ensure sound mechanical integrity in all processes.

Checklist for Determining Report Completeness
Mechanical Integrity

_____ 13.1 Written maintenance procedures

_____ 13.2 Maintenance training

_____ 13.3 Equipment inspection and testing

- _____ 13.3.1 Description of the inspection or test
- _____ 13.3.2 Equipment description including serial number
- _____ 13.3.3 Date of the inspection or test
- _____ 13.3.4 Name of the employee who performed the service
- _____ 13.3.5 Results of the inspection or test

_____ 13.4 Equipment deficiencies

_____ 13.5 Quality assurance

13.1 Written maintenance procedures. These are required to maintain the on-going integrity of process equipment. They include detailed steps involved in the maintenance of parts and equipment applicable to process operations. Manufacturer's handbooks may be used to outline maintenance procedures.

13.2 Maintenance training. Each employee involved in the maintenance of process equipment must be trained in an overview of the process and its hazards, as well as in procedures applicable to the employee's job tasks to assure that the job is performed in a safe manner.

13.3 Equipment inspection and testing. This is to be performed on all process equipment. The frequency must be at least consistent with applicable manufacturers' recommendations and good engineering practices. Inspection and testing may be performed more frequently if deemed necessary by prior operating experience. The installation must keep a maintenance schedule which lists frequency of inspection and maintenance of equipment and parts, along with records which document the following:

13.3.1 A description of all inspections and tests performed on process equipment.
13.3.2 A description of the equipment, including serial number or other identifier.
13.3.3 The date of the inspection or test.
13.3.4 The name of the employee who performed the service.
13.3.5 The results of the inspection or test.

13.4 Equipment deficiencies. Deficiencies should be corrected prior to further use of process equipment, or in a timely manner provided necessary means are available for safe operation of equipment. A brief description of which equipment, if any, is deficient or requires correction, is required, along with the status of the applicable process operation in light of this deficiency. The status of the correction is also required.

13.5 Quality assurance. As new plants and equipment are constructed, the installation must perform checks and inspections on the equipment, including maintenance material and spare parts. This is to ensure that it is suitable for its corresponding process operation, is properly installed, and is consistent with design specification and manufacturers' instructions.

Technical Section 14- Management of Change

This is a key element in the prevention of accidents and the preservation of employee safety. Major accidents can and have occurred, often due to subtle changes in operating procedures (written procedures become out-of-date), temporary operations outside the normally specified limits, system technology that has not been reviewed and found safe, operations outside the safe boundaries of previously reviewed parameters, and replacement of equipment which is not "replacement-in-kind" (e.g., replacement part is identical to original) of original safe equipment. The installation is therefore required to document that a proposed change is technically sound and does not result in employee health and safety hazards, and that equipment will remain within the boundaries of proper operating conditions in both temporary and permanent changes. It should be noted that changes made to a process which make it inherently safer (such as replacement of outdated equipment with newer technology) do not provide an exemption to this requirement.

Checklist for Determining Report Completeness
Management of Change

_____ 14.1 Written procedures to manage changes

- _____ 14.1.1 Technical basis for the change
- _____ 14.1.2 Impact on safety and health
  - _____ 14.1.2.1 Degree of hazard
  - _____ 14.1.2.2 Significance of proposed change
  - _____ 14.1.2.3 Risk level
  - _____ 14.1.3 Modifications to operating procedures
- _____ 14.1.4 Necessary time period for the change
- _____ 14.1.5 Authorizations required for the proposed change

_____ 14.2 Employee information and training

_____ 14.3 Process safety information and operating procedures updates

14.1 Written procedures. These are required to manage changes to process chemicals, technology, equipment, and procedures, as well as to changes to stationary sources that affect a covered process. These changes do not include "replacements in kind". Prior to any change, these procedures must address the following:

14.1.1 Technical basis for the change. This includes a description of the change and a design of the change, along with any drawings, sketches, or diagrams.

14.1.2 The impact of change on safety and health. This includes an assessment of potential hazards and would involve evaluating the following using a simple checklist:

14.1.2.1 Degree of hazard (high or low), which depends on such factors as any introduction of or change in a significant source of potential chemical, mechanical, thermal, or electrical energy, any increase in inventory of toxic, flammable, or reactive materials, any involvement of thermally, chemically, or physically unstable materials in the changed process, any increase in the potential for personnel exposure to a hazardous material, or any significant negative community impact.

14.1.2.2 Significance of the proposed change (high or low), which is based on such factors as whether the change could take the process outside previous limits of normal, safe operations, whether the change would involve introduction of new molecules, whether the change would alter the sequence of operations of the process, whether the change would impact the energy or mass balance, and whether the change would alter or bypass a safety device or critical control system.

14.1.2.3 Risk level, which is assessed based on a combination of the degree of hazard (high or low) and the significance of proposed change (high or low).

14.1.3 Modifications to operating procedures. This includes a brief description of such modifications.

14.1.4 Necessary time period for the change. This includes a best estimate for the amount of time necessary to complete the change and the date the change is planned to go into effect.

14.1.5 Authorizations required for the proposed change. This includes a list of applicable personnel, officials, and/or agencies which must review and authorize the design, installation, and startup of the proposed changed process.

14.2 Employee information and training. All employees, including contract employees, whose operation or maintenance job tasks will be affected by a change in the process shall be informed of, and trained in the change, prior to startup of the changed process.

14.3 Process Safety Information and operating procedures updates. If any change in a process results in a change in the information prepared in accordance with the Process Safety Information section or the Operating Procedures section, such information and corresponding procedures must be updated accordingly.

Technical Section 15 - Pre-startup Review

This review must be performed for new and modified processes when new information is significant enough to require a change in the information prepared in accordance with the Process Safety Information section. The review is conducted after installation of the change and prior to startup, by a team composed of participants from several departments, representing a variety of skills and perspectives. A simple checklist, which includes any comments by team members is recommended. Prior to process startup, any and all applicable personnel, officials, and/or agencies must review the pre-startup review (checklist, if used) and then authorize the startup.

Checklist for Determining Report Completeness Pre-startup Review
_____ 15.1 Construction and equipment are in accordance with design specifications
_____ 15.2 Safety, operating, maintenance, and emergency procedures are in place
_____ 15.3 For new stationary sources, a PHA has been performed
_____ 15.4 Modified stationary sources meet requirements in Management of Change section
_____ 15.5 Each employee involved in operating the process has completed training

15.1 Construction and equipment are in accordance with design specification.

15.2 Safety, operating, maintenance, and emergency procedures are in place and are adequate.

15.3 For new stationary sources, a PHA has been performed and recommendations have been resolved or implemented before startup.

15.4 Modified stationary sources meet the requirements contained in the Management of Change section.

15.5 Each employee involved in operating the process has completed training.

Technical Section 16 - Compliance Audits

The installation must evaluate the procedures and operations of the stationary source at least every three years, to certify that they are in compliance with the Prevention Program. The audit should include applicable subjects from all sections discussed (a checklist is recommended).

Checklist for Determining Report Completeness Compliance Audits
_____ 16.1 Audit team
_____ 16.2 Audit report

16.1 Audit team. This must include at least one individual knowledgeable in the process technology.

16.2 Audit report. A report of the findings must be prepared, and an appropriate response to each of the findings, along with any corresponding corrective actions, must be documented. The two most recent compliance audit reports must be retained on file.

Technical Section 17 - Incident Investigation

The installation must investigate any incident which could have potentially resulted in, or actually did result in a catastrophic release of a regulated substance. This must be initiated as soon as possible, but no later than 48 hours following the incident.

Checklist for Determining Report Completeness
Incident Investigation

_____ 17.1 Investigation team

_____ 17.2 Investigation report

- _____ 17.2.1 Date of incident
- _____ 17.2.2 Date investigation began
- _____ 17.2.3 Description of incident
- _____ 17.2.4 Contributing factors
- _____ 17.2.5 Recommendations

_____ 17.3 System

17.1 Investigation team. This must include at least one person knowledgeable in the process involved and other persons with appropriate knowledge and experience to thoroughly analyze the incident.

17.2 Investigation report. This must be prepared upon conclusion of the investigation. The final investigation report will be reviewed by all employees, including contract employees, potentially affected by the incident or whose job tasks are relevant to the incident findings. The report must include the following:

17.2.1 Date of the incident

17.2.2 Date the investigation began

17.2.3 A description of the incident

17.2.4 Factors that contributed to the incident

17.2.5 Any recommendations resulting from the investigation

17.3 System. This must be developed to promptly address and resolve the report findings and recommendations, and to document resolutions and corrective actions. All incident investigation reports must be retained for a minimum of five (5) years.

Technical Section 18 - Employee Participation

The installation must consult with employees and their representatives on the conduct and development of PHAs and of other elements covered in the Prevention Program. They must make such information available to employees.

Checklist for Determining Report Completeness Employee Participation
_____ 18.1 Written plan of action

18.1 Plan of action. This would implement employee participation and must be developed by the installation.

Technical Section 19 - Hot Work Permit

The installation must issue hot work permits for any hot work operations, such as welding, conducted on or near a covered process.

Checklist for Determining Report Completeness
Hot Work Permit

_____ 19.1 Hot work permit is issued and documents:

- _____ 19.1.1 Authorized date (s)
- _____ 19.2.2 Object
- _____ 19.2.3 Fire prevention and protection requirements have been implemented

_____ 19.2 Permit on file until work is completed

19.1 This permit must document the following:

19.1.1 The authorized date (s) for the work.

19.1.2 The object on which the work is to be performed.

19.1.3 That the fire prevention and protection requirements in 29 CFR 1910.252(a) have been implemented.

19.2 The permit must be kept on file until the hot work is completed.

This applies to contractors performing maintenance or repair, turnaround, major renovation, or specialty work on a covered process; not to contractors providing incidental services such as janitorial, food, or delivery services, etc. which do not influence process safety. **NOTE: Installation CO and COR's must be aware of this section of the rule if any applicable contracts are being managed.**

Checklist to Determine Report Completeness
Contractors

_____ 20.1 Process owner/operator responsibilities

- _____ 20.1.1 Evaluate contractor's safety performance and programs
- _____ 20.1.2 Inform the contractor of hazards
- _____ 20.1.3 Explain to the contractor Emergency Response provisions
- _____ 20.1.4 Implement practices to control contractors' entrance, presence, and exit
- _____ 20.1.5 Evaluate contractor performance
- _____ 20.1.6 Keep records of work related injuries or illnesses

_____ 20.2 Contractor responsibilities

- _____ 20.2.1 Ensure each employee is trained and training is documented
- _____ 20.2.2 Inform employees of hazards
- _____ 20.2.3 Instruct employees in Emergency Response provisions
- _____ 20.2.4 Ensure employees follow safety rules, including Operating Procedures provisions
- _____ 20.2.5 Inform the owner/operator of hazards found or created by work

20.1 The installation has the following responsibilities:

20.1.1 Obtain and evaluate information regarding the contractor's safety performance and programs, prior to selecting a contractor.

20.1.2 Inform the contractor of any known potential fire, explosion, or toxic release hazards related to the process work to be performed.

20.1.3 Explain to the contractor any applicable provisions of the Emergency Response section discussed below.

20.1.4 Ensure that safe work practices are implemented which would control the entrance, presence, and exit of contractors in the process areas.

20.1.5 Periodically evaluate the performance of the contractor regarding fulfillment of obligations.

20.1.6 Keep records of any work related injuries or illnesses.

20.2 The contractor has the following responsibilities:

20.2.1 Ensure that all contract employees involved in the process work are adequately trained to perform the job tasks and that training is documented for each employee. The documentation must include the name of the employee, the date of training, and the means used to verify that the employee understood the training.

20.2.2 Ensure employees are aware of any potential fire, explosion, or toxic release hazards associated with the work.

20.2.3 Ensure employees are aware of applicable provisions in the Emergency Response section.

20.2.4 Ensure that each employee follows all applicable safety rules of the facility, including applicable provisions described in the Operating Procedures section.

20.2.5 Inform the owner/operator of the process of any hazards which may have been created or found by the contractor work.

Appendix A

EPA RMP Data Elements and Instruction

RISK MANAGEMENT PLAN DATA ELEMENTS

The owner or operator of a stationary source subject to the risk management program rule shall submit a single Risk Management Plan (RMP) that includes the information required in §§ 68.155 through 68.185 for all covered processes. A covered process is defined as a process that has a regulated substance present in more than a threshold quantity as determined under § 68.115 of the rule. The following elements should be submitted to EPA as specified in § 68.150.

EXECUTIVE SUMMARY: As specified in §68.155, the owner or operator must provide an executive summary in the RMP. The executive summary should be brief and concise, no more than four pages in length for sources with one or two regulated substances. Your executive summary should include descriptions of:

1. The accidental release prevention and emergency response policies at the stationary source.

2. The stationary source and regulated substances handled. This information may be presented in a paragraph or as bullets. The information should include the following:

   - Primary activities (e.g., manufacturer of polyethylene, pulp mill, chlorine wholesaler);

   - Use of regulated substances (e.g., chlorine used to produce bleach, treat wastewater, repackage for sale);

   - Quantities handled or stored.

3. The worst-case release scenario(s) and the alternative release scenario(s), including administrative controls and mitigation measures to limit the distances for each reported scenario. The information should include the following:

   - The scenario (e.g., failure of the storage tank containing 40,000 pounds of chlorine, storage quantity limited to 60 percent of tank's capacity by company procedures; 10 minute release);

   - Distance to endpoint (e.g., under worst-case weather, the substance could travel x miles before dispersing enough to no longer pose a hazard to the public).

4. The general accidental release prevention program and chemical-specific prevention steps. For example, you may state that you are in compliance with the OSHA PSM rule and this rule. You may want to highlight general or specific steps that you believe are key to your prevention program. These steps may be either technological (e.g., backup systems) or procedural/managerial (e.g., improved maintenance or training).

5. The five-year accident history. This should be a summary (e.g., we have had five accidental releases of chlorine in the past five years; the largest release was 1500 pounds. No one offsite was injured, but several houses were evacuated as a precautionary measure during the 10/25/95 and 5/1/96 releases). Do not present the information in a table format.

6. The emergency response program (e.g., source has an emergency response plan, which has been coordinated with the community plan. The source hazmat team has conducted joint training and drills with the local fire department. Mention any public notification and alert systems).

7. Planned changes to improve safety.

1. **REGISTRATION:** The owner or operator should complete a single registration for the entire source. The registration should cover all regulated substances handled in covered processes.

1.1 **Source identification:** These fields indicate the location of the source and should be completed using street or local road designation. Do NOT use post office box numbers or rural box numbers.

a. **Name:** This is the name of the source, which may include the name of any parent company. The name should be specific to the site.

b-f. **Address (Street, City, County, State, Zip):** This is the location of the source using local street and road designations. Do not use post office box numbers or rural box numbers. This is not a mailing address.

g-h. **Latitude and Longitude:** Latitude is the distance north or south of the equator. Longitude is the distance east or west of the prime meridian. Latitude and longitude are measured in degrees, minutes, and seconds. The best tool for determining your latitude and longitude measurements are U.S. Geological Survey (USGS) topographic quadrangle maps.

1.2 **Source Dun and Bradstreet number:** This is an identification number that allows your business to be cross referenced to various business information. Dun & Bradstreet is a service mark for an agency furnishing subscribers with information as to the financial standing and credit rating of a business. You may be able to obtain this number from your finance department. Not all sources will have a Dun & Bradstreet number.

1.3 **Name and Dun and Bradstreet Number of corporate parent company (if applicable):** These fields provide information about the source's parent company.

a. **Name of corporate parent company (if applicable):** The parent company is the corporation or other business entity that owns at least 50 percent of the voting stock of another company.

b. **Dun and Bradstreet number of corporate parent company (if applicable):** This is an identification number that allows the parent company to be cross referenced to various business information. Not all sources will have a Dun & Bradstreet number.

1.4 **Owner/operator:** This section contains information about the person who owns or operates the source. The owner or operator means any person who owns, leases, operates, controls, or supervises a stationary source.

a. **Name:** This is the name of the person who owns or operates the source. This owner/operator is the highest ranking company executive on-site. Unmanned sources should supply the name of the executive responsible for the source.

b. **Phone:** This is the business phone number for the owner or operator.

c. **Mail Address:** This is the business mailing address for the owner or operator of the source. Please use post office box numbers or rural box numbers, as appropriate, and the proper zip code to correctly identify the owner's or operator's mailing address.

1.5 **Name and title of person responsible for part 68 implementation:** This is the person designated under § 68.15. This item is not applicable to a source with only Program 1 processes.

1.6 **Emergency contact:**

a. **Name:** This is the name of the person who has been designated as the emergency contact for the source. This person should be knowledgeable about the site and any emergency plans and be able to mitigate a release, fight a fire, or direct response personnel conducting such tasks. This person should be an employee (or a contract employee) of the source. The emergency contact may be the owner or operator of the source.

b. **Title:** The title or job classification of the emergency contact..

c. **Phone:** This is the phone number where the emergency contact can be reached during normal working hours. It is probably the phone number of the source. If the source does not have a phone number, you may either use the business phone number of the emergency contact, the phone number of the dispatcher, or the phone number of customer service.

d. **24-hour Phone:** This is the phone number where the emergency contact can be reached during non-working hours. It is probably the home phone number of the emergency contact or a 24-hour emergency notification "beeper" service.

1.7 **For each covered process:** Provide the chemical name, CAS number, quantity, SIC code, and program level for each covered process at the source.

1. **Chemical Name:** The name of the regulated chemical. Space is provided to list all regulated chemicals present about the threshold quantity in a process at the source. *Note: See 40 CFR Part 68 "List of Regulated Substances and Thresholds for Accidental Release Prevention and Risk Management Programs."*

2. **CAS number:** The Chemical Abstract Service registry number for the chemical.

3. **Quantity:** The maximum inventory quantity of each regulated substance or mixture in the process in pounds to two significant digits.

4. **SIC Code:** The four-digit Standard Industrial Classification (SIC) Code is the federal government category of business activity. See Standard Industrial Classification Manual, Office of Management and Budget, U.S. Government Printing Office, Washington, D.C. The four-digit SIC code should be applicable to the process, not the source as a whole.

5. **Program level:** Enter either Program 1, 2, or 3 to identify with which program the process complies.

1.8 **EPA Identifier:** This will be the key identifier number [reserved pending key identifier rule]

1.9 **Number of full-time employees:** This is the number of full-time equivalent workers. Part-time or seasonal workers can be added together to approximate an equivalent full-time worker. Part-time and seasonal workers should be weighted against a full-time work schedule. For example, a part-time worker who works 30 hours per week is 3/4 of a full-time worker, and a seasonal worker who works 3 months per year is 1/4 of a full-time worker.

1.10 **Covered by:** Indicate with a check mark whether the source is covered by the following regulatory programs.

a. **OSHA PSM:** The OSHA Process Safety Management Standard, codified at 29 CFR 1910.119, is similar to the Program 3 prevention program, and is designed to protect workers from the effects of accidental releases of hazardous substances. Note that this question covers all processes at your source; if any process at your source is subject to OSHA PSM, you must answer yes even if the PSM process is not covered by this rule.

b. **EPCRA section 302:** This question refers to the Emergency Planning and Community Right-to-Know-Act, which requires notification of local authorities of the presence of certain Extremely Hazardous Substances listed in 40 CFR 302. If you have a toxic regulated substance about the threshold quantity in a process, you are subject to EPCRA section 302. If you are covered for only flammable regulated substances, you are not subject to 40 CFR 355 for those substances, although you may be for toxic substances not affected by this rule.

c. **CAA Title V operating permit:** State and local operating permit programs are required under Title V of the Clean Air Act (40 CFR Part 70). Title V requires major sources of air pollution to receive permits, pay fees to cover costs of administering the program, and sign a binding certification of compliance on all permit applications and documents.

1.11 **Last safety inspection:** Record the date of the last safety inspection of your source and check the appropriate agency (OSHA, State OSHA, EPA, State EPA, Fire department, Other, or not applicable) that performed the inspection.

2. **TOXICS: WORST CASE:** Complete once for each Program 1 process containing a regulated toxic, and once to represent all regulated toxic substances held above the threshold quantity in Program 2 and Program 3 processes. In addition, you may need to complete additional worst-case release scenario(s) for a hazard class if a worst case release from another process within the source potentially affects public receptors different from those potentially affected by the worst-case release reported. See the RMP Offsite Consequence Analysis (OCA) Guidance for more information on determining your worst-case release scenarios.

2.1 **Chemical name:** The name of the regulated chemical evaluated in the worst-case scenario.

2.2 **Physical state:** Indicate with a check mark the physical state of the chemical as it is released in the scenario.

a. **Gas:** Indicate with a check if the chemical is a gas.

b. **Liquid:** Indicate with a check if the chemical is a liquid.

2.3 **Results based on:** Indicate with a check mark whether you used the reference tables provided in the RMP OCA guidance or conducted modelling to calculate your worst-case release. If you performed modelling, you must also indicate which model was used.

2.4 **Scenario:** Indicate with a check mark which of the following release scenarios describes your worst-case release scenario.

a. **Explosion:** A rapid chemical reaction with the production of noise, heat, and violent expansion of gasses.

b. **Fire:** A product (e.g., fuel) in a state of combustion.

c. **Toxic gas release:** A release of the substance in a vapor state.

d. **Liquid spill and vaporization:** A release of the substance in a liquid state with subsequent vaporization.

2.5 **Quantity released:** Indicate the quantity of the chemical released during the worst-case release in pounds.

2.6 **Release rate:** Indicate the rate of release in pounds per minute.

2.7 **Release duration (if modeled):** Indicate the length of time in minutes for the vessel, pipeline, or other location of the regulated substance to release all of its contents. For gasses, the duration is 10 minutes.

2.8 **Wind speed:** This is 1.5 meters per second unless you can demonstrate that local meteorological data applicable to the source show a higher minimum wind speed at all times during the last three years. If you can demonstrate higher minimums existed at all times, these minimums may be used. Provide wind speed in meters per second.

2.9 **Stability class:** This is an "F" stability class unless you can demonstrate that local meteorological data applicable to the source show a less stable atmosphere at all times. If you can demonstrate less stable conditions existed at all times, these minimums may be used.

2.10 **Topography (check one):** Indicate with a check mark whether the local topography is urban or rural. Urban means that there are many obstacles in the immediate area; obstacles include buildings or trees. Rural means that there are few buildings or other obstacles in the immediate area.

2.11 **Distance to endpoint:** Indicate the distance to the endpoint in miles for the chemical, using the endpoint specified for the chemical in Appendix A of the risk management program rule.

2.12 **Residential population within distance:** Indicate the population within the distance to the endpoint as specified in question 11 of this section. Populations should be estimated within a circle with a center at the point of the release and a radius determined by the distance to the endpoint. Populations estimated need only include residential populations and may be rounded to two significant digits (e.g., 5,500, 11,000).

2.13 **Public receptors:** These are the public receptors within the distance to the endpoint specified in the worst-case release. Public receptor means locations offsite where members of the public may be exposed to toxic concentrations, radiant heat, or overpressure as a result of an accidental release. Residences, institutions, industrial, office, and commercial buildings, parks, or recreational areas inhabited or occupied by the public at any time without restriction by the source are public receptors. You do not need to list specific locations or estimate populations at these locations. The presence of these receptors may be determined by using local street maps. Check all that apply.

a. **Schools:** Public and private elementary, secondary, or higher education schools.

b. **Residences**

c. **Hospitals**

d. **Prisons**

e. **Public recreational areas or arenas:** These include stadiums, parks, and public pools.

f. **Major commercial, office or industrial areas:** Industrial parks, office buildings, shopping malls, commercial areas.

2.14 **Environmental receptors within distance:** Environmental receptors should be identified within a circle with a center at the point of the release and a radius determined by the distance to the endpoint. Environmental receptor means natural areas, such as national or state parks, forests, or monuments; officially designated wildlife sanctuaries, preserves, refuges, or areas; and federal wilderness areas that could be exposed at any time to toxic concentrations, radiant hear, or overpressure as a result of an accidental release and that can be identified on local U.S. Geological Survey maps. Check all that apply.

a. **National or state parks, forests, or monuments**

b. **Officially designated wildlife sanctuaries, preserves, or refuges**

c. **Federal wilderness areas**

2.15 **Passive mitigation considered:** Mitigation means specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment. Passive mitigation means equipment, devices, or technologies that function without human, mechanical, or other energy input. Check all that were considered in defining the release quantity or rate to the worst-case scenario.

a. **Dikes:** A low wall that acts as a barrier to prevent a spill from spreading.

b. **Enclosures:** Physical containment of the release within a structure (e.g., a building).

c. **Berms:** A mound or wall of earth at the top or bottom of a slope that prevents a spill from spreading.

d. **Drains:** A channel that carries off surface water.

e. **Sumps:** A pit or tank that catches liquid runoff for drainage or disposal.

f. **Other (specify)**

3. **TOXICS: ALTERNATIVE RELEASES:** Complete for each toxic regulated substance held above the threshold quantity in a Program 2 or Program 3 process.

3.1 **Chemical:** The name of the regulated chemical evaluated in the alternative release scenario.

3.2 **Physical state:** Indicate with a check mark the physical state of the chemical as it is released in the scenario. See question 2.2 of this guidance for an explanation of each physical state.

3.3 **Results based on:** Indicate with a check mark whether you used the reference tables provided in the OCA guidance or conducted modelling to calculate your worst-case release. If you performed modelling, you must also indicate which model was used.

3.4 **Scenario (check one):** Indicate with a check mark which of the following scenarios describes your alternative release scenario.

a. **Transfer Hose Failure:** Failure of the connection between two or more vessels.

b. **Pipe Leak:** Release through a rupture in a pipe.

c. **Vessel Leak:** Release through a rupture in a vessel.

d. **Overfilling:** Release due to filling a pipe, vessel, or other container past its capacity.

e. **Rupture Disk/Relief Valve:** Release due to failure of a rupture disk/relief valve to function properly. A rupture disk/relieve valve is a valve that relieves pressure beyond a specified limit and recloses upon return to normal operating conditions.

f. **Excess Flow Valve Failure:** Release caused by the failure of excess flow device to function properly and prevent surges from reaching downstream equipment.

g. **Other (specify)**

3.5 **Quantity released:** Indicate the quantity of the chemical released during the alternative release scenario in pounds.

3.6 **Release rate:** Indicate the rate of release in pounds per minute.

3.7 **Release duration:** Indicate the length of time in minutes for the vessel, pipeline, or other location of the regulated substance to release the quantity indicated in question 3.5.

3.8 **Wind speed:** If you use the RMP OCA guidance, list 3 m/s. If you modeled your scenario indicate the wind speed used. This wind speed should be the average daily wind speed based on annual data collected at your site or at a local meteorological station.

3.9 **Stability class:** If you use the RMP OCA guidance, list "D" stability. If you modeled your scenario indicate the stability used. The stability should be the average daily stability based on annual data collected at your site or at a local meteorological station.

3.10 **Topography (check one):** Indicate with a check mark whether the local topography is urban or rural. Urban means that there are many obstacles in the immediate area; obstacles include buildings or trees. Rural means that there are few buildings or other obstacles in the immediate area.

3.11 **Distance to endpoint:** Indicate the distance to the endpoint in miles for the chemical, using the endpoint specified for the chemical in Appendix A of the risk management program rule.

3.12 **Residential population within distance:** Indicate the population within the distance to the endpoint as specified in question 11 of this section. Populations should be estimated within a circle with a center at the point of the release and a radius determined by the distance to the endpoint. Populations estimated need only include residential populations and may be rounded to two significant digits (e.g., 5,500, 11,000).

3.13 **Public receptors:** These are the public receptors within the distance to the endpoint specified in the alternative release. Check all that apply. See question 2.13 of this guidance.

3.14 **Environmental receptors within distance:** Environmental receptors should be identified within a circle with a center at the point of the release and a radius determined by the distance to the endpoint. Check all that apply. See question 2.14 of this guidance.

3.15 **Passive mitigation considered:** Mitigation means specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment. Passive mitigation means equipment, devices, or technologies that function without human, mechanical, or other energy input. Check all that were considered in defining the release quantity or rate of the alternative release scenario. See question 2.15 of this guidance.

3.16 **Active mitigation considered:** Mitigation means specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment. Active mitigation means equipment, devices, or technologies that need human, mechanical, or other energy input to function. Check all that were considered in defining the release quantity or rate of the alternative release scenario.

a. **Sprinkler Systems:** A system for protecting a building against fire by means of overhead pipes which convey an extinguishing fluid through heat activated outlets.

b. **Deluge Systems:** A system to overflow an area of a release with water or other extinguishing fluid.

c. **Water Curtain:** A spray of water from a horizontal pipe through nozzles, the curtain may be activated manually or automatically.

d. **Neutralization:** Making a toxic chemical harmless through chemical reaction.

e. **Excess Flow Valve:** A system for diverting overflow.

f. **Flares:** A device for disposing of combustible gases from a chemical process by burning them in the open.

g. **Scrubbers:** A pre-release protection measure that uses water or aqueous mixtures containing scrubbing reagents to remove discharging liquids and possibly also treating the discharging chemical.

h. **Emergency Shutdown Systems:** Controls that are triggered when process limits are exceeded and that shut down that process.

i. **Other (specify)**

4. **FLAMMABLES: WORST CASE:** Complete once for each Program 1 process, and once to cover all flammables held above the threshold quantity in Program 2 or Program 3 processes. See the RMP Offsite Consequence Analysis (OCA) Guidance for more information on determining your worst-case release scenarios.

4.1 **Chemical:** The name of the regulated chemical evaluated in the worst-case scenario.

4.2 **Results based on (check one):** Indicate with a check mark whether you used the reference tables provided in the OCA guidance or conducted modelling to calculate your worst-case release. If you performed modelling, you must also indicate which model was used.

4.3 **Scenario (check one):** Indicate with a check mark which of the following release scenarios is appropriate to describe your worst-case release scenario. Generally the worst-case release scenario is a vapor cloud explosion.

a. **Vapor Cloud Explosion:** An explosion of a cloud made of a mixture of a flammable vapor or gas with air.

b. **Fireball:** The atmospheric burning of a fuel-air cloud in which the energy is mostly emitted in the form of radiant heat. As buoyancy forces of the hot gases begin to dominate, the burning cloud rises and becomes spherical in shape. Often caused by the ignition of a vapor cloud of a flammable substance.

4.4 **Quantity released:** Indicate the quantity of the chemical released during the worst-case release in pounds.

4.5 **Endpoint used:** For vapor cloud explosions, the endpoint is 1 PSI overpressure; for a fireball the endpoint is 5 kw/m^2 for 40 seconds.

4.6 **Distance to endpoint:** Indicate the distance in miles to the endpoint for the chemical specified.

4.7 **Residential population within distance:** Indicate the population within the distance to the endpoint as specified in question 6 of this section. Populations should be estimated within a circle with a center at the point of the release and a radius determined by the distance to the endpoint. Populations estimated need only include residential populations and may be rounded to two significant digits (e.g., 5,500, 11,000).

4.8 **Public receptors:** These are the public receptors within the distance to the endpoint specified in the worst-case release. Check all that apply. See question 2.13 of this guidance.

4.9 **Environmental receptors within distance:** Environmental receptors should be identified within a circle with a center at the point of the release and a radius determined by the distance to the endpoint. Check all that apply. See question 2.14 of this guidance.

4.10 **Passive mitigation considered:** Mitigation means specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment. Passive mitigation means equipment, devices, or technologies that function without human, mechanical, or other energy input. Check all that were considered in defining the release quantity or rate to the worst-case scenario.

a. **Dikes:** A low wall that acts as a barrier to prevent a spill from spreading.

b. **Fire Walls:** A wall constructed to prevent the spread of fire.

c. **Blast Walls:** A heavy wall used to isolate buildings or areas that contain highly combustible or explosive materials.

d. **Enclosures:** Physical containment of the release within a structure (e.g., a building).

e. **Other (specify)**

5. **FLAMMABLES: ALTERNATIVE RELEASES:** Complete once for all flammable regulated substances held above the threshold quantity in a Program 2 or Program 3 process.

5.1 **Chemical:** The name of the regulated chemical evaluated in the alternative release scenario.

5.2 **Results based on (check one):** Indicate with a check mark whether you used the reference tables provided in the OCA guidance or conducted modelling to calculate your alternative release scenario. If you performed modelling, you must also indicate which model was used.

5.3 **Scenario (check one):** Indicate with a check mark which of the following release scenarios describes your alternative release scenario.

a. **Vapor Cloud Explosion:** An explosion of a cloud made of a mixture of a flammable vapor or gas with air.

b. **Fireball:** The atmospheric burning of a fuel-air cloud in which the energy is mostly emitted in the form of radiant heat. As buoyancy forces of the hot gases begin to dominate, the burning cloud rises and becomes spherical in shape. Often caused by the ignition of a vapor cloud of a flammable substance.

c. **BLEVE:** Boiling Liquid Expanding Vapor Explosion: used to describe the sudden rupture of a vessel/system containing liquefied flammable gas under pressure due to radiant heat flux. The pressure burst and the flashing of the liquid to vapor creates a blast wall and potential missile damage, and immediate ignition of the expanding fuel-air mixture leads to an intense combustion creating a fireball.

d. **Pool Fire:** The combustion of material evaporating from a layer of liquid at the base of the fire.

e. **Jet Fire:** Gas discharging or venting from a rupture will form a gas jet that "blows" into the atmosphere in the direction the whole is facing, all the while entraining and mixing with air. If the gas is flammable and encounters an ignition source, a flame jet may form.

f. **Vapor Cloud Fire:** A flash fire results from the ignition of a released flammable cloud in which there is essentially no increase in the combustion rate.

5.4 **Quantity released:** Indicate the quantity of the chemical released during the release in pounds.

5.5 **Endpoint used:** For vapor cloud explosions, the endpoint is 1 PSI overpressure; for a fireball the endpoint is 5 kw/m^2 for 40 seconds. A lower flammability limit may be listed as specified in NFPA documents or other generally recognized sources.

5.6 **Distance to endpoint:** This is the distance in miles to the endpoint in miles for the chemical.

5.7 **Residential population within distance:** Indicate the population within the distance to the endpoint as specified in question 6 of this section. Populations should be estimated within a circle with a center at the point of the release and a radius determined by the distance to the endpoint. Populations estimated need only include residential populations and may be rounded to two significant digits (e.g., 5,500, 11,000).

5.8 **Public receptors:** These are the public receptors within the distance to the endpoint specified in the alternative release. Check all that apply. See question 2.13 of this guidance.

5.9 **Environmental receptors within distance:** Environmental receptors should be identified within a circle with a center at the point of the release and a radius determined by the distance to the endpoint. Check all that apply. See question 2.14 of this guidance.

5.10 **Passive mitigation considered:** Mitigation means specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment. Passive mitigation means equipment, devices, or technologies that function without human, mechanical, or other energy input. Check all that were considered in defining the release quantity or rate to the worst-case scenario. See question 4.10 of this guidance.

5.11 **Active mitigation considered:** Mitigation means specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment. Active mitigation means equipment, devices, or technologies that need human, mechanical, or other energy input to function.

Check all that were considered in defining the release quantity or rate of the alternative release scenario. See question 3.16 of this guidance.

6. **FIVE-YEAR ACCIDENT HISTORY:** Complete a separate record for each accidental release from covered processes that occurred within the last five years and that resulted in deaths, injuries, or significant property damage on site, or known offsite deaths, injuries, evacuations, sheltering in place, property damage, or environmental damage.

6.1 **Date:** Indicate the date on which the accident occurred.

6.2 **Time:** Indicate the time the release began.

6.3 **Release duration:** Indicate the approximate length of time of the release in minutes.

6.4 **Chemical(s):** Indicate the regulated substance(s) released.

6.5 **Quantity released:** Indicate the amount of each substance released in pounds.

6.6 **Release event:** Indicate with a check mark which of the following release events best describes your accident.

a. **Gas Release:** A release of the substance in a vapor state.

b. **Liquid Spill/Evaporation:** A release of the substance in a liquid state with subsequent vaporization.

c. **Fire:** A product (e.g., fuel) in a state of combustion.

d. **Explosion:** A rapid chemical reaction with the production of noise, heat, and violent expansion of gasses.

6.7 **Release source:** Indicate which best describes the source of the release. Check all that apply.

a. **Storage Vessel:** A container for storing, holding, or transporting a liquid.

b. **Piping:** A system of pipes used to carry a fluid.

c. **Process Vessel:** A container in which regulated substances are blended to form a mixture or reacted to convert them into some other final product or form.

d. **Transfer Hose:** A connection between two or more vessels.

e. **Valve:** A structure that closes temporarily a passage or permits movement of fluid in one direction only.

f. **Pump:** A device that raises, transfers, or compresses fluids or that attenuates gases by suction or pressure or both.

6.8 **Weather conditions at time of event (if known):** This information is important to those concerned with predicting the effects of accidents. Reliable information from those involved in the incident is better information than can be obtained from a meteorological weather station located miles from the incident site. Complete as much of the following as possible.

a. **Wind Speed/Direction:** Wind speed is an estimate of how fast the wind is traveling. Indicate the speed in miles per hour, meters per second, or knots. Be sure to identify the units of measure. Wind direction is the direction from which the wind comes. For example, a wind that blows from west to east comes from the west. You may describe the direction that the wind blows from as a standard compass reading such as "*Northeast*" or "*South-southwest.*" You may also describe the direction in degrees with North as zero degrees and East as 90 degrees. Thus northeast would represent 45 degrees, and south-southwest would represent 202.5 degrees. Abbreviations for the wind direction such as NE (for northeast) and SSW (for south-southwest) are also acceptable.

b. **Temperature:** The ambient temperature at the scene of the accident in degrees Fahrenheit.

c. **Stability Class:** This is a general indication of the degree of mixing present in the atmosphere accounting for windspeed and sunlight. The designation ranges from "A to F," where "A" represents extremely unstable conditions (high mixing) and "F" represents extremely stable or clam (little mixing) conditions. "F" conditions occur on overcast nights with low wind speeds and "A" conditions occur on clear days at high wind speeds. See the RMP OCA guidance for more information.

d. **Precipitation Present:** Check yes or no based on whether there was precipitation at the time of the accident.

e. **Unknown:** If you have no record of weather conditions check this.

6.9 **On site impacts:** Complete as much of the following as possible about on-site effects.

a. **Deaths:** Indicate the number of on-site deaths that are attributed to the accident or mitigation activities. On-site deaths means the number of employees or contract employees who were killed during the accident of performing any mitigation activities. What about offsite response contractors?

b. **Injuries:** Indicate the number of employees or contract personnel who were injured as a result of the accident or mitigation activities. An injury may or may not involve lost work time. An injury means any effect that results either from direct exposure to toxic concentrations, radiant heat, or overpressures from accidental releases or from the direct consequences of a vapor cloud explosion from an accidental release that requires medical treatment or hospitalization. Medical treatment means treatment, other than first aid, administered by a physician or registered professional personnel under standing orders from a physician.

c. **Property Damage:** Estimate the value of the equipment or business structures (for your business alone) that were damaged by the accident or mitigation activities. Record the value in American dollars. Do not include any losses that you may have incurred by business interruption.

6.10 **Known offsite impacts:** These are impacts that you are aware of or that were reported to the source. You are not required to conduct additional investigation to determine offsite impacts. Offsite means areas beyond the property boundary of the source or areas within the property boundary to which the public has routine and unrestricted access during or outside business hours.

a. **Deaths:** Indicate the number of offsite deaths that are attributable to the accident or mitigation activities. Offsite deaths means the number of community members and members of public response agencies who were killed during the accident or performing any mitigation activities.

b. **Hospitalizations:** Indicate the number of injuries that are attributable to the accident or mitigation activities where community members or members of response agencies required hospitalization due to the injury.

c. **Other Medical Treatment:** Indicate the number of injuries that are attributable to the accident or mitigation activities where community members or members of response agencies required medical treatment, not including first aid, due to the injury.

d. **Evacuated:** Indicate the number of members of the community who were evacuated as a result of the accident. A total count of the number of people evacuated is preferable to the number of houses evacuated.

e. **Sheltered:** Indicate the number of members of the community who were sheltered-in-place during the accident. Sheltering-in-place is the official designation when the incident commander orders community members to remain inside their residence or place of work until the emergency is over to prevent exposure to the substance. Usually these are associated with an emergency broadcast or similar method of mass notification by response agencies.

f. **Property Damage:** Estimate the value of any property (not belonging to the source) that may have been damaged as a result of the accident. Record the value in American dollars. Include the value of damages to any response equipment.

g. **Environmental Damage:** Indicate whether any environmental damage occurred and specify the type. The damage is not limited to environmental receptors listed in the rule. Any damage to the environment (e.g., defoliation, water contamination) should be considered. You are not, however, required to conduct surveys to determine whether such impact occurred.

6.11 Initiating event: Indicate with a check mark the initiating event that best describes the cause of the accident, if known.

a. **Equipment Failure:** A device or piece of equipment did not function as designed.

b. **Human Error:** An operator performs an operation improperly.

c. **Weather Condition:** Weather conditions, such as lightning, hail, ice storms, tornados, hurricanes, floods, or high winds caused the accident.

6.12 Contributing factors: These are factors that contributed to the accident occurring but were not the initiating event, if known. Check all that apply.

a. **Equipment Failure:** A device or piece of equipment did not function as designed thereby allowing a substance to be released.

b. **Human Error:** An operator performs an operation improperly or makes a mistake resulting in a release.

c. **Improper Procedures:** The procedure did not reflect the current method of operation, the procedure omitted steps that affected the accident, or the procedure was written in a manner that allowed for mis-interpretation of the instructions.

d. **Overpressurization:** The process was operated at pressures exceeding the design working pressure.

e. **Upset Condition:** Release caused by incorrect process conditions (e.g., increased temperature or pressure).

f. **By-pass Condition:** A pipe or channel that provides an alternate pathway that detours the main pathway fails releasing a substance.

g. **Maintenance Activity/Inactivity:** This is any failure that occurs because of maintenance activity or inactivity. For example, the pipes remain unpainted for so long that corrosion caused the pipe to fail, or the maintenance mechanic began to repair the wrong pump.

h. **Process Design:** Any failure that may be design related.

i. **Unsuitable Equipment:** The equipment used was incorrect for the process.

j. **Unusual Weather Condition:** Weather conditions, such as lightning, hail, ice storms, tornados, hurricanes, floods, or high winds caused the accident.

k. **Management Error:** This may be used to describe failures that occur because management did not exercise its managerial control to prevent the situation from occurring. This is usually used to describe faulty procedures, inadequate training, or failure to follow existing administrative procedures.

6.13 **Offsite responders notified:** Indicate with a check mark whether agencies were contacted.

6.14 **Changes introduced as a result of the accident:** Indicate with a check mark any measures that you have taken at the source to prevent recurrence of the accident.

a. **Improved/Upgraded Equipment:** A device or piece of equipment that did not function as designed was repaired or replaced.

b. **Revised Maintenance:** Maintenance processes were clarified or changed to ensure safe operation and timely maintenance.

c. **Revised Training:** Training programs were clarified or changed to ensure that employees and contract employees are aware of and are practicing correct safety, process, and administrative procedures.

d. **Revised Operating Procedures:** Operating procedures were clarified or changed to ensure that employees and contract employees are trained on process operating procedures.

e. **New Process Controls:** New process designs and controls were installed to correct problems and prevent recurrence of an accidental release.

f. **New Mitigation Systems:** New mitigation systems were initiated to limit accidental releases.

g. **Revised Emergency Response Plan:** The emergency response plan was revised.

h. **Changed process**

i. **Reduced Inventory:** Inventory was reduced at the source to prevent accidental release.

j. **Other**

k. **None**

7. **PREVENTION PROGRAM — PROGRAM 3:** Complete the following information about each Program 3 process at your source. If the same information applies to more than once covered process, the owner or operator may provide the information only once, but shall indicate to which process the information applies.

7.1 **SIC code for process:** The four-digit Standard Industrial Classification (SIC) Code is the federal government category of business activity. See Standard Industrial Classification

Manual, Office of Management and Budget, U.S. Government Printing Office, Washington, D.C. The four-digit SIC code should be applicable to the process, not the source as a whole.

7.2 **Name of substance(s) covered:** The name of the regulated substance(s) in the process.

7.3 **Date on which the safety information was last reviewed or revised:**

7.4 **PHA:** Answer the following questions about the status of your Process Hazard Analysis (PHA). The owner or operator must perform a PHA on processes covered by the risk management program rule.

a. **The date of completion of the most recent PHA or update**

b. **The technique used:** Indicate which of the following methodologies were used to evaluate the hazards of the process. Check all that apply.

1. **What If:** A What If analysis considers the consequences associated with events that occur as a result of failures involving equipment, design, or procedures. All possible system failures may be collected in checklist form and evaluated. Compiling a list of failures requires a basic understanding of what is intended and the ability to combine or synthesize possible deviations and reject incredible situations.

2. **Checklist:** This system involves developing a checklist of failure areas and reviewing each area to determine the possible effects of failure.

3. **What If/Checklist:** This methodology combines the what if and checklist analysis methodologies to identify and evaluate process hazards.

4. **HAZOP:** Hazard and Operability Studies (HAZOPs) are conducted by teams that brainstorm to systematically identify hazards or operability problems throughout a source through the use of certain guidewords such as "no flow" and "no cooling". The consequences of the deviation associated with the guidewords are assessed and credible deviations are identified and addressed.

5. **Failure Mode and Effects Analysis:** This is a methodology of tabulating the source's equipment, failure modes (how equipment fails), each failure mode's effect on the source, and a ranking of each failure mode.

6. **Fault Tree Analysis:** This is a deductive technique that focuses on one particular accident event and provides a method for determining causes of the event. The fault tree is a graphic model that displays the various combinations of equipment faults and failures that can result in a release.

7. **Other (specify)**

c. **The expected date of completion of any changes resulting from the PHA:** Not all recommendations will have resulted in changes. Record the date of expected final implementation of any changes that are made as a result of PHA recommendations.

d. **Major hazards:** Indicate with a check mark <u>all</u> major hazards that were identified for the Program 3 process at your source as a result of the PHA. Major hazards are defined as the potential for:

1. **Toxic Release:** If an accidental release occurred a regulated toxic substance could be released.

2. **Fire:** Process upsets, leaks, equipment failure, etc., could result in a fire. For listed flammables, fire will always be a major hazard. Fire, however, may also be a hazard in other processes and could lead to a toxic release.

3. **Explosion:** Confined or unconfined vapor cloud explosions, BLEVES; explosion will be a major hazard for listed flammables. It may also be a hazard for toxics, especially those handled at extreme conditions.

4. **Runaway Reaction:** An uncontrolled reaction that proceeds at an increasing rate.

5. **Polymerization:** A chemical reaction that produces the bonding of two or more monomers.

6. **Overpressurization:** Instantaneous energy release or detonation.

7. **Corrosion:** The presence of the regulated substance could lead to destruction of equipment and a release. Corrosion may be a major hazard for substances identified as corrosives on MSDSs unless the equipment used limits the hazard.

8. **Overfilling:** Filling a tank or vessel beyond its maximum safe capacity.

9. **Contamination:** A release could occur if inappropriate substances are introduced into storage or process vessels. Contamination may be a major hazard if controlling inappropriate substances (e.g., H_2O) is difficult.

10. **Equipment Failure:** Equipment failure is likely to be a major hazard for most processes because such failure could lead to a release. Equipment failure includes cracks, weld failures, disk failures, ruptures, pump/gauge/control system failures, etc.

11. **Loss of Cooling, Heating, Electricity, Instrument Air:** These losses could be major hazards if they would lead to releases. For example, loss of cooling could lead to an increase in pressure and failure of a vessel or pipe; a loss of heating or power could lead to unstable processes. These conditions are less

likely to be major hazards for substances handles at atmospheric temperatures and pressures.

12. **Earthquake:** Report these only if they are frequent enough or likely enough to occur at your site so that you design and plan for them.

13. **Floods (Flood Plain):** Report these only if they are frequent enough or likely enough to occur at your site so that you design and plan for them.

14. **Tornado:** Report these only if they are frequent enough or likely enough to occur at your site so that you design and plan for them.

15. **Hurricanes:** Report these only if they are frequent enough or likely enough to occur at your site so that you design and plan for them.

16. **Other (specify)**

e. **Process controls:** Indicate all of the process controls used on this Program 3 process. Process controls are equipment and associated procedures used to prevent or limit releases. Check all that apply.

1. **Vents:** An opening provided for the discharge of pressure or release of pressure form tanks, vessels, processing equipment, etc.

2. **Relief Valves:** A relief valve is a valve that relieves pressure beyond a specified limit and recloses upon return to normal operating conditions.

3. **Check Valves:** A device for automatically limiting flow in a piping system to a single direction,

4. **Scrubbers:** A pre-release protection measure that uses water or aqueous mixtures containing scrubbing reagents to remove discharging liquids and possibly also treating the discharging chemical.

5. **Flares:** A pre-release protection measure used for flammable gases and vapors to remove and possibly treat discharged liquids.

6. **Manual Shutoffs:** Controls the shutoff flow to a pipe or vessel and that must be operated manually.

7. **Automatic Shutoffs:** Controls the shutoff flow to a pipe or vessel and that are triggered automatically when process conditions are exceeded.

8. **Interlocks:** A switch or other device that prevents activation of a piece of equipment when a protective door is open or some other hazard exists.

9. **Alarms and Procedures:** Systems that operate a warning device after the occurrence of a hazardous condition and procedures to activate the alarm system.

10. **Keyed Bypass:** A bypass system that is activated by a control signal.

11. **Emergency Air Supply:** A backup system to provide air to a process when the regular air supply fails.

12. **Emergency Power:** Backup power systems.

13. **Backup Pump:** A secondary pump intended to serve the same function as the primary pump if the primary pump fails.

14. **Grounding Equipment:** Devices that ground electrical equipment to avoid explosions.

15. **Inhibitor Addition:** A substance that is added to a reaction that is capable of stopping or retarding a chemical reaction.

16. **Rupture Disks:** A rupture disk is a device that relieves pressure beyond a specified limit and recloses upon return to normal operating conditions.

17. **Excess Flow Device:** Flow-limiting equipment that protects downstream equipment from surges.

18. **Quench System:** A system that cools by removing excess heat or immersing liquid into a cooling medium.

19. **Purge System:** A system that replaces the atmosphere in a container with an inert substance to prevent the formation of an explosive mixture.

20. **Other (specify)**

f. **Mitigation systems:** Indicate with a check mark all of the mitigation systems in place to control a release should one occur from the process.

1. **Sprinkler System:** A system for protecting a building against fire by means of overhead pipes which convey an extinguishing fluid through heat activated outlets.

2. **Dikes:** A low wall that acts as a barrier to prevent a spill from spreading.

3. **Fire Walls:** A wall constructed to prevent the spread of fire.

4. **Blast Walls:** A heavy wall used to isolate buildings or areas that contain highly combustible or explosive materials.

5. **Deluge System:** A system to overflow an area of a release with water or other extinguishing fluid.

6. **Water Curtain:** A spray of water from a horizontal pipe through nozzles, the curtain may be activated manually or automatically.

7. **Enclosure:** Physical containment of the release within a structure (e.g., a building).

8. **Neutralization:** Controlling a release by neutralizing the released chemical.

9. **Other (specify)**

g. **Monitoring/detection systems:** Indicate with a check mark the monitoring and detection systems installed to detect a release of a regulated substance from the process.

1. **Process Area Detectors:** Detection systems located on or close to process equipment. Detection systems include indicator tubes, and chromatographic, spectrometric, electrochemical, and colorimetric gas analysis.

2. **Perimeter Monitors:** Integrated detection networks at the source boundary. Detection systems can include fluorescent SO_2 analyzers, photoelectric tape sensors, or electrolytic chlorine detectors.

3. **Other (specify)**

h. **Changes since last PHA update:** Indicate with a check mark all of the changes made to the process since the last PHA. Check all that apply.

1. **Reduction in Chemical Inventory:** Decrease in the quantity of regulated substances stored on site.

2. **Increase in Chemical Inventory:** Increase in the quantity of regulated substances stored on site.

3. **Change in Process Parameters:** Increase or decrease in temperature, pressure, flow rates, etc.

4. **Installation of Process Controls:** Addition of controls such as those listed in question 5 above.

5. **Installation of Process Detection Systems:** Addition of systems such as those listed in question 7 above.

6. **Installation of Perimeter Monitoring Systems:** Addition of systems such as those listed in question 7 above.

7. **Installation of Mitigation Systems:** Addition of systems such as those listed in question 6 above.

8. **Other (specify)**

9. **None Required/Recommended:** PHA team recommended no change.

7.5 **The date of the most recent review or revision of operating procedures:** You should have developed and implemented written operating procedures as defined in § 68.69 that provide clear instructions for safely conducting activities involved in each covered process that are consistent with the process safety information. Operating procedures shall be reviewed as often as necessary to assure that they reflect current operating practice, including changes that result from changes in process chemicals, technology, and equipment, and changes to stationary sources. Indicate the date of the most recent review or revision.

7.6 **Training:** The training program, as specified in § 68.71, should cover initial training for each employee involved in operating a process that emphasizes specific safety and health hazards, emergency operations including shutdown, and safe work practices. You should also offer refresher training at least every three years and training documentation to show that each employee involved in operating a process has received and understood the required training.

a. **The date of the most recent review or revision of training programs**

b. **The type of training provided:** Indicate whether the training was held in a classroom, was a combination of classroom and on the job, on the job, or other.

c. **The type of competency testing used:** Indicate with a check mark how employees were tested to determine and evaluate comprehension of the training materials.

7.7 **Maintenance:** The maintenance program, defined in § 68.73, ensures the mechanical integrity of process equipment. The maintenance program procedures should be written, training should be provided for employees involved in maintenance activities, inspection and testing should be performed in process equipment, equipment deficiencies should be corrected before further use or in a safe and timely manner, and the owner or operator should ensure that the equipment is installed properly and consistent with design specifications.

a. **The date of the most recent review or revision of maintenance procedures**

b. **The date of the most recent equipment inspection or test**

c. **The equipment inspected or tested**

7.8 **Management of Change:** The owner or operator shall establish and implement written procedures to manage changes (except for "replacements in kind") to process chemicals, technology, equipment, and procedures; and, changes to stationary sources that affect a covered process as specified in § 68.75.

a. **The date of the most recent change that triggered management of change procedures**

b. **The date of the most recent review or revision of management of change procedures**

7.8 **The date of the most recent pre-startup review:** Pre-start up review, as specified in § 68.77, shall be performed for new stationary sources and for modified stationary sources when the modification is significant enough to require a change in the process safety information.

7.9 **Compliance audits:** Compliance audits, as specified in § 68.79, evaluate whether the source is in compliance with the risk management program provisions and should be conducted at least every three years by a person knowledgeable in the process.

a. **The date of the most recent compliance audit**

b. **The expected date of completion of any changes resulting from the compliance audit**

7.10 **Incident investigation:** The owner or operator should have procedures, as specified in § 68.81, to investigate each incident that resulted in, or could reasonably have resulted in a catastrophic release of a regulated substance.

a. **The date of the most recent incident investigation**

b. **The expected date of completion of any changes resulting from the investigation**

7.11 **The date of the most recent review or revision of employee participation plans:** Employee participation is described in § 68.83.

7.12 **The date of the most recent review or revision of hot work permit procedures:** Hot work permits are described in § 68.85.

7.13 **The date of the most recent review or revision of contractor safety procedures:** Contractor safety procedures, as described in § 68.87, describe procedures to oversee contractors performing maintenance or repair work, turnaround, major renovation, or specialty work on or adjacent to a covered process. This section does not apply to contractors providing incidental services that do not influence process safety (e.g., trash removal, groundkeeping).

7.14 **The date of the most recent evaluation of contractor safety performance:** Contractor safety procedures are described in § 68.87.

8. **PREVENTION PROGRAM — PROGRAM 2:** For each Program 2 process, the owner or operator must provide the following information. If the same information applies to more

than once covered process, the owner or operator may provide the information only once, but shall indicate to which process the information applies.

8.1 **SIC code for process:** The Standard Industrial Classification (SIC) Code is the federal government category of business activity. See Standard Industrial Classification Manual, Office of Management and Budget, U.S. Government Printing Office, Washington, D.C. The SIC code should be applicable to the process, not the source as a whole.

8.2. **Chemicals:** The name of the regulated substances in the process.

8.3 **Safety information:** As described in § 68.48 the owner or operator shall compile and maintain up-to-date safety information related to regulated substances, processes, and equipment.

a. **The date of the most recent review or revision of the safety information:**

b. **A list of Federal or state regulations or industry-specific design codes and standards used to demonstrate compliance with the safety information requirement:** Indicate with a check mark whether you are using any of the following:

1. **NFPA 58 (or state law based on NFPA 58):** National Fire Protection Association propane handling laws. Propane laws are based on NFPA 59 except in the states of California and texas.

2. **OSHA (29 CFR 1910.111):** OSHA rule for handling anhydrous ammonia.

3. **ASTM Standards:** American Society of Testing Materials standards. Establishes standards for materials, products, systems, services, test methods, specifications, classifications, definitions, and recommended practices.

4. **ANSI Standards:** American National Standards Institute standards. Nationally coordinates voluntary standards. Gives status to standards in such areas as definitions, terminology, symbols, and abbreviations; materials, performance characteristics, procedure, and methods of rating; methods of testing and analysis; size, weight, and volume; safety, health, and building construction.

5. **ASME Standards:** American Society of Mechanical Engineers standards. Conducts research and develops boiler, pressure vessel, and power test codes. Also develops safety codes and standards for equipment.

6. **Other (specify)**

7. **None**

8.4 **Hazard review:** Your hazard review, as specified in § 68.50, must identify the hazards associated with the process, opportunities for equipment malfunctions or human errors, safeguards needed to control the hazards or prevent equipment malfunction or human error, and any steps used or needed to detect or monitor releases.

a. **The date of completion of the most recent hazard review or update**

b. **The expected date of completion of any changes resulting from the hazard review**

c. **Major hazards:** Indicate with a check mark all major hazards that were identified for the Program 2 process at your source as a result of the hazard review. Major hazards are defined in 7.4(d) of this guidance.

d. **Process controls:** Indicate with a check mark all of the process controls used on this Program 2 process. Process controls are equipment and associated procedures used to prevent or limit releases. Process controls are described in 7.4(e) of this guidance.

e. **Mitigation systems:** Indicate with a check mark all of the mitigation systems in place to control a release should one occur from the process. Mitigation systems are defined in 7.4(f) of this guidance.

f. **Monitoring/detection systems:** Indicate with a check mark the monitoring and detection systems installed to detect a release of a regulated substance from the process. Monitoring/detection systems are described in 7.4(g) of this guidance.

g. **Changes since last PHA update:** Indicate with a check mark all of the changes made to the process since the last PHA. PHA changes are described in 7.4(h) of this guidance.

8.5 **The date of the most recent review or revision of operating procedures:** You should have developed and implemented written operating procedures as defined in § 68.52 that provide clear instructions for safely conducting activities involved in each covered process that are consistent with the process safety information. Operating procedures shall be reviewed as often as necessary to assure that they reflect current operating practice, including changes that result from changes in process chemicals, technology, and equipment, and changes to stationary sources. Indicate the date of the most recent review or revision.

8.6 **Training:** The training program, as specified in § 68.54, should cover initial training for each employee involved in operating a process that emphasizes specific safety and health hazards, emergency operations including shutdown, and safe work practices. You should also offer refresher training at least every three years.

a. **The date of the most recent review or revision of training programs**

b. **The type of training provided:** Indicate whether the training was held in a classroom, was a combination of classroom and on the job, on the job, or other.

c. **The type of competency testing used:** Indicate with a check mark how employees were tested to determine and evaluate comprehension of the training materials.

8.7 **Maintenance:** The maintenance program, as specified in § 68.56, ensures mechanical integrity of process equipment. The maintenance program procedures should be written, training should be provided for employees involved in maintenance activities, and inspection and testing should be performed in process equipment.

a. The date of the most recent review or revision of maintenance procedures

b. The date of the most recent equipment inspection or test

c. The equipment inspected or tested

8.8 **Compliance audits:** Indicate the date of your last compliance audit, as specified in § 68.58. Compliance audits are important to evaluate whether the source is in compliance with the risk management program provisions and should be conducted at least every three years by a person knowledgeable in the process.

a. The date of the most recent compliance audit

b. The expected date of completion of any changes resulting from the compliance audit

8.9 **Incident investigation:** Indicate the date of your most recent incident investigation. As specified in § 68.60, you must investigate each incident that resulted in, or could reasonably have resulted in a catastrophic release of a regulated substance.

a. The date of the most recent incident investigation

b. The expected date of completion of any changes resulting from the investigation

8.10 **The date of the most recent change that triggered a review or revision of safety information, the hazard review, operating or maintenance procedures, or training:**

9. EMERGENCY RESPONSE

9.1 **Do you have a written emergency response plan?** Indicate whether or not your source has a written emergency response plan. You are not required to have a plan if all response activities will be handled by public responders or other non-employees.

9.2 **Does the plan include specific actions to be taken in response to an accidental releases of a regulated substance?** Indicate whether or not whether your plan includes specific actions that should be taken in response to an accidental release of a regulated substance.

9.3 **Does the plan include procedures for informing the public and local agencies responsible for responding to accidental releases?** Indicate whether or not the plan includes procedures for public notification and notification of local agencies responsible for responding to accidental releases.

9.4 **Does the plan include information on emergency health care?** Indicate whether or not the plan includes information on emergency health care.

9.5 **The date of the most recent review or update of the emergency response plan**

9.6 **The date of the most recent emergency response training for employees:** Enter the date of the last emergency response training. Drills involving your personnel with or without outside emergency response agencies and tabletop exercises of your emergency response plan are acceptable. Single purpose drills (e.g., alarm system drills) may be listed, but exercises that test more aspects of the plan are preferable.

9.7 **The name and telephone number of the local agency with which the plan is coordinated:** Indicate the name and phone number of the agency that reviewed your plan (e.g., fire department). If you do not have a plan, indicate the agency that will handle responses to releases at your source.

9.8 **Subject to:** The following is a list of federal and state regulations dealing with emergency response plans. You may or may not be covered under these regulations. Check all that apply.

a. **OSHA 1910.38:** OSHA's Emergency Action Plan. All sources are subject to this rule except state and local governments in states without delegated OSHA programs.

b. **OSHA 1910.120:** OSHA's Hazardous Waste Operations and Emergency Response (HAZWOPER) plan.

c. **Clean Water Act/SPCC (40 CFR 112):** EPA's oil Spill Prevention Control and Countermeasures Plan requirements.

d. **RCRA (40 CFR 264, 265, 279.52):** EPA's Resource Conservation and Recovery Act permitting requirements for solid waste.

e. **OPA 90 (40 CFR 112, 33 CFR 154, 49 CFR 194, 30 CFR 254):** EPA, U.S. Coast Guard, Department of Transportation, and Department of the Interior facility response plan requirements. Currently these apply only to oil.

f. **State EPCRA Rules/Law:** These are the state emergency planning and community right-to-know laws. Federal EPCRA does not require facility response plans, but some state laws may.

g. **Other (specify)**

RISK MANAGEMENT PLAN DATA ELEMENTS

1. REGISTRATION

1.1 Source identification
a. Name
b. Street
c. City   d. County   e. State   f. Zip
g. Latitude   h. Longitude

1.2 Source Dun and Bradstreet number

1.3 a. Name of corporate parent company (if applicable)
b. Dun and Bradstreet number of corporate parent company (if applicable)

1.4 Owner/operator
a. Name   b. Phone
c. Mailing address

1.5 Name and title of person responsible for part 68 implementation

1.6 Emergency contact
a. Name   b. Title
c. Phone   d. 24-hour phone

1.7 For each covered process:

a.	1. Chemical name	2. CAS number	3. Quantity	4. SIC code	5. Program level
b.	1. Chemical name	2. CAS number	3. Quantity	4. SIC code	5. Program level
c.	1. Chemical name	2. CAS number	3. Quantity	4. SIC code	5. Program level

1.8 EPA Identifier

1.9 Number of full-time employees

1.10 Covered by

a.	OSHA PSM	1. ___ Yes	2. ___ No
b.	EPCRA section 302	1. ___ Yes	2. ___ No
c.	CAA Title V operating permit	1. ___ Yes	2. ___ No

1.11 Last safety inspection

Date   By
a.______________ b. ___ OSHA
c. ___ State OSHA
d. ___ EPA
e. ___ State EPA
f. ___ Fire department

g. ___ Other (specify)
h. ___ Not applicable

2. TOXICS: WORST CASE (complete at least one)

2.1 Chemical name

2.2 Physical state

a. ___ Gas　　b. ___ Liquid

2.3 Results based on

a. ___ Reference table　　b. ___ Modeling

c. Model used ____________________

2.4 Scenario

a. ___ Explosion　　c. ___ Toxic gas release

b. ___ Fire　　d. ___ Liquid spill and vaporization

2.5 Quantity released ________ lbs　　2.6 Release rate ______ lbs/min.

2.7 Release duration (if modeled) ______ min.

2.8 Wind speed ________ m/sec　　2.9 Stability class ______

2.10 Topography (check one) a. ___ Urban b. ___ Rural

2.11 Distance to endpoint _____ miles

2.12 Residential population within distance (number) ___________

2.13 Public receptors (check all that apply)

a. ___ Schools　　d. ___ Prisons

b. ___ Residences　　e. ___ Public recreational areas or arenas

c. ___ Hospitals　　f. ___ Major commercial, office, or industrial areas

2.14 Environmental receptors within distance (check all that apply)

a. ___ National or state parks, forests, or monuments

b. ___ Officially designated wildlife sanctuaries, preserves, or refuges

c. ___ Federal wilderness areas

2.15 Passive mitigation considered (check all that apply)

a. ___ Dikes　　d. ___ Drains

b. ___ Enclosures　　e. ___ Sumps

c. ___ Berms　　f. ___ Other (specify)

3. TOXICS: ALTERNATIVE RELEASES (complete for each toxic)

3.1 Chemical

3.2 Physical state

a. ___ Gas   b. ___ Liquid

3.3 Results based on

a. ___ Reference table   b. ___ Modeling
c. Model used ______________________________

3.4 Scenario (check one)

a. ___ Transfer hose failure
b. ___ Pipe leak
c. ___ Vessel leak
d. ___ Overfilling
e. ___ Rupture disk/relief valve
f. ___ Excess flow valve failure
g. ___ Other (specify) ____________________________

3.5 Quantity released ________ lbs   3.6 Release rate ______ lbs/min.

3.7 Release duration ______ min.

3.8 Wind speed ________ m/sec   3.9 Stability class ______

3.10 Topography (check one) a. __ Urban   b. __ Rural

3.11 Distance to endpoint _____ miles

3.12 Residential population within distance (number) ___________

3.13 Public receptors (check all that apply)

a. ___ Schools
b. ___ Residences
c. ___ Hospitals
d. ___ Prisons
e. ___ Public recreational areas or arenas
f. ___ Major commercial, office, or industrial areas

3.14 Environmental receptors within distance (check all that apply)

a. ___ National or state parks, forests, or monuments
b. ___ Officially designated wildlife sanctuaries, preserves, or refuges
c. ___ Federal wilderness areas

3.15 Passive mitigation considered (check all that apply)

a. ___ Dikes
b. ___ Enclosures
c. ___ Berms
d. ___ Drains
e. ___ Sumps
f. ___ Other (specify)

3.16 Active mitigation considered (check all that apply)

a. ___ Sprinkler systems
b. ___ Deluge system
c. ___ Water curtain
d. ___ Neutralization
e. ___ Excess flow valve
f. ___ Flares
g. ___ Scrubbers
h. ___ Emergency shutdown systems
i. ___ Other (specify)

4. **FLAMMABLES WORST CASE** (complete one)

4.1 Chemical

4.2 Results based on (check one)

a. ___ Reference table b. ___ Modeling
c. Model used ______________________________

4.3 Scenario (check one)

a. ___ Vapor cloud explosion b. ___ Fireball

4.4 Quantity released ________ lbs

4.5 Endpoint used _________

4.6 Distance to endpoint _____ miles

4.7 Residential population within distance (number) ___________

4.8 Public receptors (check all that apply)

a. ___ Schools
b. ___ Residences
c. ___ Hospitals
d. ___ Prisons
e. ___ Public recreational areas or arenas
f. ___ Major commercial, office, or industrial areas

4.9 Environmental receptors within distance (check all that apply)

a. ___ National or state parks, forests, or monuments
b. ___ Officially designated wildlife sanctuaries, preserves, or refuges
c. ___ Federal wilderness areas

4.10 Passive mitigation considered (check all that apply)

a. ___ Dikes
b. ___ Fire walls
c. ___ Blast walls
d. ___ Enclosures
e. ___ Other (specify)

5. FLAMMABLES ALTERNATIVE RELEASES (complete one)

5.1 Chemical

5.2 Results based on (check one)

a. ___ Reference table
b. ___ Modeling
c. Model used ____________________

5.3 Scenario (check one)

a. ___ Vapor cloud explosion
b. ___ Fireball
c. ___ BLEVE
d. ___ Pool fire
e. ___ Jet fire
f. ___ Vapor cloud fire

5.4 Quantity released _______ lbs

5.5 Endpoint used ________

5.6 Distance to endpoint _____ miles

5.7 Residential population within distance (number) __________

5.8 Public receptors (check all that apply)

a. ___ Schools
b. ___ Residences
c. ___ Hospitals
d. ___ Prisons
e. ___ Public recreational areas or arenas
f. ___ Major commercial, office, or industrial areas

5.9 Environmental receptors within distance (check all that apply)

a. ___ National or state parks, forests, or monuments
b. ___ Officially designated wildlife sanctuaries, preserves, or refuges
c. ___ Federal wilderness areas

5.10 Passive mitigation considered (check all that apply)

a. ___ Dikes
b. ___ Fire walls
c. ___ Blast walls

5.11 Active mitigation considered (check all that apply)

a. ___ Sprinkler systems
b. ___ Deluge system
c. ___ Water curtain
d. ___ Excess flow valve

6. FIVE-YEAR ACCIDENT HISTORY (complete the following for each release)

6.1 Date ______________ 6.2 Time ______
6.3 Release duration ______________

6.4 Chemical(s)

6.5 Quantity released (lbs) ______________

6.6 Release event

a. ___ Gas release
b. ___ Liquid spill/evaporation
c. ___ Fire
d. ___ Explosion

6.7 Release source

a. ___ Storage vessel
b. ___ Piping
c. ___ Process vessel
d. ___ Transfer hose
e. ___ Valve
f. ___ Pump

6.8 Weather conditions at time of event (if known)

a. Wind speed/direction _______
b. Temperature _______
c. Stability class ______
d. Precipitation present _____
e. Unknown ____

6.9 On-site impacts

a. Deaths ________ (number)
b. Injuries _______ (number)
c. Property damage ($) ________

6.10 Known offsite impacts

a. Deaths ________ (number)
b. Hospitalizations _______ (number)
c. Other medical treatment _______ (number)
d. Evacuated ___________ (number)
e. Sheltered __________ (number)
f. Property damage ($) _________
g. Environmental damage ________ (specify type)

6.11 Initiating event

a. ___ Equipment failure
b. ___ Human error
c. ___ Weather condition

6.12 Contributing factors (check all that apply)

a. ___ Equipment failure
b. ___ Human error
c. ___ Improper procedures
d. ___ Overpressurization
e. ___ Upset condition

f. ___ By-pass condition
g. ___ Maintenance activity/Inactivity
h. ___ Process design
i. ___ Unsuitable equipment
j. ___ Unusual weather condition
k. ___ Management error

6.13 Offsite responders notified a. ___Yes b. ___ No

6.14 Changes introduced as a result of the accident

a. ___ Improved/upgrade equipment
b. ___ Revised maintenance
c. ___ Revised training
d. ___ Revised operating procedures
e. ___ New process controls
f. ___ New mitigation systems
g. ___ Revised emergency response plan
h. ___ Changed process
i. ___ Reduced inventory
j. ___ Other
k. ___ None

7. PREVENTION PROGRAM **PROGRAM 3** (For Each Program 3 Process)

7.1 SIC code for process ________

7.2 Name of substance(s) covered

a. b. c.

7.3 Date on which the safety information was last reviewed or revised

7.4 PHA

a. The date of completion of the most recent PHA or update

b. The technique used

1. ___ What If
2. ___ Checklist
3. ___ What If/Checklist
4. ___ HAZOP
5. ___ Failure Mode and Effects Analysis
6. ___ Fault Tree Analysis
7. ___ Other

c. The expected date of completion of any changes resulting from the PHA

d. Major hazards identified (check all that apply)

1. _____ Toxic release
2. _____ Fire
3. _____ Explosion
4. _____ Runaway reaction
5. _____ Polymerization
6. _____ Overpressurization
7. _____ Corrosion
8. _____ Overfilling
9. _____ Contamination
10. _____ Equipment failure
11. _____ Loss of cooling, heating, electricity, instrument air
12. _____ Earthquake
13. _____ Floods (flood plain)
14. _____ Tornado
15. _____ Hurricanes
16. _____ Other

e. Process controls in use (check all that apply)

1. _____ Vents
2. _____ Relief valves

7.6 Training

a. The date of the most recent review or revision of training programs

b. The type of training provided
1. ___ Classroom
2. ___ Classroom plus on the job
3. ___ On the job
4. ___ Other

c. The type of competency testing used
1. ___ Written tests
2. ___ Oral tests
3. ___ Demonstration
4. ___ Observation
5. ___ Other

7.7 Maintenance

a. The date of the most recent review or revision of maintenance procedures
b. The date of the most recent equipment inspection or test
c. The equipment inspected or tested

7.8 Management of Change

a. The date of the most recent change that triggered management of change procedures
b. The date of the most recent review or revision of management of change procedures

7.8 The date of the most recent pre-startup review

7.9 Compliance audits

a. The date of the most recent compliance audit
b. The expected date of completion of any changes resulting from the compliance audit

7.10 Incident investigation

a. The date of the most recent incident investigation
b. The expected date of completion of any changes resulting from the investigation

7.11 The date of the most recent review or revision of employee participation plans

7.12 The date of the most recent review or revision of hot work permit procedures

7.13 The date of the most recent review or revision of contractor safety procedures

7.14 The date of the most recent evaluation of contractor safety performance

3. _____ Check valves
4. _____ Scrubbers
5. _____ Flares
6. _____ Manual shutoffs
7. _____ Automatic shutoffs
8. _____ Interlocks
9. _____ Alarms and procedures
10. _____ Keyed bypass
11. _____ Emergency air supply
12. _____ Emergency power
13. _____ Backup pump
14. _____ Grounding equipment
15. _____ Inhibitor addition
16. _____ Rupture disks
17. _____ Excess flow device
18. _____ Quench system
19. _____ Purge system
20. _____ Other

f. Mitigation systems in use (check all that apply)

1. _____ Sprinkler system
2. _____ Dikes
3. _____ Fire walls
4. _____ Blast walls
5. _____ Deluge system
6. _____ Water curtain
7. _____ Enclosure
8. _____ Neutralization
9. _____ Other

g. Monitoring/detection systems in use (check all the apply)

1. _____ Process area detectors
2. _____ Perimeter monitors
3. _____ Other

h. Changes since last PHA update (check all that apply)

1. _____ Reduction in chemical inventory
2. _____ Increase in chemical inventory
3. _____ Change in process parameters
4. _____ Installation of process controls
5. _____ Installation of process detection systems
6. _____ Installation of perimeter monitoring systems
7. _____ Installation of mitigation systems
8. _____ Other
9. _____ None required/recommended

7.5 The date of the most recent review or revision of operating procedures

8. PREVENTION PROGRAM   PROGRAM 2 (For Each Program 2 Process)

8.1 SIC code for process _________

8.2. Chemicals

a.
b.

8.3 Safety information

a. The date of the most recent review or revision of the safety information
b. A list of Federal or state regulations or industry-specific design codes and standards used to demonstrate compliance with the safety information requirement.

1. ___ NFPA 58 (or state law based on NFPA 58)
2. ___ OSHA 1910.111
3. ___ ASTM
4. ___ ANSI standards
5. ___ ASME standards
6. ___ Other (specify)
7. ___ None

8.4 Hazard review

a. The date of completion of the most recent hazard review or update

b. The expected date of completion of any changes resulting from the hazard review

c. Major hazards identified (check all that apply)

1. _____ Toxic release
2. _____ Fire
3. _____ Explosion
4. _____ Runaway reaction
5. _____ Polymerization
6. _____ Overpressurization
7. _____ Corrosion
8. _____ Overfilling
9. _____ Contamination
10. _____ Equipment failure
11. _____ Loss of cooling, heating, electricity, instrument air
12. _____ Earthquake
13. _____ Floods (flood plain)
14. _____ Tornado
15. _____ Hurricanes
16. _____ Other

d. Process controls in use (check all that apply)

1. _____ Vents
2. _____ Relief valves
3. _____ Check valves
4. _____ Scrubbers
5. _____ Flares
6. _____ Manual shutoffs
7. _____ Automatic shutoffs
8. _____ Interlocks
9. _____ Alarms and procedures
10. _____ Keyed bypass
11. _____ Emergency air supply
12. _____ Emergency power
13. _____ Backup pump
14. _____ Grounding equipment
15. _____ Inhibitor addition
16. _____ Rupture disks
17. _____ Excess flow device
18. _____ Quench system
19. _____ Purge system
20. _____ Other

e. Mitigation systems in use (check all that apply)

1. _____ Sprinkler system
2. _____ Dikes
3. _____ Fire walls
4. _____ Blast walls
5. _____ Deluge system
6. _____ Water curtain
7. _____ Enclosure
8. _____ Neutralization
9. _____ Other

f. Monitoring/detection systems in use

1. _____ Process area detectors
2. _____ Perimeter monitors
3. _____ Other

g. Changes since last hazard review update (check all that apply)

1. _____ Reduction in chemical inventory
2. _____ Increase in chemical inventory
3. _____ Change in process parameters
4. _____ Installation of process controls
5. _____ Installation of process detection systems
6. _____ Installation of perimeter monitoring systems
7. _____ Installation of mitigation systems

8. _____ Other
9. _____ None required/recommended

8.5 The date of the most recent review or revision of operating procedures

8.6 Training

a. The date of the most recent review or revision of training programs

b. The type of training provided
1. ___ Classroom
2. ___ Classroom plus on the job
3. ___ On the job
4. ___ Other

c. The type of competency testing used
1. ___ Written tests
2. ___ Oral tests
3. ___ Demonstration
4. ___ Observation
5. ___ Other

8.7 Maintenance

a. The date of the most recent review or revision of maintenance procedures
b. The date of the most recent equipment inspection or test
c. The equipment inspected or tested

8.8 Compliance audits

a. The date of the most recent compliance audit
b. The expected date of completion of any changes resulting from the compliance audit

8.9 Incident investigation

a. The date of the most recent incident investigation
b. The expected date of completion of any changes resulting from the investigation

8.10 The date of the most recent change that triggered a review or revision of safety information, the hazard review, operating or maintenance procedures, or training

9. EMERGENCY RESPONSE

9.1 Do you have a written emergency response plan? a. ___ Yes b. ___ No

9.2 Does the plan include specific actions to be taken in response to an accidental releases of a regulated substance? a. ___ Yes b. ___ No

9.3 Does the plan include procedures for informing the public and local agencies responsible for responding to accidental releases? a. ___ Yes b. ___ No

9.4 Does the plan include information on emergency health care? a. ___ Yes b. ___ No

9.5 The date of the most recent review or update of the emergency response plan

9.6 The date of the most recent emergency response training for employees

9.7 The name and telephone number of the local agency with which the plan is coordinated

a. Name b. Telephone number

9.8 Subject to (check all that apply)

a. ___ OSHA 1910.38 (Emergency Action Plan)
b. ___ OSHA 1910.120 (HAZWOPER)
c. ___ Clean Water Act/SPCC
d. ___ RCRA
e. ___ OPA-90
f. ___ State EPCRA Rules/Law
g. ___ Other (specify)

Appendix B

USACHPPM Compliance Assistance Checklist

Risk Management Plan (RMP) Checklist

1. **Applicability:**

a. The enclosed checklist is designed to help the installation determine whether it has any covered processes subject to the requirements of Section 112(r) of the Clean Air Act Amendment of 1990 (CAAA-90), "Prevention of Accidental Releases". The "checklist" is enclosed in three parts: an instruction section; a checklist and information sheet; and a list of chemical uses at Department of Defense (DOD) installations.

b. This regulation is frequently referred to as the Risk Management Plan (RMP) rule, or simply, Section 112(r). Affected installations will be required to submit an RMP to the U.S. Environmental Protection Agency (EPA). Installation personnel have expressed concern over this major rulemaking for a number of reasons. Since some installations will have no requirements, and because the Department of the Army (DA) is preparing assistance for those installations which will have compliance requirements, this checklist has been developed.

c. This checklist will help installations assess whether listed Section 112(r) chemicals are used or stored in amounts that do (or potentially could) exceed published threshold levels. If they are, then a RMP will be required. The completed RMP checklist will assist in planning RMP work and quality assurance (QA) reviews, and will be used as an Environmental Compliance Assessment System guideline.

2. **Background:**

a. Section 112(r) represents a major EPA rule. The regulation requires industry and government agencies to work toward preventing catastrophic chemical accidents. The regulation requires that a RMP be submitted to the EPA. The RMP is a summary of the installation's risk management *program* (NOTE: some documentation will use "RMP" to refer to the *Program* rather than the *Plan*. To emphasize, the Risk Management Plan is what you submit, a risk management program is what you do. This document will consistently refer to the Plan as the RMP, the regulation as Section 112(r), and the program will be spelled out.) A risk management program consists of four elements: management, hazard assessment, accident prevention planning, and emergency response. The RMP reflects specific requirements of each of these elements depending on the risk level of the chemical in question.

b. A unique list of substances has been developed for this rule. This list was published by the EPA, 21 January 1994. It includes toxic chemicals and flammable substances. Toxic chemicals have individual threshold values, while all flammables have thresholds of 10,000 pounds. "Threshold" is the amount present at a covered process that subjects that process to Section 112(r) requirements.

c. Chlorine is expected to exceed threshold quantities on many military installations due to it's common use in water and wastewater treatment systems. Ammonia, sulfur dioxide, and flammables such as butane, methane and/or propane may also be found at some installations in sufficient amounts to trigger Section 112(r) requirements.

d. The Section 112(r) rule that lists toxic and flammable substances also includes a general duty clause. This requires facilities to perform activities to prevent releases of harmful substances as a matter of general business practice and regardless of the type or quantity of the substance in a process. The general duty clause requirements are not limited to substances listed in the January 1994 rule making. Activities include hazards identification and assessment, design, maintenance and operation of a safe facility, and minimizing the consequences of accidental releases if they occur. The Tri-Services are currently discussing how to comply with the general duty. Policy guidance is expected to be prepared and distributed in the near future.

e. Please be reminded that explosives are not presently considered eligible as a Section 112(r) substance due to an agreement between the Institute of Makers of Explosives and the EPA.

f. The enclosed "Uses of Listed Section 112(r) Substances at DOD Installations" (encl 3 to encl) was generated by cross-referencing the Section 112(r) list of toxic chemicals and flammable substances against the Navy Hazardous Materials Information System (HMIS) CD-ROM. Output from the cross-index yielded materials likely to contain Section 112(r) chemicals. ***This listing is not comprehensive.*** The authors are not familiar with *all* Army processes and chemical uses. It is intended that institutional knowledge combined with the chemical use list as a "memory jogger", will provide a complete applicability review.

3. **Ongoing Work.**

a. The Army is currently resolving policy issues and is coordinating with other services Major Army Command (MACOM) representatives for consistent Section 112(r) implementation. This effort includes DA MACOM telephone conferences and Tri-Service Committee meetings.

b. The U.S. Army Environmental Center (AEC) has provided resources to the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) to prepare the following:

(1) This document (RMP Checklist).

(2) An interim model scope of work to be delivered to installations 1st Qtr fiscal year (FY) 97 and a Final Version (incorporating lessons learned) to be delivered 3d Qtr FY97.

(3) An interim technical assistance document to be delivered to installations 1st Qtr FY97 and a Final Version (incorporating lessons learned) to be delivered 3d Qtr FY97.

c. During FY97 and FY98 the AEC will provide resources to USACHPPM to perform QA reviews on all Army Risk Management Plans.

4. **Further Information.**

a. The point of contact for this document is Dr. David A. Reed or CPT Jeanne Pricer, Commander, USACHPPM, ATTN: MCHB-DC-EAP, APG, MD 21010-5422, DSN 584-3500/3954 or commercial, (410) 671 3500/3549.

b. Other sources of information include:

(1) <u>**EPA Air Bulletin Board**</u>
World Wide Web: http://ttnwww.rtpnc.epa.gov/
PC Modem Dialup: 919-333-5067 (for non-www users)
Telnet to: ttnbbs.rtpnc.epa.gov

Available from the EPA are the Final Rule, pre-amble to the final rule, off-site consequence guidance, ammonia refrigeration facility draft model RMP, data elements for an RMP, and instruction for the data elements.

(2) **DENIX**

World Wide Web: http://denix.cecer.army.mil/denix/denix.html
PC Modem Dialup: 217-541-5742 (for non-www users)
Telnet to: osiris.cso.uiuc.edu

The Hazardous Air Pollutant (HAP) Status binder 112(r) section can be downloaded from the HAP library of the general file library. (NOTE: The rest of the HAP Status binder can also be obtained from the general file library.)

(3) The USACHPPM contacts named above can also provide this information by E-mail or direct mailing.

RMP Checklist Instructions

1. Definitions. The following definitions must be understood by installation personnel before determining applicability. The EPA definitions from the final rule are italicized below, followed by comment:

a. *Offsite means areas beyond the property boundary of the stationary source, and areas within the property boundary to which the public has routine and unrestricted access during or outside business hours.* Note that for DA installations that are open posts, **property boundary will have no meaning for this regulation.** The definition of off-site would include military family housing, recreation centers, AAFES, museums, etc.

b. *Process means any activity involving a regulated substance including any use, storage, manufacturing handling, or on-site movement of such substances, or combination of these activities. For the purposes of this definition, any group of vessels that are interconnected, or separate vessels that are located such that a regulated substance could be involved in a potential release, shall be considered a single process.* Note that if materiel is brought onsite to a warehouse and then transported to be used, the storage, transport and use could be defined as one "process". Note also the concept of *involved in a potential release* is integral to this definition (see paragraph e., below).

c. *Public receptor means offsite residences, institutions (e.g., schools, hospitals), industrial, commercial, and office buildings, parks, or recreational areas inhabited or occupied by the public at any time without restriction by the stationary source where members of the public could be exposed to toxic concentrations, radiant heat, or overpressure as a result of an accidental release.* The terms "public" and "off-site" in this definition clarifies the applicability of the rule to onpost areas.

d. *Public means any person except employees or contractors at the stationary source.* By this definition, public would include military dependants and retirees, as well as members of the general public.

e. *Threshold quantity means the quantity specified for regulated substances pursuant to section 112(r)(5) of the Clean Air Act as amended, listed in § 68.130 and determined to be present at a stationary source as specified in § 68.115 of this Part.*

To avoid tracking the references, this can be understood by looking at EPA's explanation of the definition for threshold quantity as found in the preamble text to the final rule:

As recommended by most commenters, EPA is retaining the threshold determination based on the total quantity in a process, using the same process definition as [Occupational Safety and Health Act] *(OSHA). This approach focuses on the quantity of a substance that might be released in a single accident, and that could be reasonably anticipated to cause effects of concern as a result of an accidental release. This threshold determination approach is consistent with OSHA's* [Process Safety Management] *PSM standard.*

The critical point to note is that the threshold can only be exceeded within a single process and must be capable of being released in a single catastrophic accident.

2. Examples.

a. Chlorine is a regulated substance, with a Section 112(r) listed threshold quantity of 2,500 pounds. An installation that has 1,400 pounds of chlorine at the wastewater treatment plant and 1,300 pounds at the drinking water plant, (total 2,700 pounds) **would not trigger the Section 112(r) requirements** threshold and would not have to report chlorine (unless, in the unusual case that all these were co-located or connected via process piping).

b. An installation that has two 1-ton cylinders of chlorine (4,000 pounds) at the wastewater treatment plant and 1,000 pounds of chlorine at the drinking water plant **would trigger the Section 112(r) requirements** and have one covered process (the wastewater treatment plant). The chlorine at the drinking water plant would not trigger the applicability threshold and would not be considered for submission.

c. If the installation has two 1-ton cylinders at the treatment plant and two 1- ton cylinders at the drinking water plant, the installation would trigger the Section 112(r) requirements, having two covered processes with one listed chemical. The USACHPPM is aware of at least one DA installation which will meet this scenario.

d. As a contrast to the above, the USACHPPM is aware of an installation which exceeds the threshold for chlorine and sulfur dioxide in their wastewater treatment plant. This installation will have two listed chemicals in one covered process.

3. Special Note About Chlorine. Most swimming pools are not expected to be considered covered processes since most use solid disinfectants (such as the commercially available product, HTH). These substances are often called "chlorine" but are not. The active component in these substances is usually a form of hypochlorite, which is not a Section 112(r) listed substance. Only chlorine gas (usually found in cylinders, under pressure) is the chemical of concern.

4. Other Applicability Concerns.

a. Mixture Rules.

(1) Mixtures containing 112(r) listed ***toxic chemicals*** present at a concentration of one percent or greater by weight must be considered when determining if threshold amounts are exceeded. Only the weight of the listed chemical in the mixture is considered for determining the threshold (e.g., total weight of mixture multiplied by the percentage listed chemical). Mixtures containing regulated toxic substances which exceed the threshold are exempt from 112(r) eligibility if the facility demonstrates that the partial pressure of the regulated substance in the mixture under all storage or handling conditions is less than 10mm Hg.

2) Mixtures containing 112(r) listed ***flammable substances*** present at a concentration of one percent or greater by weight must also be considered. In this case, the *entire weight of the mixture, not just the chemical present,* is applied to threshold determination. Mixtures containing regulated flammable substances are exempt from threshold determination if the facility demonstrates that the mixture itself does not meet the criteria for flammability: flash point below 73° F, and boiling point below 100° F.

b. The Section 112(r) requirements will apply when a threshold is *first* exceeded. Installations may wish to consider mobilization situations or other surge conditions in which chemical amounts and usage may reach their greatest value. Personnel should be aware that not only are threshold amounts in processes included, but also storage of chemicals in warehouses and intra-installation transportation of chemicals.

c. Concerning storage of chemicals; large storage containers (above ground tanks) would be expected to fall under the "potentially involved in a single catastrophic release" concept. Even a large collection of drums could possibly meet this definition. In the case of large amounts of small containers (e.g., hundreds or even thousands of 1 gallon cans), we recommend installation personnel seek the opinion of their fire department to determine if the listed chemical could possibly be involved in a single catastrophic release. The USACHPPM is currently seeking to clarify and provide guidance on the level of concern which should be given to warehousing operations.

RMP CHECKLIST

1) The following substances are most likely to trigger a RMP on installations. The USACHPPM recommends that priority be placed on specifically investigating these initial substances to determine whether they potentially can, or currently do exist onpost at greater than threshold quantities. The most probable locations for these chemicals are listed.

CHEMICAL SUBSTANCES

_____ a) Chlorine. Check for chlorine water disinfection at wastewater treatment plants or drinking water plants. Installations which receive drinking water from local municipalities and/or send wastewater to local Publicly Owned Treatment Works may not exceed a chlorine threshold. If disinfection of water does occur onpost, determine the amount of chlorine used at the various locations. Note that only chlorine is listed. Common disinfection chemicals such as calcium hypochlorite or other "solid" disinfection chemicals are not reportable. The chlorine threshold is 2,500 pounds.

_____ b) Sulfur Dioxide. This substance is used in wastewater treatment plants on some installations. It can exist for other water treatment, chemical reactant, manufacturing, or process purposes. Only anhydrous sulfur dioxide is listed. The threshold value for sulfur dioxide is 5,000 pounds.

_____ c) Ammonia. Pure ammonia tanks can be found in some agricultural applications. There is, however, a farming exemption. Note that solid fertilizer and many liquid fertilizers do not contain pure ammonia, rather, they contain ammonia compounds that are not covered by this rule. Only anhydrous ammonia and ammonia at greater than 20% concentration is considered for the RMP rule. Anhydrous ammonia has a threshold value of 10,000 pounds and ammonia solutions greater than 20% have a threshold of 20,000 pounds.

_____ d) Hydrochloric Acid. Hydrochloric acid is commonly used in many industrial and laboratory type applications. It is only reportable via the RMP if it exists at greater than 30 percent concentration with a threshold of 15,000 pounds or in the anhydrous form with a threshold of 5,000 pounds.

_____ e) Nitric Acid. Nitric acid is commonly used in many industrial and laboratory type applications. It is only reportable via the RMP if it exists at greater than 80 percent concentration with a threshold of 15,000 pounds.

FLAMMABLE SUBSTANCES

_____ f) Propane. Propane exists primarily for heating or for vehicle fuel. Installation propane storage can be large for installations not on natural gas pipelines and that don't have a central heating plant. The tanks can be especially large if used for heating buildings. If large propane tanks are being used, the installation's Contracts and Facility Engineers Offices should be aware of them.

_____ g) Methane. Installation natural gas (methane) pipelines will not trigger RMP requirements unless a Compressed Natural Gas (CNG) storage system is used. The USACHPPM is aware of one DA installation planning such a system to be located at the refueling point for alternative fueled vehicles. If large methane tanks are being used, or are planning to be used, the installation's Contracts, Facilities Engineers or Environmental Office should be aware of them.

_____ h) Butane and Propane as propellants. Propane is noted above as a common fuel. Both butane and propane may exist in large quantities in warehousing operations which contain aerosol cans. Many aerosols use butane and/or propane as the propellant mixture. The threshold for either one of these is 10,000 pounds.

2. Other chemicals of concern. Installations are advised to check spill plans and Emergency Planning and Community Right-to-Know Act inventories against the Section 112(r) list of toxic and flammable substances. To aid the installation, enclosed is Uses of Listed Section 112(r) Substances at DOD Installations (encl 3 to encl).

CAAA-90, Section 112(r), RMP Checklist

REPRODUCE THIS PAGE FOR EACH SECTION 112 (r) SUBSTANCE EXCEEDING A THRESHOLD

1. Listed Chemical ______________________
2. Maximum Amount ______________________
3. Covered Process ______________________
4. Approximate Distance To Nearest Public Receptor ______________________
5. Installation RMP Contact
   a. Name ______________________
   b. Address ______________________
      ____
      ____
      ____
   c. Phone/Fax ______________________
   d. E-mail (if applicable) ______________________

Do not submit Classified or Sensitive information on this sheet

CAAA-90, Section 112(r), RMP Checklist

Uses of Listed Section 112(r) Substances at DOD Installations

A. The following Section 112(r) listed chemicals were found in the Navy Hazardous Material Information System (HMIS) database and therefore, could exist on military installations. Section 112(r) toxic chemicals are listed first followed by 112(r) flammable substances. Within each list, commonly expected items are listed first, followed by those not expected to be a large impact to military installations. Most of the "low impact" items listed are used in small amounts on an installation and are not expected to trigger thresholds. Only for warehousing operations or unique situations would it be expected that many of the below listed items be considered. Installation personnel should be aware of such large concentrations of these products.

B. Many of the items listed are trade name and trade marked items. The use of these materials for inclusion on this list does not represent an endorsement from any Federal Agency.

C. Toxic Chemicals:

1. Chlorine:
<u>Probable location(s)</u>: Waste water and drinking water treatment plants, swimming pools.
<u>Threshold (pounds)</u>: 2,500.
<u>Comments</u>: Water treatment will be one of the most common covered processes found on Army installations. Chlorine is most often found in 1-ton or 150-pound cylinders. Swimming pools are unlikely to have threshold amounts stored or utilized on location. Particular attention must be paid to possible interconnections of storage vessels through piping, and intra-installation transport.
<u>May be Present in the Following Mixtures</u>: UNK

2. Sulfur Dioxide:
<u>Probable location(s)</u>: Wastewater treatment plants.
<u>Threshold (pounds)</u>: 5,000.
<u>Comments: Primary impact to military installations will probably be wastewater treatment</u>.
<u>May be Present in the Following Mixtures</u>: (concentration range: 1-100%): coulamats, various process compounds/solutions.

3. Ammonia:
Probable location(s): refrigeration, chemical laboratories, shops.
Threshold (pounds): anhydrous: 10,000; conc. 20 percent or greater: 20,000.
Comments: Anhydrous ammonia is 100 percent concentration, certain agricultural exemptions apply.
May be Present in the Following Mixtures: Process mixtures, disinfection and cleaning solutions. Fertilizer solutions.

4. Liquid fuels used for motor vehicles:
NOTE: At this time USACHPPM does not believe that liquid fuels will trigger RMP reporting.
Probable location(s): Gasoline (MOGAS), diesel, jet fuels (JP4, JP5, JP8); tanks and stations.
Comments: The RMP listed *chemical* components of gasoline are exempt from consideration by EPA. Diesel and jet fuels need not be considered since they do not meet the above mentioned criteria for flammability: flash point below 73° F, boiling point below 100° F. Also, any listed components are not present in the fuel mixture in amounts at or above 1 percent. Propane is discussed below.
May be Present in the Following Mixtures: UNK

5. Chloroform (trichloromethane):
Probable location(s): Dental clinics, laboratories, shops.
Threshold (pounds): 20,000.
Comments: An ODC substance.
May be Present in the Following Mixtures: Dental applications, solvents/thinners, hydranal coulamat, titration solutions, Aquimicron, Turco.

6. Ethylene oxide:
Probable location(s): Hospitals, shops.
Threshold (pounds): 10,000.
Comments: Used for sterilization. Unlikely to be present in threshold amounts.
May be Present in the Following Mixtures: Various paints and strippers, Penngas, sterilant mixtures.

7. Fluorine:
Probable location(s): UNK.
Threshold (pounds): 1,000.
Comments: None.
May be Present in the Following Mixtures: DAP, research applications, aluminum foundries.

8. Formaldehyde:
Probable location(s): Hospitals, biological laboratories, museums, shops.
Threshold (pounds): 15,000.
Comments: None.
May be Present in the Following Mixtures (concentration range: 1-100%): adhesives, sealers, gels, stabilizers and replenishers, paints and enamels, fixation and embalming fluids, resins, reduction solutions, Aqua-kem, formo-cresol, hexaphene, Bouin's fluid, developers, fixatives, hardeners, fireproofing, formalyne.

9. Hydrazine:
Probable location(s): Ordnance manufacturing plants, rockets, ordnance.
Threshold (pounds): 15,000.
Comments: May be present at open burning/open detonation sites.
May be Present in the Following Mixtures: (concentration range: 1-100%): Various hydrazine solutions, Fairzine, propelants.

10. Hydrochloric Acid:
Probable location(s): Shops, chemical laboratories
Threshold (pounds): Anhydrous: 5,000; conc. greater than 30 percent: 15,000.
Comments: Unlikely to be present in any significant amounts on Army installations, in concentrations greater than 30 percent.
May be Present in the Following Mixtures: arsenious acid solutions, some metal cleaners, some plasma standards. (Acid concentration greater than 30%): Coil conditioners/cleaners, some metal cleaners, some descalers.

11. Nitric acid:
Probable location(s): Shops, chemical laboratories.
Threshold (pounds): 15,000 (conc. greater than 80%).
Comments: Unlikely to be present in any significant amounts on Army posts at threshold quantities.
May be Present in the Following Mixtures (concentration range: greater than 80%): fuming nitric acid.

12. Nitric Oxide:
Probable locations(s): UNK
Threshold (pounds): 10,000.
Comment: Emissions from boilers, engines, turbines would not qualify for RMP consideration. Unlikely to be present in any significant amounts on Army posts. Not found in any mixture.
May be Present in the Following Mixtures: UNK.

13. Phosgene (Carbonic dichloride):
Probable location(s): Chemical agent aresenals.
Threshold (pounds): 500.
Comments: Component in mustard gas,
May be Present in the Following Mixtures: UNK.

14. Toluene 2,4 diisocyanate:
Probable location(s): Chemical laboratories, shops.
Threshold (pounds): 10,000.
Comment: This chemical is NOT pure toluene.
May be Present in the Following Mixtures: (concentration range: 1-100%): urethanes, catalysts, Mondur TD-80, coatings, hardeners, resins, primers, Select Seal hand mix, Stepanfoam.

15. Toluene 2,6 diisocyanate:
Probable location(s): Chemical laboratories, shops.
Threshold (pounds): 10,000.
Comment: This chemical is NOT pure toluene.
May be Present in the Following Mixtures: (concentration range: 2-100%): Mondur, Stepanfoam, prepolymer, Conathane, Chempol, various toluene compounds.

16. Methyl chloride:
Probable location(s): Shops, chemical laboratories, printers.
Threshold (pounds): 10,000.
Comments: None.
May be Present in the Following Mixtures: (concentration range: 1-33%): The PDS, foam adhesive (100% concentration), Formula 1070, ink.

17. Carbon disulfide:
Probable location(s): Chemical laboratories, janitorial shops.
Threshold (pounds): 20,000.
Comments: Substances routinely used in janitorial maintenance are not included in RMPs.
May be Present in the Following Mixtures: (concentration range: 10-100%): Various cleaning compounds, lemon polish.

18. Sulfur trioxide:
Probable location(s): Shops, chemical laboratories.
Threshold (pounds): 10,000.
Comments: None.
May be Present in the Following Mixtures: (concentration range: 1-100%): cement mixing, oleum, fuming sulfuric acid, some coal fired boiler operations.

19. Oleum (fuming sulfurinc acid):
Probable location(s): Chemical laboratories.
Threshold (pounds): 10,000.
Comments: Not found in any mixture, only as fuming sulfuric acid or oleum.
May be Present in the Following Mixtures: UNK.

20. Hydrogen sulfide:
Probable location(s): Chemical laboratories.
Threshold (pounds): 10,000.
Comment: Wastewater treatment emissions would not qualify for RMP considerations.
May be Present in the Following Mixtures: (concentration range: 2-100%): Acetylene, various hydrogen sulfide compounds.

21. Bromine:
Probable location(s): Chemical laboratories, shops, medical facilities.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 10-100%): E-313 part A, various bromine compounds, specialty greases and lubricants.

22. Hydrogen fluoride (hydrofluoric acid):
Probable location(s): Shops, chemical laboratories.
Threshold (pounds): 1,000.
Comments: None
May be Present in the Following Mixtures: (hydrogen fluoride concentration range: 1-100%): Most etchants, brighteners, metal cleaners, 2192 LMX coil cleaner, erusticator, welding flux, strippers, electrical joint compounds, pickling paste, Oakite, Alodine, Zep-a-lume, Bonderite, hydro-foam, various hydrogen fluoride solutions. (Hydrofluoric acid concentration greater than 50%): Most hydrofluoric acids, fluoric acid, Coil Brite.

23. Vinyl acetate:
Probable location(s): Shops.
Threshold (pounds): 15,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-100%): Paints.

24. Epichlorohydrin:
Probable location(s): Shops.
Threshold (pounds): 20,000.
Comments: Unlikely to be present at even 1 percent in mixture, and therefore not subject to RMP.
May be Present in the Following Mixtures: (concentration range: up to 1%): Adhesives, photoprocessing solutions.

25. Acrolein:
Probable location(s): Janitorial shops.
Threshold (pounds): 5,000.
Comments: Substances routinely used in janitorial maintenance are not included in RMPs.
May be Present in the Following Mixtures: (concentration: 10%): Lemon polish.

26. Acrylonitrile:
Probable location(s): Shops.
Threshold (pounds): 20,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 10%): Resins, adhesives, sealants.

27. Ethylenediamine:
Probable location(s): Shops.
Threshold (pounds): 20,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-100%): Plating and stripping substances.

28. Allyl alcohol:
Probable location(s): UNK
Threshold (pounds): 15,000.
Comments: Unlikely to be present at even 1 percent in mixture, and therefore not subject to RMP.
May be Present in the Following Mixtures: (concentration range: up to 1%): Index matching liquid.

29. Cyclohexylamine:
Probable location(s): Shops.
Threshold (pounds): 15,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-90%): Corrosion inhibitor, line treatments.

30. Piperidine:
Probable location(s): Printers.
Threshold (pounds): 15,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-3%): Writing fluid.

31. Crotonaldehyde:
Probable location(s): UNK
Threshold (pounds): 20,000.
Comments: Unlikely to be present in significant quantities on Army installations.
May be Present in the Following Mixtures: (concentration range: UNK): Fluorobrene.

32. Methacrylonitrile:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

33. Ethyleneimine:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 30%): Catalyst for Aquarius Plas-tite II.

34. Tetranitromethane:
Probable location(s): Landscape maintenance.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 20%): Crabgrass stopper.

35. Hydrocyanic acid:
Probable location(s): Shops, chemical laboratories.
Threshold (pounds): 2,500.
Comments: None
May be Present in the Following Mixtures: concentration range: 1-15%): Crest 1700, pump chamber fluid, Hycar.

36. Methyl mercaptan:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: Used to add odor to natural and propane gas. This use would not be considered for RMP reporting since the gas would trigger RMP first.
May be Present in the Following Mixtures: UNK

37. Titanium tetrachloride:
Probable location(s): UNK
Threshold (pounds): 2,500.
Comments: Not found in any mixture. Comprises 100 percent of Smoke Bottle.
May be Present in the Following Mixtures: UNK

38. Propylene oxide:
Probable location(s): Shops, chemical laboratories.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-100%): Solder, Microstop, windshield sealer, various propylene oxide compounds.

39. Trimethylchlorosilane:
Probable location(s): Chemical laboratories.
Threshold (pounds): 10,000.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

40. Dimethyldichlorosilane:
Probable location(s): Chemical laboratories.
Threshold (pounds): 5,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 5%): Sylon-CT Pint.

41. Methyltrichlorosilane:
Probable location(s): UNK
Threshold (pounds): 5,000.
Comments: Comprises 100 percent of Silane Z.
May be Present in the Following Mixtures: UNK

42. Boron trifluoride:
Probable location(s): Shops, chemical laboratories.
Threshold (pounds): 5,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 14-100%): Welding/casting flux, various boron trifluoride compounds.

43. Phosphorous trichloride:
Probable location(s): UNK
Threshold (pounds): 15,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 4-100%): Accelerator.

44. Sulfur tetrafluoride:
Probable location(s): UNK
Threshold (pounds): 2,500.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

45. Arsenous trichloride:
Probable location(s): UNK
Threshold (pounds): 15,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-100%): Various arsenous trichloride compounds.

46. Arsine:
Probable location(s): Welding shops, chemical laboratories.
Threshold (pounds): 1,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 2%, some UNK): Acetylene.

47. Peracetic acid:
Probable location(s): Chemical laboratories.
Threshold (pounds): 10,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 4-35%): Sterilant concentrates, reverse osmosis membranes.

48. Methyl chloroformate:
Probable location(s): UNK
Threshold (pounds): 5,000.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

49. Phosphine:
Probable location(s): UNK
Threshold (pounds): 5,000.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

50. Phosphorous oxychloride:
Probable location(s): UNK
Threshold (pounds): 5,000.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

51. Chlorine dioxide:
Probable location(s): UNK
Threshold (pounds): 1,000.
Comments: Disinfectants used for routine janitorial purposes are not considered for RMP.
May be Present in the Following Mixtures: (concentration range: UNK): Disinfectants.

52. Boron trichloride:
Probable location(s): UNK
Threshold (pounds): 5,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: UNK): Various boron trichloride compounds.

53. Diborane:
Probable location(s): UNK
Threshold (pounds): 2,500.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

54. Toluene diisocyanate:
Probable location(s): Shops, chemical laboratories.
Threshold (pounds): 10,000.
Comment: Do not consider pure toluene as this chemical.
May be Present in the Following Mixtures: (concentration range: 1-100%): Resins, hardeners, activators, polyurethanes, sealants, flatproofing, Stafoam, Uralite, Mondur, Stathane.

D. Flammable Substances.

1. Acetylene (ethyne):
Probable location(s): Shops, especially welding shops, chemical laboratories.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-100%): Welding gas, calibration gas.

2. Butane:
Probable location(s): Shops, motor pools, clean fuel areas, cooking facilities.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 2-4%): Propanes, fuel cells, Snapback, starting fluid, propellant.

3. Ethane:
Probable location(s): Shops, motor pools, clean fuel areas, cooking facilities.
Threshold (pounds): 10,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 1-100%): Propanes, liquid petroleum gas.

4. Hydrogen:
Probable location(s): Shops, chemical laboratories, fuel operations.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: UNK

5. Methane:
Probable location(s):
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixture: (concentration range: 90%): Ethene.

6. Pentane:
Probable location(s): Shops.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 10-80%): Adhesives, petroleum spirits.

7. Propane:
Probable location(s): Vehicle fueling stations, clean fuel areas, shops, cooking facilities.
Threshold (pounds): 10,000.
Comments: Also used for field and recreational cookstoves, heat and light.
May be Present in the Following Mixtures: (concentration range: 1-100%): Frequently present in aerosol cans, Clean fuels, MAP gas, starting fluid, v-belt dressing, Snapback, Dermastat.

8. Isobutane (2-methyl propane):
Probable location(s): Vehicle fueling stations, clean fuel areas, shops, cooking facilities.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-100%): Propanes, paints, primers, lacquers, adhesives, insulation, teflon lube, Snapback, mold release, calibration mix, 3M Super 77, Statebuf.

9. Isopentane (2-methyl butane):
Probable location(s): Shops.
Threshold (pounds): 10,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 1-100%): Petroleum spirits, calibration mix, airbrush propellant, N-pentane.

10. Ethylene:
Probable location(s): Shops, motor pools, chemical laboratories.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 6-100%): Engine starting fluid.

11. Ethyl ether:
Probable location(s): Shops, motor pools, chemical laboratories.
Threshold (pounds): 10,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 1-100%): Starting fluid, varnish, solvent/thinner, N910023 9247, collodion, correction fluid, ethers.

12. Butene:
Probable location(s): Chemical laboratories, shops.
Threshold (pounds): 10,000.
Comments: Unlikely to be present in even 1 percent of mixture and therefore not considered for RMP.
May be Present in the Following Mixtures: (concentration range: up to 1%): 1-butene in nitrogen.

13. Silane:
Probable location(s): Shops, dental clinics.
Threshold (pounds): 10,000.
Comments: Also present in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 1-100%): Binding agents, dental restoratives, fiberglass fabric F-72, Megatech.

14. 1,3 Butadiene:
Probable location(s): Shops, motor pools.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-10%): Fuel cylinders, Crest 1700A.

15. 2-Butene:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: Not found in any mixtures.
May be Present in the Following Mixtures: UNK

16. Methyl formate:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: Not found in any mixtures.
May be Present in the Following Mixtures: UNK

17. Vinyl ethyl ether:
<u>Probable location(s)</u>: Shops.
<u>Threshold (pounds)</u>: 10,000.
<u>Comments</u>: None
<u>May be Present in the Following Mixtures</u>: (concentration range: 3-7%): Adhesives.

18. Propylene:
<u>Probable location(s)</u>: Vehicle fueling stations, clean fuel areas, motor pools, shops, cooking facilities.
<u>Threshold (pounds)</u>: 10,000.
<u>Comments</u>: None
<u>May be Present in the Following Mixtures</u>: (concentration range: 1-100%): Various propylene compounds, propanes, clean fuels, fuel cells, FG-2, Xerox developer.

19. Methyl ether:
<u>Probable location(s)</u>: Shops, motor pools.
<u>Threshold (pounds)</u>: 10,000.
<u>Comments</u>: None
<u>May be Present in the Following Mixtures</u>: (concentration range: 1-100%): Poycel, flat fixer, aerosol sprays, adhesives, spray paints, epoxy primer, paints, rust treatment, insulation, dry film Vydax, mold treatment, FANTA-Zs.

20. 2-methylpropene:
<u>Probable location(s)</u>: Shops, maintenance facilities.
<u>Threshold (pounds)</u>: 10,000.
<u>Comments</u>: Also found in pure form (100%).
<u>May be Present in the Following Mixtures</u>: (concentration range: 10-100%): Aerosols, silencer strip.

21. Tetrafluoroethylene:
<u>Probable location(s)</u>: Shops, laboratories, copier storage/ maintenance.
<u>Threshold (pounds)</u>: 10,000.
<u>Comments</u>: None
<u>May be Present in the Following Mixtures</u>: (concentration range: 1-100%): Teflons, sealants and lubricants with teflon, fluorobestos sheet, style number 1123, active #2331, pyrotechnic igniter, urafilm TFE, RL 1688 grommet, halon resins, CW 1649 release agent, DLX 6000, Bakerseal T40, molybdenum disulfide, TEX PTFE insulation, dry film Vydax, synthetic blood controls, fluon

G series, transfer recording cartridge for telecopiers, Fluoroglide spray, Centripacs, 6 Chem-pac, Plasite 4300, pipe tape, Mogul C-47,48, and 49, Lubri-pack anaerobic LO-399.

22. Dimethylamine:
Probable location(s): Landscape maintenance, chemical laboratories.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 2-100%): Herbicides, various dimethylamine compounds.

23. Cyanogen:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration: 29%): Copper cyanide.

24. Propadiene:
Probable location(s): Shops.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: UNK): Impulse fuel cell.

25. Carbon oxysulfide:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: Not found in any mixtures.
May be Present in the Following Mixtures: UNK

26. 1,3-Pentadiene:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 90%): Piperylene.

27. 2-Pentene (Z):
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: Not found in any mixtures.
May be Present in the Following Mixtures: UNK

28. 2-Pentene (E):
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: Not found in any mixtures.
May be Present in the Following Mixtures: UNK

29. Methylamine:
Probable location(s): Chemical laboratories.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 40-100%): Various methylamine compounds.

30. Propyne:
Probable location(s): Vehicle fueling stations, clean fuel areas, motor pools, shops, cooking facilities.
Threshold (pounds): 10,000.
Comments: None.
May be Present in the Following Mixtures: (concentration range: 1-44%): Clean burn fuel, methylacetylenes.

31. Ethyl chloride:
Probable location(s): Shops.
Threshold (pounds): 10,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 4-100%): Polystyrene insulation, v-belt dressing.

32. Vinyl Chloride:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: greater than 3%): Dolflex CC-1022.

33. Ethylamine:
Probable location(s): UNK
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 1-20%): Megatech, Turco 4366.

34. Acetaldehyde:
Probable location(s): Shops.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: greater than 1%): Anhydrol solvent.

35. Ethyl mercaptan:
Probable location(s): Vehicle fueling stations, clean fuel areas, shops, cooking facilities, chemical laboratories..
Threshold (pounds): 10,000.
Comments: Also found in pure form (100%).
May be Present in the Following Mixtures: (concentration range: 1-100%): Propane.

36. Isopropylamine:
Probable location(s): Landscape maintenance, shops.
Threshold (pounds): 10,000.
Comments: Also found in pure form (100%). If substances used for routine janitorial work, then not subject to RMP.
May be Present in the Following Mixtures: (concentration range: 1-100%): Herbicides, Bix Tuff-job, dual spot concentrate.

37. Difluoroethane:
Probable location(s): Shops, insecticide maintenance, medical clinics.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 10-100%): Precor fogger, .47 percent Dichlorvos 1 percent Propoxur Total Release, Freon 500, RIP 500, Cramolin sprays, medical adhesive spray, Derma Stat, Forane 500, SUVA MP66, R-500, Genetron 152A/isobutane, De-ox it-D5, Preserv it-P5, Progold spray, Static All spray, Dymel aerosol propellant, air brush propellant, SUVA MP39.

38. Vinylidene chloride:
Probable location(s): Shops.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: 4-10%): Foam coat concentrate, primer for parylene, 1001 vapor barrier.

39. Trimethylamine:
Probable location(s): Chemical laboratories.
Threshold (pounds): 10,000.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

40. Tetramethylsilane:
Probable location(s): Chemical laboratories.
Threshold (pounds): 10,000.
Comments: Not found in any mixture.
May be Present in the Following Mixtures: UNK

41. Isoprene:
Probable location(s): Shops.
Threshold (pounds): 10,000.
Comments: None
May be Present in the Following Mixtures: (concentration range: greater than 1%): Resin bonded aluminum, resin bonded silicon abrasive.

42. Trifluorochloroethylene:
Probable location(s): Shops.
Threshold (pounds): 10,000.
Comments: Comprises 100 pecent of oxweld anti-friction compound.
May be Present in the Following Mixtures: UNK

Appendix C

EPA Section 112(r) Final Rule

federal register

Thursday
June 20, 1996

Part III

Environmental Protection Agency

40 CFR Part 68

Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act, Section 112(r)(7); List of Regulated Substances and Thresholds for Accidental Release Prevention, Stay of Effectiveness; and Accidental Release Prevention Requirements: Risk Management Programs Under Section 112(r)(7) of the Clean Air Act as Amended, Guidelines; Final Rules and Notice

List of Subjects in 40 CFR Part 68

Environmental protection, Chemicals, Hazardous substances, Intergovernmental relations.

Dated: May 24, 1996.

Carol M. Browner,

Administrator.

For the reasons set out in the preamble, 40 CFR Part 68 is amended as follows:

PART 68—[AMENDED]

1. The authority citation for part 68 is revised to read as follows:

Authority: 42 U.S.C. 7412(r), 7601(a)(1), 7661–7661f.

2. Part 68 is amended by redesignating Subpart C (§§ 68.100—68.130) as Subpart F.

Subpart A—[Amended]

4. Section 68.3 is amended to add the following definitions:

§ 68.3 Definitions.

Act means the Clean Air Act as amended (42 U.S.C. 7401 et seq.)

* * * * *

Administrative controls mean written procedural mechanisms used for hazard control.

AIChE/CCPS means the American Institute of Chemical Engineers/Center for Chemical Process Safety.

* * * * *

API means the American Petroleum Institute.

ASME means the American Society of Mechanical Engineers.

Catastrophic release means a major uncontrolled emission, fire, or explosion, involving one or more regulated substances that presents imminent and substantial endangerment to public health and the environment.

Classified information means "classified information" as defined in the Classified Information Procedures Act, 18 U.S.C. App. 3, section 1(a) as "any information or material that has been determined by the United States Government pursuant to an executive order, statute, or regulation, to require protection against unauthorized disclosure for reasons of national security."

Covered process means a process that has a regulated substance present in more than a threshold quantity as determined under § 68.115.

Designated agency means the state, local, or Federal agency designated by the state under the provisions of § 68.215(d).

* * * * *

Environmental receptor means natural areas such as national or state parks, forests, or monuments; officially designated wildlife sanctuaries, preserves, refuges, or areas; and Federal wilderness areas, that could be exposed at any time to toxic concentrations, radiant heat, or overpressure greater than or equal to the endpoints provided in § 68.22(a), as a result of an accidental release and that can be identified on local U. S. Geological Survey maps.

Hot work means work involving electric or gas welding, cutting, brazing, or similar flame or spark-producing operations.

Implementing agency means the state or local agency that obtains delegation for an accidental release prevention program under subpart E, 40 CFR part 63. The implementing agency may, but is not required to, be the state or local air permitting agency. If no state or local agency is granted delegation, EPA will be the implementing agency for that state.

Injury means any effect on a human that results either from direct exposure to toxic concentrations; radiant heat; or overpressures from accidental releases or from the direct consequences of a vapor cloud explosion (such as flying glass, debris, and other projectiles) from an accidental release and that requires medical treatment or hospitalization.

Major change means introduction of a new process, process equipment, or regulated substance, an alteration of process chemistry that results in any change to safe operating limits, or other alteration that introduces a new hazard.

Mechanical integrity means the process of ensuring that process equipment is fabricated from the proper materials of construction and is properly installed, maintained, and replaced to prevent failures and accidental releases.

Medical treatment means treatment, other than first aid, administered by a physician or registered professional personnel under standing orders from a physician.

Mitigation or mitigation system means specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment. Passive mitigation means equipment, devices, or technologies that function without human, mechanical, or other energy input. Active mitigation means equipment, devices, or technologies that need human, mechanical, or other energy input to function.

NFPA means the National Fire Protection Association.

Offsite means areas beyond the property boundary of the stationary source, and areas within the property boundary to which the public has routine and unrestricted access during or outside business hours.

OSHA means the U.S. Occupational Safety and Health Administration.

Owner or operator means any person who owns, leases, operates, controls, or supervises a stationary source.

Population means the public.

* * * * *

Public means any person except employees or contractors at the stationary source.

Public receptor means offsite residences, institutions (e.g., schools, hospitals), industrial, commercial, and office buildings, parks, or recreational areas inhabited or occupied by the public at any time without restriction by the stationary source where members of the public could be exposed to toxic concentrations, radiant heat, or overpressure, as a result of an accidental release.

* * * * *

Replacement in kind means a replacement that satisfies the design specifications.

RMP means the risk management plan required under subpart G of this part.

SIC means Standard Industrial Classification.

* * * * *

Typical meteorological conditions means the temperature, wind speed, cloud cover, and atmospheric stability class, prevailing at the site based on data gathered at or near the site or from a local meteorological station.

* * * * *

Worst-case release means the release of the largest quantity of a regulated substance from a vessel or process line failure that results in the greatest distance to an endpoint defined in § 68.22(a).

5. Section 68.10 is added to subpart A to read as follows:

§ 68.10 Applicability.

(a) An owner or operator of a stationary source that has more than a threshold quantity of a regulated substance in a process, as determined under § 68.115, shall comply with the requirements of this part no later than the latest of the following dates:

(1) June 21, 1999;

(2) Three years after the date on which a regulated substance is first listed under § 68.130; or

(3) The date on which a regulated substance is first present above a threshold quantity in a process.

(b) Program 1 eligibility requirements. A covered process is eligible for

Program 1 requirements as provided in § 68.12(b) if it meets all of the following requirements:

(1) For the five years prior to the submission of an RMP, the process has not had an accidental release of a regulated substance where exposure to the substance, its reaction products, overpressure generated by an explosion involving the substance, or radiant heat generated by a fire involving the substance led to any of the following offsite:

(i) Death;

(ii) Injury; or

(iii) Response or restoration activities for an exposure of an environmental receptor;

(2) The distance to a toxic or flammable endpoint for a worst-case release assessment conducted under Subpart B and § 68.25 is less than the distance to any public receptor, as defined in § 68.30; and

(3) Emergency response procedures have been coordinated between the stationary source and local emergency planning and response organizations.

(c) Program 2 eligibility requirements. A covered process is subject to Program 2 requirements if it does not meet the eligibility requirements of either paragraph (b) or paragraph (d) of this section.

(d) Program 3 eligibility requirements. A covered process is subject to Program 3 if the process does not meet the requirements of paragraph (b) of this section, and if either of the following conditions is met:

(1) The process is in SIC code 2611, 2812, 2819, 2821, 2865, 2869, 2873, 2879, or 2911; or

(2) The process is subject to the OSHA process safety management standard, 29 CFR 1910.119.

(e) If at any time a covered process no longer meets the eligibility criteria of its Program level, the owner or operator shall comply with the requirements of the new Program level that applies to the process and update the RMP as provided in § 68.190.

6. Section 68.12 is added to subpart A to read as follows:

§ 68.12 General requirements.

(a) General requirements. The owner or operator of a stationary source subject to this part shall submit a single RMP, as provided in §§ 68.150 to 68.185. The RMP shall include a registration that reflects all covered processes.

(b) Program 1 requirements. In addition to meeting the requirements of paragraph (a) of this section, the owner or operator of a stationary source with a process eligible for Program 1, as provided in § 68.10(b), shall:

(1) Analyze the worst-case release scenario for the process(es), as provided in § 68.25; document that the nearest public receptor is beyond the distance to a toxic or flammable endpoint defined in § 68.22(a); and submit in the RMP the worst-case release scenario as provided in § 68.165;

(2) Complete the five-year accident history for the process as provided in § 68.42 of this part and submit it in the RMP as provided in § 68.168;

(3) Ensure that response actions have been coordinated with local emergency planning and response agencies; and

(4) Certify in the RMP the following: "Based on the criteria in 40 CFR 68.10, the distance to the specified endpoint for the worst-case accidental release scenario for the following process(es) is less than the distance to the nearest public receptor: [list process(es)]. Within the past five years, the process(es) has (have) had no accidental release that caused offsite impacts provided in the risk management program rule (40 CFR 68.10(b)(1)). No additional measures are necessary to prevent offsite impacts from accidental releases. In the event of fire, explosion, or a release of a regulated substance from the process(es), entry within the distance to the specified endpoints may pose a danger to public emergency responders. Therefore, public emergency responders should not enter this area except as arranged with the emergency contact indicated in the RMP. The undersigned certifies that, to the best of my knowledge, information, and belief, formed after reasonable inquiry, the information submitted is true, accurate, and complete. [Signature, title, date signed]."

(c) Program 2 requirements. In addition to meeting the requirements of paragraph (a) of this section, the owner or operator of a stationary source with a process subject to Program 2, as provided in § 68.10(c), shall:

(1) Develop and implement a management system as provided in § 68.15;

(2) Conduct a hazard assessment as provided in §§ 68.20 through 68.42;

(3) Implement the Program 2 prevention steps provided in §§ 68.48 through 68.60 or implement the Program 3 prevention steps provided in §§ 68.65 through 68.87;

(4) Develop and implement an emergency response program as provided in §§ 68.90 to 68.95; and

(5) Submit as part of the RMP the data on prevention program elements for Program 2 processes as provided in § 68.170.

(d) Program 3 requirements. In addition to meeting the requirements of paragraph (a) of this section, the owner or operator of a stationary source with a process subject to Program 3, as provided in § 68.10(d) shall:

(1) Develop and implement a management system as provided in § 68.15;

(2) Conduct a hazard assessment as provided in §§ 68.20 through 68.42;

(3) Implement the prevention requirements of §§ 68.65 through 68.87;

(4) Develop and implement an emergency response program as provided in §§ 68.90 to 68.95 of this part; and

(5) Submit as part of the RMP the data on prevention program elements for Program 3 processes as provided in § 68.175.

7. Section 68.15 is added to subpart A to read as follows:

§ 68.15 Management.

(a) The owner or operator of a stationary source with processes subject to Program 2 or Program 3 shall develop a management system to oversee the implementation of the risk management program elements.

(b) The owner or operator shall assign a qualified person or position that has the overall responsibility for the development, implementation, and integration of the risk management program elements.

(c) When responsibility for implementing individual requirements of this part is assigned to persons other than the person identified under paragraph (b) of this section, the names or positions of these people shall be documented and the lines of authority defined through an organization chart or similar document.

8. Subpart B—is added to read as follows:

Subpart B—Hazard Assessment

Sec.

Subpart B—Hazard Assessment

§ 68.20 Applicability.

The owner or operator of a stationary source subject to this part shall prepare a worst-case release scenario analysis as provided in § 68.25 of this part and complete the five-year accident history as provided in § 68.42. The owner or operator of a Program 2 and 3 process must comply with all sections in this subpart for these processes.

§ 68.22 Offsite consequence analysis parameters.

(a) Endpoints. For analyses of offsite consequences, the following endpoints shall be used:

(1) Toxics. The toxic endpoints provided in Appendix A of this part.

(2) Flammables. The endpoints for flammables vary according to the scenarios studied:

(i) Explosion. An overpressure of 1 psi.

(ii) Radiant heat/exposure time. A radiant heat of 5 kw/m^2 for 40 seconds.

(iii) Lower flammability limit. A lower flammability limit as provided in NFPA documents or other generally recognized sources.

(b) Wind speed/atmospheric stability class. For the worst-case release analysis, the owner or operator shall use a wind speed of 1.5 meters per second and F atmospheric stability class. If the owner or operator can demonstrate that local meteorological data applicable to the stationary source show a higher minimum wind speed or less stable atmosphere at all times during the previous three years; these minimums may be used. For analysis of alternative scenarios, the owner or operator may use the typical meteorological conditions for the stationary source.

(c) Ambient temperature/humidity. For worst-case release analysis of a regulated toxic substance, the owner or operator shall use the highest daily maximum temperature in the previous three years and average humidity for the site, based on temperature/humidity data gathered at the stationary source or at a local meteorological station; an owner or operator using the RMP Offsite Consequence Analysis Guidance may use 25°C and 50 percent humidity as values for these variables. For analysis of alternative scenarios, the owner or operator may use typical temperature/humidity data gathered at the stationary source or at a local meteorological station.

(d) Height of release. The worst-case release of a regulated toxic substance shall be analyzed assuming a ground level (0 feet) release. For an alternative scenario analysis of a regulated toxic substance, release height may be determined by the release scenario.

(e) Surface roughness. The owner or operator shall use either urban or rural topography, as appropriate. Urban means that there are many obstacles in the immediate area; obstacles include buildings or trees. Rural means there are no buildings in the immediate area and the terrain is generally flat and unobstructed.

(f) Dense or neutrally buoyant gases. The owner or operator shall ensure that tables or models used for dispersion analysis of regulated toxic substances appropriately account for gas density.

(g) Temperature of released substance. For worst case, liquids other than gases liquified by refrigeration only shall be considered to be released at the highest daily maximum temperature, based on data for the previous three years appropriate for the stationary source, or at process temperature, whichever is higher. For alternative scenarios, substances may be considered to be released at a process or ambient temperature that is appropriate for the scenario.

§ 68.25 Worst-case release scenario analysis.

(a) The owner or operator shall analyze and report in the RMP:

(1) For Program 1 processes, one worst-case release scenario for each Program 1 process;

(2) For Program 2 and 3 processes:

(i) One worst-case release scenario that is estimated to create the greatest distance in any direction to an endpoint provided in Appendix A of this part resulting from an accidental release of regulated toxic substances from covered processes under worst-case conditions defined in § 68.22;

(ii) One worst-case release scenario that is estimated to create the greatest distance in any direction to an endpoint defined in § 68.22(a) resulting from an accidental release of regulated flammable substances from covered processes under worst-case conditions defined in § 68.22; and

(iii) Additional worst-case release scenarios for a hazard class if a worst-case release from another covered process at the stationary source potentially affects public receptors different from those potentially affected by the worst-case release scenario developed under paragraphs (a)(2)(i) or (a)(2)(ii) of this section.

(b) Determination of worst-case release quantity. The worst-case release quantity shall be the greater of the following:

(1) For substances in a vessel, the greatest amount held in a single vessel, taking into account administrative controls that limit the maximum quantity; or

(2) For substances in pipes, the greatest amount in a pipe, taking into account administrative controls that limit the maximum quantity.

(c) Worst-case release scenario—toxic gases.

(1) For regulated toxic substances that are normally gases at ambient temperature and handled as a gas or as a liquid under pressure, the owner or operator shall assume that the quantity in the vessel or pipe, as determined under paragraph (b) of this section, is released as a gas over 10 minutes. The release rate shall be assumed to be the total quantity divided by 10 unless passive mitigation systems are in place.

(2) For gases handled as refrigerated liquids at ambient pressure:

(i) If the released substance is not contained by passive mitigation systems or if the contained pool would have a depth of 1 cm or less, the owner or operator shall assume that the substance is released as a gas in 10 minutes;

(ii) If the released substance is contained by passive mitigation systems in a pool with a depth greater than 1 cm, the owner or operator may assume that the quantity in the vessel or pipe, as determined under paragraph (b) of this section, is spilled instantaneously to form a liquid pool. The volatilization rate (release rate) shall be calculated at the boiling point of the substance and at the conditions specified in paragraph (d) of this section.

(d) Worst-case release scenario—toxic liquids.

(1) For regulated toxic substances that are normally liquids at ambient temperature, the owner or operator shall assume that the quantity in the vessel or pipe, as determined under paragraph (b) of this section, is spilled instantaneously to form a liquid pool.

(i) The surface area of the pool shall be determined by assuming that the liquid spreads to 1 centimeter deep unless passive mitigation systems are in place that serve to contain the spill and limit the surface area. Where passive mitigation is in place, the surface area of the contained liquid shall be used to calculate the volatilization rate.

(ii) If the release would occur onto a surface that is not paved or smooth, the owner or operator may take into account the actual surface characteristics.

(2) The volatilization rate shall account for the highest daily maximum temperature occurring in the past three years, the temperature of the substance in the vessel, and the concentration of the substance if the liquid spilled is a mixture or solution.

(3) The rate of release to air shall be determined from the volatilization rate of the liquid pool. The owner or operator may use the methodology in the RMP Offsite Consequence Analysis Guidance or any other publicly available techniques that account for the modeling conditions and are recognized by industry as applicable as part of

current practices. Proprietary models that account for the modeling conditions may be used provided the owner or operator allows the implementing agency access to the model and describes model features and differences from publicly available models to local emergency planners upon request.

(e) Worst-case release scenario—flammables. The owner or operator shall assume that the quantity of the substance, as determined under paragraph (b) of this section, vaporizes resulting in a vapor cloud explosion. A yield factor of 10 percent of the available energy released in the explosion shall be used to determine the distance to the explosion endpoint if the model used is based on TNT-equivalent methods.

(f) Parameters to be applied. The owner or operator shall use the parameters defined in § 68.22 to determine distance to the endpoints. The owner or operator may use the methodology provided in the RMP Offsite Consequence Analysis Guidance or any commercially or publicly available air dispersion modeling techniques, provided the techniques account for the modeling conditions and are recognized by industry as applicable as part of current practices. Proprietary models that account for the modeling conditions may be used provided the owner or operator allows the implementing agency access to the model and describes model features and differences from publicly available models to local emergency planners upon request.

(g) Consideration of passive mitigation. Passive mitigation systems may be considered for the analysis of worst case provided that the mitigation system is capable of withstanding the release event triggering the scenario and would still function as intended.

(h) Factors in selecting a worst-case scenario. Notwithstanding the provisions of paragraph (b) of this section, the owner or operator shall select as the worst case for flammable regulated substances or the worst case for regulated toxic substances, a scenario based on the following factors if such a scenario would result in a greater distance to an endpoint defined in § 68.22(a) beyond the stationary source boundary than the scenario provided under paragraph (b) of this section:

(1) Smaller quantities handled at higher process temperature or pressure; and

(2) Proximity to the boundary of the stationary source.

§ 68.28 Alternative release scenario analysis.

(a) The number of scenarios. The owner or operator shall identify and analyze at least one alternative release scenario for each regulated toxic substance held in a covered process(es) and at least one alternative release scenario to represent all flammable substances held in covered processes.

(b) Scenarios to consider. (1) For each scenario required under paragraph (a) of this section, the owner or operator shall select a scenario:

(i) That is more likely to occur than the worst-case release scenario under § 68.25; and

(ii) That will reach an endpoint offsite, unless no such scenario exists.

(2) Release scenarios considered should include, but are not limited to, the following, where applicable:

(i) Transfer hose releases due to splits or sudden hose uncoupling;

(ii) Process piping releases from failures at flanges, joints, welds, valves and valve seals, and drains or bleeds;

(iii) Process vessel or pump releases due to cracks, seal failure, or drain, bleed, or plug failure;

(iv) Vessel overfilling and spill, or overpressurization and venting through relief valves or rupture disks; and

(v) Shipping container mishandling and breakage or puncturing leading to a spill.

(c) Parameters to be applied. The owner or operator shall use the appropriate parameters defined in § 68.22 to determine distance to the endpoints. The owner or operator may use either the methodology provided in the RMP Offsite Consequence Analysis Guidance or any commercially or publicly available air dispersion modeling techniques, provided the techniques account for the specified modeling conditions and are recognized by industry as applicable as part of current practices. Proprietary models that account for the modeling conditions may be used provided the owner or operator allows the implementing agency access to the model and describes model features and differences from publicly available models to local emergency planners upon request.

(d) Consideration of mitigation. Active and passive mitigation systems may be considered provided they are capable of withstanding the event that triggered the release and would still be functional.

(e) Factors in selecting scenarios. The owner or operator shall consider the following in selecting alternative release scenarios:

(1) The five-year accident history provided in § 68.42; and

(2) Failure scenarios identified under §§ 68.50 or 68.67.

§ 68.30 Defining offsite impacts—population.

(a) The owner or operator shall estimate in the RMP the population within a circle with its center at the point of the release and a radius determined by the distance to the endpoint defined in § 68.22(a).

(b) Population to be defined. Population shall include residential population. The presence of institutions (schools, hospitals, prisons), parks and recreational areas, and major commercial, office, and industrial buildings shall be noted in the RMP.

(c) Data sources acceptable. The owner or operator may use the most recent Census data, or other updated information, to estimate the population potentially affected.

(d) Level of accuracy. Population shall be estimated to two significant digits.

§ 68.33 Defining offsite impacts—environment.

(a) The owner or operator shall list in the RMP environmental receptors within a circle with its center at the point of the release and a radius determined by the distance to the endpoint defined in § 68.22(a) of this part.

(b) Data sources acceptable. The owner or operator may rely on information provided on local U.S. Geological Survey maps or on any data source containing U.S.G.S. data to identify environmental receptors.

68.36 Review and update.

(a) The owner or operator shall review and update the offsite consequence analyses at least once every five years.

(b) If changes in processes, quantities stored or handled, or any other aspect of the stationary source might reasonably be expected to increase or decrease the distance to the endpoint by a factor of two or more, the owner or operator shall complete a revised analysis within six months of the change and submit a revised risk management plan as provided in § 68.190.

§ 68.39 Documentation.

The owner or operator shall maintain the following records on the offsite consequence analyses:

(a) For worst-case scenarios, a description of the vessel or pipeline and substance selected as worst case, assumptions and parameters used, and the rationale for selection; assumptions shall include use of any administrative controls and any passive mitigation that were assumed to limit the quantity that could be released. Documentation shall include the anticipated effect of the controls and mitigation on the release quantity and rate.

(b) For alternative release scenarios, a description of the scenarios identified, assumptions and parameters used, and the rationale for the selection of specific scenarios; assumptions shall include use of any administrative controls and any mitigation that were assumed to limit the quantity that could be released. Documentation shall include the effect of the controls and mitigation on the release quantity and rate.

(c) Documentation of estimated quantity released, release rate, and duration of release.

(d) Methodology used to determine distance to endpoints.

(e) Data used to estimate population and environmental receptors potentially affected.

§ 68.42 Five-year accident history.

(a) The owner or operator shall include in the five-year accident history all accidental releases from covered processes that resulted in deaths, injuries, or significant property damage on site, or known offsite deaths, injuries, evacuations, sheltering in place, property damage, or environmental damage.

(b) Data required. For each accidental release included, the owner or operator shall report the following information:

(1) Date, time, and approximate duration of the release;

(2) Chemical(s) released;

(3) Estimated quantity released in pounds;

(4) The type of release event and its source;

(5) Weather conditions, if known;

(6) On-site impacts;

(7) Known offsite impacts;

(8) Initiating event and contributing factors if known;

(9) Whether offsite responders were notified if known; and

(10) Operational or process changes that resulted from investigation of the release.

(c) Level of accuracy. Numerical estimates may be provided to two significant digits.

9. Subpart C is added to read as follows:

Subpart C—Program 2 Prevention Program

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Subpart C—Program 2 Prevention Program

§ 68.48 Safety information.

(a) The owner or operator shall compile and maintain the following up-to-date safety information related to the regulated substances, processes, and equipment:

(1) Material Safety Data Sheets that meet the requirements of 29 CFR 1910.1200(g);

(2) Maximum intended inventory of equipment in which the regulated substances are stored or processed;

(3) Safe upper and lower temperatures, pressures, flows, and compositions;

(4) Equipment specifications; and

(5) Codes and standards used to design, build, and operate the process.

(b) The owner or operator shall ensure that the process is designed in compliance with recognized and generally accepted good engineering practices. Compliance with Federal or state regulations that address industry-specific safe design or with industry-specific design codes and standards may be used to demonstrate compliance with this paragraph.

(c) The owner or operator shall update the safety information if a major change occurs that makes the information inaccurate.

§ 68.50 Hazard review.

(a) The owner or operator shall conduct a review of the hazards associated with the regulated substances, process, and procedures. The review shall identify the following:

(1) The hazards associated with the process and regulated substances;

(2) Opportunities for equipment malfunctions or human errors that could cause an accidental release;

(3) The safeguards used or needed to control the hazards or prevent equipment malfunction or human error; and

(4) Any steps used or needed to detect or monitor releases.

(b) The owner or operator may use checklists developed by persons or organizations knowledgeable about the process and equipment as a guide to conducting the review. For processes designed to meet industry standards or Federal or state design rules, the hazard review shall, by inspecting all equipment, determine whether the process is designed, fabricated, and operated in accordance with the applicable standards or rules.

(c) The owner or operator shall document the results of the review and ensure that problems identified are resolved in a timely manner.

(d) The review shall be updated at least once every five years. The owner or operator shall also conduct reviews whenever a major change in the process occurs; all issues identified in the review shall be resolved before startup of the changed process.

§ 68.52 Operating procedures.

(a) The owner or operator shall prepare written operating procedures that provide clear instructions or steps for safely conducting activities associated with each covered process consistent with the safety information for that process. Operating procedures or instructions provided by equipment manufacturers or developed by persons or organizations knowledgeable about the process and equipment may be used as a basis for a stationary source's operating procedures.

(b) The procedures shall address the following:

(1) Initial startup;

(2) Normal operations;

(3) Temporary operations;

(4) Emergency shutdown and operations;

(5) Normal shutdown;

(6) Startup following a normal or emergency shutdown or a major change that requires a hazard review;

(7) Consequences of deviations and steps required to correct or avoid deviations; and

(8) Equipment inspections.

(c) The owner or operator shall ensure that the operating procedures are updated, if necessary, whenever a major change occurs and prior to startup of the changed process.

§ 68.54 Training.

(a) The owner or operator shall ensure that each employee presently operating a process, and each employee newly assigned to a covered process have been trained or tested competent in the operating procedures provided in § 68.52 that pertain to their duties. For those employees already operating a process on June 21, 1999, the owner or operator may certify in writing that the employee has the required knowledge, skills, and abilities to safely carry out the duties and responsibilities as provided in the operating procedures.

(b) Refresher training. Refresher training shall be provided at least every three years, and more often if necessary, to each employee operating a process to ensure that the employee understands and adheres to the current operating procedures of the process. The owner or operator, in consultation with the employees operating the process, shall determine the appropriate frequency of refresher training.

(c) The owner or operator may use training conducted under Federal or state regulations or under industry-specific standards or codes or training conducted by covered process equipment vendors to demonstrate compliance with this section to the extent that the training meets the requirements of this section.

(d) The owner or operator shall ensure that operators are trained in any updated or new procedures prior to startup of a process after a major change.

§ 68.56 Maintenance.

(a) The owner or operator shall prepare and implement procedures to maintain the on-going mechanical integrity of the process equipment. The owner or operator may use procedures or instructions provided by covered process equipment vendors or procedures in Federal or state regulations or industry codes as the basis for stationary source maintenance procedures.

(b) The owner or operator shall train or cause to be trained each employee involved in maintaining the on-going mechanical integrity of the process. To ensure that the employee can perform the job tasks in a safe manner, each such employee shall be trained in the hazards of the process, in how to avoid or correct unsafe conditions, and in the procedures applicable to the employee's job tasks.

(c) Any maintenance contractor shall ensure that each contract maintenance employee is trained to perform the maintenance procedures developed under paragraph (a) of this section.

(d) The owner or operator shall perform or cause to be performed inspections and tests on process equipment. Inspection and testing procedures shall follow recognized and generally accepted good engineering practices. The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations, industry standards or codes, good engineering practices, and prior operating experience.

§ 68.58 Compliance audits.

(a) The owner or operator shall certify that they have evaluated compliance with the provisions of this subpart at least every three years to verify that the procedures and practices developed under the rule are adequate and are being followed.

(b) The compliance audit shall be conducted by at least one person knowledgeable in the process.

(c) The owner or operator shall develop a report of the audit findings.

(d) The owner or operator shall promptly determine and document an appropriate response to each of the findings of the compliance audit and document that deficiencies have been corrected.

(e) The owner or operator shall retain the two (2) most recent compliance audit reports. This requirement does not apply to any compliance audit report that is more than five years old.

§ 68.60 Incident investigation.

(a) The owner or operator shall investigate each incident which resulted in, or could reasonably have resulted in a catastrophic release.

(b) An incident investigation shall be initiated as promptly as possible, but not later than 48 hours following the incident.

(c) A summary shall be prepared at the conclusion of the investigation which includes at a minimum:

(1) Date of incident;

(2) Date investigation began;

(3) A description of the incident;

(4) The factors that contributed to the incident; and,

(5) Any recommendations resulting from the investigation.

(d) The owner or operator shall promptly address and resolve the investigation findings and recommendations. Resolutions and corrective actions shall be documented.

(e) The findings shall be reviewed with all affected personnel whose job tasks are affected by the findings.

(f) Investigation summaries shall be retained for five years.

10. Subpart D is added to read as follows:

Subpart D—Program 3 Prevention Program

Subpart D—Program 3 Prevention Program

§ 68.65 Process safety information.

(a) In accordance with the schedule set forth in § 68.67, the owner or operator shall complete a compilation of written process safety information before conducting any process hazard analysis required by the rule. The compilation of written process safety information is to enable the owner or operator and the employees involved in operating the process to identify and understand the hazards posed by those processes involving regulated substances. This process safety information shall include information pertaining to the hazards of the regulated substances used or produced by the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process.

(b) Information pertaining to the hazards of the regulated substances in the process. This information shall consist of at least the following:

(1) Toxicity information;

(2) Permissible exposure limits;

(3) Physical data;

(4) Reactivity data:

(5) Corrosivity data;

(6) Thermal and chemical stability data; and

(7) Hazardous effects of inadvertent mixing of different materials that could foreseeably occur.

Note to paragraph (b): Material Safety Data Sheets meeting the requirements of 29 CFR 1910.1200(g) may be used to comply with this requirement to the extent they contain the information required by this subparagraph.

(c) Information pertaining to the technology of the process.

(1) Information concerning the technology of the process shall include at least the following:

(i) A block flow diagram or simplified process flow diagram;

(ii) Process chemistry;

(iii) Maximum intended inventory;

(iv) Safe upper and lower limits for such items as temperatures, pressures, flows or compositions; and,

(v) An evaluation of the consequences of deviations.

(2) Where the original technical information no longer exists, such information may be developed in conjunction with the process hazard analysis in sufficient detail to support the analysis.

(d) Information pertaining to the equipment in the process.

(1) Information pertaining to the equipment in the process shall include:

(i) Materials of construction;

(ii) Piping and instrument diagrams (P&ID's);

(iii) Electrical classification;

(iv) Relief system design and design basis;

(v) Ventilation system design;

(vi) Design codes and standards employed;

(vii) Material and energy balances for processes built after June 21, 1999; and

(viii) Safety systems (e.g. interlocks, detection or suppression systems).

(2) The owner or operator shall document that equipment complies with recognized and generally accepted good engineering practices.

(3) For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, the owner or operator shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

§ 68.67 Process hazard analysis.

(a) The owner or operator shall perform an initial process hazard analysis (hazard evaluation) on processes covered by this part. The process hazard analysis shall be appropriate to the complexity of the process and shall identify, evaluate, and control the hazards involved in the process. The owner or operator shall determine and document the priority order for conducting process hazard analyses based on a rationale which includes such considerations as extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process. The process hazard analysis shall be conducted as soon as possible, but not later than June 21, 1999. Process hazards analyses completed to comply with 29 CFR 1910.119(e) are acceptable as initial process hazards analyses. These process hazard analyses shall be updated and revalidated, based on their completion date.

(b) The owner or operator shall use one or more of the following methodologies that are appropriate to determine and evaluate the hazards of the process being analyzed.

(1) What-If;

(2) Checklist;

(3) What-If/Checklist;

(4) Hazard and Operability Study (HAZOP);

(5) Failure Mode and Effects Analysis (FMEA);

(6) Fault Tree Analysis; or

(7) An appropriate equivalent methodology.

(c) The process hazard analysis shall address:

(1) The hazards of the process;

(2) The identification of any previous incident which had a likely potential for catastrophic consequences.

(3) Engineering and administrative controls applicable to the hazards and their interrelationships such as appropriate application of detection methodologies to provide early warning of releases. (Acceptable detection methods might include process monitoring and control instrumentation with alarms, and detection hardware such as hydrocarbon sensors.);

(4) Consequences of failure of engineering and administrative controls;

(5) Stationary source siting;

(6) Human factors; and

(7) A qualitative evaluation of a range of the possible safety and health effects of failure of controls.

(d) The process hazard analysis shall be performed by a team with expertise in engineering and process operations, and the team shall include at least one employee who has experience and knowledge specific to the process being evaluated. Also, one member of the team must be knowledgeable in the specific process hazard analysis methodology being used.

(e) The owner or operator shall establish a system to promptly address the team's findings and recommendations; assure that the recommendations are resolved in a timely manner and that the resolution is documented; document what actions are to be taken; complete actions as soon as possible; develop a written schedule of when these actions are to be completed; communicate the actions to operating, maintenance and other employees whose work assignments are in the process and who may be affected by the recommendations or actions.

(f) At least every five (5) years after the completion of the initial process hazard analysis, the process hazard analysis shall be updated and revalidated by a team meeting the requirements in paragraph (d) of this section, to assure that the process hazard analysis is consistent with the current process. Updated and revalidated process hazard analyses completed to comply with 29 CFR 1910.119(e) are acceptable to meet the requirements of this paragraph.

(g) The owner or operator shall retain process hazards analyses and updates or revalidations for each process covered by this section, as well as the documented resolution of recommendations described in paragraph (e) of this section for the life of the process.

§ 68.69 Operating procedures.

(a) The owner or operator shall develop and implement written operating procedures that provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information and shall address at least the following elements.

(1) Steps for each operating phase:

(i) Initial startup;

(ii) Normal operations;

(iii) Temporary operations;

(iv) Emergency shutdown including the conditions under which emergency shutdown is required, and the assignment of shutdown responsibility to qualified operators to ensure that emergency shutdown is executed in a safe and timely manner.

(v) Emergency operations;

(vi) Normal shutdown; and,

(vii) Startup following a turnaround, or after an emergency shutdown.

(2) Operating limits:

(i) Consequences of deviation; and

(ii) Steps required to correct or avoid deviation.

(3) Safety and health considerations:

(i) Properties of, and hazards presented by, the chemicals used in the process;

(ii) Precautions necessary to prevent exposure, including engineering controls, administrative controls, and personal protective equipment;

(iii) Control measures to be taken if physical contact or airborne exposure occurs;

(iv) Quality control for raw materials and control of hazardous chemical inventory levels; and,

(v) Any special or unique hazards.

(4) Safety systems and their functions.

(b) Operating procedures shall be readily accessible to employees who work in or maintain a process.

(c) The operating procedures shall be reviewed as often as necessary to assure that they reflect current operating practice, including changes that result from changes in process chemicals, technology, and equipment, and changes to stationary sources. The owner or operator shall certify annually that these operating procedures are current and accurate.

(d) The owner or operator shall develop and implement safe work practices to provide for the control of hazards during operations such as lockout/tagout; confined space entry; opening process equipment or piping; and control over entrance into a stationary source by maintenance, contractor, laboratory, or other support personnel. These safe work practices shall apply to employees and contractor employees.

§ 68.71 Training.

(a) Initial training. (1) Each employee presently involved in operating a process, and each employee before being involved in operating a newly assigned process, shall be trained in an overview of the process and in the operating procedures as specified in § 68.69. The training shall include emphasis on the specific safety and health hazards, emergency operations including shutdown, and safe work practices applicable to the employee's job tasks.

(2) In lieu of initial training for those employees already involved in operating a process on June 21, 1999 an owner or operator may certify in writing that the employee has the required knowledge, skills, and abilities to safely carry out the duties and responsibilities as specified in the operating procedures.

(b) Refresher training. Refresher training shall be provided at least every three years, and more often if necessary, to each employee involved in operating a process to assure that the employee understands and adheres to the current operating procedures of the process. The owner or operator, in consultation with the employees involved in operating the process, shall determine the appropriate frequency of refresher training.

(c) Training documentation. The owner or operator shall ascertain that each employee involved in operating a process has received and understood the training required by this paragraph. The owner or operator shall prepare a record which contains the identity of the employee, the date of training, and the means used to verify that the employee understood the training.

§ 68.73 Mechanical integrity.

(a) Application. Paragraphs (b) through (f) of this section apply to the following process equipment:

(1) Pressure vessels and storage tanks;

(2) Piping systems (including piping components such as valves);

(3) Relief and vent systems and devices;

(4) Emergency shutdown systems;

(5) Controls (including monitoring devices and sensors, alarms, and interlocks) and,

(6) Pumps.

(b) Written procedures. The owner or operator shall establish and implement written procedures to maintain the on-going integrity of process equipment.

(c) Training for process maintenance activities. The owner or operator shall train each employee involved in maintaining the on-going integrity of process equipment in an overview of that process and its hazards and in the procedures applicable to the employee's job tasks to assure that the employee can perform the job tasks in a safe manner.

(d) Inspection and testing. (1) Inspections and tests shall be performed on process equipment.

(2) Inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

(3) The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations and good engineering practices, and more frequently if determined to be necessary by prior operating experience.

(4) The owner or operator shall document each inspection and test that has been performed on process equipment. The documentation shall identify the date of the inspection or test, the name of the person who performed the inspection or test, the serial number or other identifier of the equipment on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.

(e) Equipment deficiencies. The owner or operator shall correct deficiencies in equipment that are outside acceptable limits (defined by the process safety information in § 68.65) before further use or in a safe and timely manner when necessary means are taken to assure safe operation.

(f) Quality assurance. (1) In the construction of new plants and equipment, the owner or operator shall assure that equipment as it is fabricated is suitable for the process application for which they will be used.

(2) Appropriate checks and inspections shall be performed to assure that equipment is installed properly and consistent with design specifications and the manufacturer's instructions.

(3) The owner or operator shall assure that maintenance materials, spare parts and equipment are suitable for the process application for which they will be used.

§ 68.75 Management of change.

(a) The owner or operator shall establish and implement written procedures to manage changes (except for "replacements in kind") to process chemicals, technology, equipment, and procedures; and, changes to stationary sources that affect a covered process.

(b) The procedures shall assure that the following considerations are addressed prior to any change:

(1) The technical basis for the proposed change;

(2) Impact of change on safety and health;

(3) Modifications to operating procedures;

(4) Necessary time period for the change; and,

(5) Authorization requirements for the proposed change.

(c) Employees involved in operating a process and maintenance and contract employees whose job tasks will be affected by a change in the process shall be informed of, and trained in, the change prior to start-up of the process or affected part of the process.

(d) If a change covered by this paragraph results in a change in the process safety information required by § 68.65 of this part, such information shall be updated accordingly.

(e) If a change covered by this paragraph results in a change in the operating procedures or practices required by § 68.69, such procedures or practices shall be updated accordingly.

§ 68.77 Pre-startup review.

(a) The owner or operator shall perform a pre-startup safety review for new stationary sources and for modified stationary sources when the modification is significant enough to require a change in the process safety information.

(b) The pre-startup safety review shall confirm that prior to the introduction of regulated substances to a process:

(1) Construction and equipment is in accordance with design specifications;

(2) Safety, operating, maintenance, and emergency procedures are in place and are adequate;

(3) For new stationary sources, a process hazard analysis has been performed and recommendations have been resolved or implemented before startup; and modified stationary sources meet the requirements contained in management of change, § 68.75.

(4) Training of each employee involved in operating a process has been completed.

§ 68.79 Compliance audits.

(a) The owner or operator shall certify that they have evaluated compliance with the provisions of this section at least every three years to verify that the procedures and practices developed under the standard are adequate and are being followed.

(b) The compliance audit shall be conducted by at least one person knowledgeable in the process.

(c) A report of the findings of the audit shall be developed.

(d) The owner or operator shall promptly determine and document an appropriate response to each of the findings of the compliance audit, and document that deficiencies have been corrected.

(e) The owner or operator shall retain the two (2) most recent compliance audit reports.

§ 68.81 Incident investigation.

(a) The owner or operator shall investigate each incident which resulted in, or could reasonably have resulted in a catastrophic release of a regulated substance.

(b) An incident investigation shall be initiated as promptly as possible, but not later than 48 hours following the incident.

(c) An incident investigation team shall be established and consist of at least one person knowledgeable in the process involved, including a contract employee if the incident involved work of the contractor, and other persons with appropriate knowledge and experience to thoroughly investigate and analyze the incident.

(d) A report shall be prepared at the conclusion of the investigation which includes at a minimum:

(1) Date of incident;

(2) Date investigation began;

(3) A description of the incident;

(4) The factors that contributed to the incident; and,

(5) Any recommendations resulting from the investigation.

(e) The owner or operator shall establish a system to promptly address and resolve the incident report findings and recommendations. Resolutions and corrective actions shall be documented.

(f) The report shall be reviewed with all affected personnel whose job tasks are relevant to the incident findings including contract employees where applicable.

(g) Incident investigation reports shall be retained for five years.

§ 68.83 Employee participation.

(a) The owner or operator shall develop a written plan of action regarding the implementation of the employee participation required by this section.

(b) The owner or operator shall consult with employees and their representatives on the conduct and development of process hazards analyses and on the development of the other elements of process safety management in this rule.

(c) The owner or operator shall provide to employees and their representatives access to process hazard analyses and to all other information required to be developed under this rule.

§ 68.85 Hot work permit.

(a) The owner or operator shall issue a hot work permit for hot work operations conducted on or near a covered process.

(b) The permit shall document that the fire prevention and protection requirements in 29 CFR 1910.252(a) have been implemented prior to beginning the hot work operations; it shall indicate the date(s) authorized for hot work; and identify the object on which hot work is to be performed. The permit shall be kept on file until completion of the hot work operations.

§ 68.87 Contractors.

(a) Application. This section applies to contractors performing maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to a covered process. It does not apply to contractors providing incidental services which do not influence process safety, such as janitorial work, food and drink services, laundry, delivery or other supply services.

(b) Owner or operator responsibilities. (1) The owner or operator, when selecting a contractor, shall obtain and evaluate information regarding the contract owner or operator's safety performance and programs.

(2) The owner or operator shall inform contract owner or operator of the known potential fire, explosion, or toxic release hazards related to the contractor's work and the process.

(3) The owner or operator shall explain to the contract owner or operator the applicable provisions of subpart E of this part.

(4) The owner or operator shall develop and implement safe work practices consistent with § 68.69(d), to control the entrance, presence, and exit of the contract owner or operator and contract employees in covered process areas.

(5) The owner or operator shall periodically evaluate the performance of the contract owner or operator in fulfilling their obligations as specified in paragraph (c) of this section.

(c) Contract owner or operator responsibilities. (1) The contract owner or operator shall assure that each contract employee is trained in the work practices necessary to safely perform his/her job.

(2) The contract owner or operator shall assure that each contract employee is instructed in the known potential fire, explosion, or toxic release hazards related to his/her job and the process, and the applicable provisions of the emergency action plan.

(3) The contract owner or operator shall document that each contract employee has received and understood the training required by this section. The contract owner or operator shall prepare a record which contains the identity of the contract employee, the date of training, and the means used to verify that the employee understood the training.

(4) The contract owner or operator shall assure that each contract employee follows the safety rules of the stationary source including the safe work practices required by § 68.69(d).

(5) The contract owner or operator shall advise the owner or operator of any unique hazards presented by the contract owner or operator's work, or of any hazards found by the contract owner or operator's work.

11. Subpart E is added to read as follows:

Subpart E—Emergency Response

Subpart E—Emergency Response

§ 68.90 Applicability.

(a) Except as provided in paragraph (b) of this section, the owner or operator of a stationary source with Program 2 and Program 3 processes shall comply with the requirements of § 68.95.

(b) The owner or operator of stationary source whose employees will not respond to accidental releases of regulated substances need not comply with § 68.95 of this part provided that they meet the following:

(1) For stationary sources with any regulated toxic substance held in a process above the threshold quantity, the stationary source is included in the community emergency response plan developed under 42 U.S.C. 11003;

(2) For stationary sources with only regulated flammable substances held in a process above the threshold quantity, the owner or operator has coordinated response actions with the local fire department; and

(3) Appropriate mechanisms are in place to notify emergency responders when there is a need for a response.

§ 68.95 Emergency response program.

(a) The owner or operator shall develop and implement an emergency response program for the purpose of protecting public health and the environment. Such program shall include the following elements:

(1) An emergency response plan, which shall be maintained at the stationary source and contain at least the following elements:

(i) Procedures for informing the public and local emergency response agencies about accidental releases;

(ii) Documentation of proper first-aid and emergency medical treatment necessary to treat accidental human exposures; and

(iii) Procedures and measures for emergency response after an accidental release of a regulated substance;

(2) Procedures for the use of emergency response equipment and for its inspection, testing, and maintenance;

(3) Training for all employees in relevant procedures; and

(4) Procedures to review and update, as appropriate, the emergency response plan to reflect changes at the stationary source and ensure that employees are informed of changes.

(b) A written plan that complies with other Federal contingency plan regulations or is consistent with the approach in the National Response Team's Integrated Contingency Plan Guidance ("One Plan") and that, among other matters, includes the elements provided in paragraph (a) of this section, shall satisfy the requirements of this section if the owner or operator also complies with paragraph (c) of this section.

(c) The emergency response plan developed under paragraph (a)(1) of this section shall be coordinated with the community emergency response plan developed under 42 U.S.C. 11003. Upon request of the local emergency planning committee or emergency response officials, the owner or operator shall promptly provide to the local emergency response officials information necessary for developing and implementing the community emergency response plan.

12. Subpart G is added to read as follows:

Subpart G—Risk Management Plan

Subpart G—Risk Management Plan

§ 68.150 Submission.

(a) The owner or operator shall submit a single RMP that includes the information required by §§ 68.155 through 68.185 for all covered processes. The RMP shall be submitted in a method and format to a central point as specified by EPA prior to June 21, 1999.

(b) The owner or operator shall submit the first RMP no later than the latest of the following dates:

(1) June 21, 1999;

(2) Three years after the date on which a regulated substance is first listed under § 68.130; or

(3) The date on which a regulated substance is first present above a threshold quantity in a process.

(c) Subsequent submissions of RMPs shall be in accordance with § 68.190.

(d) Notwithstanding the provisions of §§ 68.155 to 68.190, the RMP shall exclude classified information. Subject to appropriate procedures to protect such information from public disclosure, classified data or information excluded from the RMP may be made available in a classified annex to the RMP for review by Federal and state representatives who have received the appropriate security clearances.

§ 68.155 Executive summary.

The owner or operator shall provide in the RMP an executive summary that includes a brief description of the following elements:

(a) The accidental release prevention and emergency response policies at the stationary source;

(b) The stationary source and regulated substances handled;

(c) The worst-case release scenario(s) and the alternative release scenario(s), including administrative controls and mitigation measures to limit the distances for each reported scenario;

(d) The general accidental release prevention program and chemical-specific prevention steps;

(e) The five-year accident history;

(f) The emergency response program; and

(g) Planned changes to improve safety.

§ 68.160 Registration.

(a) The owner or operator shall complete a single registration form and include it in the RMP. The form shall cover all regulated substances handled in covered processes.

(b) The registration shall include the following data:

(1) Stationary source name, street, city, county, state, zip code, latitude, and longitude;

(2) The stationary source Dun and Bradstreet number;

(3) Name and Dun and Bradstreet number of the corporate parent company;

(4) The name, telephone number, and mailing address of the owner or operator;

(5) The name and title of the person or position with overall responsibility for RMP elements and implementation;

(6) The name, title, telephone number, and 24-hour telephone number of the emergency contact;

(7) For each covered process, the name and CAS number of each regulated substance held above the threshold quantity in the process, the maximum quantity of each regulated substance or mixture in the process (in pounds) to two significant digits; the SIC code, and the Program level of the process;

(8) The stationary source EPA identifier;

(9) The number of full-time employees at the stationary source;

(10) Whether the stationary source is subject to 29 CFR 1910.119;

(11) Whether the stationary source is subject to 40 CFR part 355;

(12) Whether the stationary source has a CAA Title V operating permit; and

(13) The date of the last safety inspection of the stationary source by a Federal, state, or local government agency and the identity of the inspecting entity.

§ 68.165 Offsite consequence analysis.

(a) The owner or operator shall submit in the RMP information:

(1) One worst-case release scenario for each Program 1 process; and

(2) For Program 2 and 3 processes, one worst-case release scenario to represent all regulated toxic substances held above the threshold quantity and one worst-case release scenario to represent all regulated flammable substances held above the threshold quantity. If additional worst-case scenarios for toxics or flammables are required by § 68.25(a)(2)(iii), the owner or operator shall submit the same information on the additional scenario(s). The owner or operator of Program 2 and 3 processes shall also submit information on one alternative release scenario for each regulated toxic substance held above the threshold quantity and one alternative release scenario to represent all regulated flammable substances held above the threshold quantity.

(b) The owner or operator shall submit the following data:

(1) Chemical name;

(2) Physical state (toxics only);

(3) Basis of results (give model name if used);

(4) Scenario (explosion, fire, toxic gas release, or liquid spill and vaporization);

(5) Quantity released in pounds;

(6) Release rate;

(7) Release duration;

(8) Wind speed and atmospheric stability class (toxics only);

(9) Topography (toxics only);

(10) Distance to endpoint;

(11) Public and environmental receptors within the distance;

(12) Passive mitigation considered; and

(13) Active mitigation considered (alternative releases only);

§ 68.168 Five-year accident history.

The owner or operator shall submit in the RMP the information provided in § 68.42(b) on each accident covered by § 68.42(a).

§ 68.170 Prevention program/Program 2.

(a) For each Program 2 process, the owner or operator shall provide in the RMP the information indicated in paragraphs (b) through (k) of this section. If the same information applies to more than one covered process, the owner or operator may provide the information only once, but shall indicate to which processes the information applies.

(b) The SIC code for the process.

(c) The name(s) of the chemical(s) covered.

(d) The date of the most recent review or revision of the safety information and a list of Federal or state regulations or industry-specific design codes and standards used to demonstrate compliance with the safety information requirement.

(e) The date of completion of the most recent hazard review or update.

(1) The expected date of completion of any changes resulting from the hazard review;

(2) Major hazards identified;

(3) Process controls in use;

(4) Mitigation systems in use;

(5) Monitoring and detection systems in use; and

(6) Changes since the last hazard review.

(f) The date of the most recent review or revision of operating procedures.

(g) The date of the most recent review or revision of training programs;

(1) The type of training provided—classroom, classroom plus on the job, on the job; and

(2) The type of competency testing used.

(h) The date of the most recent review or revision of maintenance procedures and the date of the most recent equipment inspection or test and the equipment inspected or tested.

(i) The date of the most recent compliance audit and the expected date of completion of any changes resulting from the compliance audit.

(j) The date of the most recent incident investigation and the expected date of completion of any changes resulting from the investigation.

(k) The date of the most recent change that triggered a review or revision of safety information, the hazard review, operating or maintenance procedures, or training.

§ 68.175 Prevention program/Program 3.

(a) For each Program 3 process, the owner or operator shall provide the information indicated in paragraphs (b) through (p) of this section. If the same information applies to more than one covered process, the owner or operator may provide the information only once, but shall indicate to which processes the information applies.

(b) The SIC code for the process.

(c) The name(s) of the substance(s) covered.

(d) The date on which the safety information was last reviewed or revised.

(e) The date of completion of the most recent PHA or update and the technique used.

(1) The expected date of completion of any changes resulting from the PHA;

(2) Major hazards identified;

(3) Process controls in use;

(4) Mitigation systems in use;

(5) Monitoring and detection systems in use; and

(6) Changes since the last PHA.

(f) The date of the most recent review or revision of operating procedures.

(g) The date of the most recent review or revision of training programs;

(1) The type of training provided—classroom, classroom plus on the job, on the job; and

(2) The type of competency testing used.

(h) The date of the most recent review or revision of maintenance procedures and the date of the most recent equipment inspection or test and the equipment inspected or tested.

(i) The date of the most recent change that triggered management of change procedures and the date of the most recent review or revision of management of change procedures.

(j) The date of the most recent pre-startup review.

(k) The date of the most recent compliance audit and the expected date of completion of any changes resulting from the compliance audit;

(l) The date of the most recent incident investigation and the expected date of completion of any changes resulting from the investigation;

(m) The date of the most recent review or revision of employee participation plans;

(n) The date of the most recent review or revision of hot work permit procedures;

(o) The date of the most recent review or revision of contractor safety procedures; and

(p) The date of the most recent evaluation of contractor safety performance.

§ 68.180 Emergency response program.

(a) The owner or operator shall provide in the RMP the following information:

(1) Do you have a written emergency response plan?

(2) Does the plan include specific actions to be taken in response to an accidental releases of a regulated substance?

(3) Does the plan include procedures for informing the public and local agencies responsible for responding to accidental releases?

(4) Does the plan include information on emergency health care?

(5) The date of the most recent review or update of the emergency response plan;

(6) The date of the most recent emergency response training for employees.

(b) The owner or operator shall provide the name and telephone number of the local agency with which the plan is coordinated.

(c) The owner or operator shall list other Federal or state emergency plan requirements to which the stationary source is subject.

§ 68.185 Certification.

(a) For Program 1 processes, the owner or operator shall submit in the RMP the certification statement provided in § 68.12(b)(4).

(b) For all other covered processes, the owner or operator shall submit in the RMP a single certification that, to the best of the signer's knowledge, information, and belief formed after reasonable inquiry, the information submitted is true, accurate, and complete.

§ 68.190 Updates.

(a) The owner or operator shall review and update the RMP as specified in paragraph (b) of this section and submit it in a method and format to a central point specified by EPA prior to June 21, 1999.

(b) The owner or operator of a stationary source shall revise and update the RMP submitted under § 68.150 as follows:

(1) Within five years of its initial submission or most recent update required by paragraphs (b)(2) through (b)(7) of this section, whichever is later.

(2) No later than three years after a newly regulated substance is first listed by EPA;

(3) No later than the date on which a new regulated substance is first present in an already covered process above a threshold quantity;

(4) No later than the date on which a regulated substance is first present above a threshold quantity in a new process;

(5) Within six months of a change that requires a revised PHA or hazard review;

(6) Within six months of a change that requires a revised offsite consequence analysis as provided in § 68.36; and

(7) Within six months of a change that alters the Program level that applied to any covered process.

(c) If a stationary source is no longer subject to this part, the owner or operator shall submit a revised registration to EPA within six months indicating that the stationary source is no longer covered.

13. Subpart H is added to read as follows:

Subpart H—Other Requirements

Subpart H—Other Requirements

§ 68.200 Recordkeeping.

The owner or operator shall maintain records supporting the implementation of this part for five years unless otherwise provided in Subpart D of this part.

§ 68.210 Availability of information to the public.

(a) The RMP required under subpart G of this part shall be available to the public under 42 U.S.C. 7414(c).

(b) The disclosure of classified information by the Department of Defense or other Federal agencies or contractors of such agencies shall be controlled by applicable laws, regulations, or executive orders concerning the release of classified information.

§ 68.215 Permit content and air permitting authority or designated agency requirements.

(a) These requirements apply to any stationary source subject to this part 68 and parts 70 or 71 of this Chapter. The 40 CFR part 70 or part 71 permit for the stationary source shall contain:

(1) A statement listing this part as an applicable requirement;

(2) Conditions that require the source owner or operator to submit:

(i) A compliance schedule for meeting the requirements of this part by the date provided in § 68.10(a) or;

(ii) As part of the compliance certification submitted under 40 CFR 70.6(c)(5), a certification statement that the source is in compliance with all requirements of this part, including the registration and submission of the RMP.

(b) The owner or operator shall submit any additional relevant information requested by the air permitting authority or designated agency.

(c) For 40 CFR part 70 or part 71 permits issued prior to the deadline for registering and submitting the RMP and which do not contain permit conditions described in paragraph (a) of this section, the owner or operator or air permitting authority shall initiate permit revision or reopening according to the procedures of 40 CFR 70.7 or 71.7 to incorporate the terms and conditions consistent with paragraph (a) of this section.

(d) The state may delegate the authority to implement and enforce the requirements of paragraph (e) of this section to a state or local agency or agencies other than the air permitting authority. An up-to-date copy of any delegation instrument shall be maintained by the air permitting authority. The state may enter a written agreement with the Administrator under which EPA will implement and enforce the requirements of paragraph (e) of this section.

(e) The air permitting authority or the agency designated by delegation or agreement under paragraph (d) of this section shall, at a minimum:

(1) Verify that the source owner or operator has registered and submitted an RMP or a revised plan when required by this part;

(2) Verify that the source owner or operator has submitted a source certification or in its absence has submitted a compliance schedule consistent with paragraph (a)(2) of this section;

(3) For some or all of the sources subject to this section, use one or more mechanisms such as, but not limited to, a completeness check, source audits, record reviews, or facility inspections to ensure that permitted sources are in compliance with the requirements of this part; and

(4) Initiate enforcement action based on paragraphs (e)(1) and (e)(2) of this section as appropriate.

§ 68.220 Audits.

(a) In addition to inspections for the purpose of regulatory development and enforcement of the Act, the implementing agency shall periodically audit RMPs submitted under subpart G of this part to review the adequacy of such RMPs and require revisions of RMPs when necessary to ensure compliance with subpart G of this part.

(b) The implementing agency shall select stationary sources for audits based on any of the following criteria:

(1) Accident history of the stationary source;

(2) Accident history of other stationary sources in the same industry;

(3) Quantity of regulated substances present at the stationary source;

(4) Location of the stationary source and its proximity to the public and environmental receptors;

(5) The presence of specific regulated substances;

(6) The hazards identified in the RMP; and

(7) A plan providing for neutral, random oversight.

(c) Exemption from audits. A stationary source with a Star or Merit ranking under OSHA's voluntary protection program shall be exempt from audits under paragraph (b)(2) and (b)(7) of this section.

(d) The implementing agency shall have access to the stationary source, supporting documentation, and any area where an accidental release could occur.

(e) Based on the audit, the implementing agency may issue the owner or operator of a stationary source a written preliminary determination of necessary revisions to the stationary source's RMP to ensure that the RMP meets the criteria of subpart G of this part. The preliminary determination shall include an explanation for the basis for the revisions, reflecting industry standards and guidelines (such as AIChE/CCPS guidelines and ASME and API standards) to the extent that such standards and guidelines are applicable, and shall include a timetable for their implementation.

(f) Written response to a preliminary determination.

(1) The owner or operator shall respond in writing to a preliminary determination made in accordance with paragraph (e) of this section. The response shall state the owner or operator will implement the revisions contained in the preliminary determination in accordance with the timetable included in the preliminary determination or shall state that the owner or operator rejects the revisions in whole or in part. For each rejected revision, the owner or operator shall explain the basis for rejecting such revision. Such explanation may include substitute revisions.

(2) The written response under paragraph (f)(1) of this section shall be received by the implementing agency within 90 days of the issue of the preliminary determination or a shorter period of time as the implementing agency specifies in the preliminary determination as necessary to protect public health and the environment. Prior to the written response being due and upon written request from the owner or operator, the implementing agency may provide in writing additional time for the response to be received.

(g) After providing the owner or operator an opportunity to respond under paragraph (f) of this section, the implementing agency may issue the owner or operator a written final determination of necessary revisions to the stationary source's RMP. The final determination may adopt or modify the revisions contained in the preliminary determination under paragraph (e) of this section or may adopt or modify the substitute revisions provided in the response under paragraph (f) of this section. A final determination that adopts a revision rejected by the owner or operator shall include an explanation of the basis for the revision. A final determination that fails to adopt a substitute revision provided under paragraph (f) of this section shall include an explanation of the basis for finding such substitute revision unreasonable.

(h) Thirty days after completion of the actions detailed in the implementation schedule set in the final determination under paragraph (g) of this section, the owner or operator shall be in violation of subpart G of this part and this section unless the owner or operator revises the RMP prepared under subpart G of this part as required by the final determination, and submits the revised RMP as required under § 68.150.

(i) The public shall have access to the preliminary determinations, responses, and final determinations under this section in a manner consistent with § 68.210.

(j) Nothing in this section shall preclude, limit, or interfere in any way with the authority of EPA or the state to exercise its enforcement, investigatory, and information gathering authorities concerning this part under the Act.

14. Part 68 Appendix A is added to read as follows:

Appendix A to Part 68—Table of Toxic Endpoints

[As defined in § 68.22 of this part]

CAS No.	Chemical name	Toxic endpoint (mg/L)
107–02–8	Acrolein [2-Propenal]	0.0011
107–13–1	Acrylonitrile [2-Propenenitrile]	0.076
814–68–6	Acrylyl chloride [2-Propenoyl chloride]	0.00090
107–18–6	Allyl alcohol [2-Propen-1-ol]	0.036
107–11–9	Allylamine [2-Propen-1-amine]	0.0032
7664–41–7	Ammonia (anhydrous)	0.14
7664–41–7	Ammonia (conc 20% or greater)	0.14
7784–34–1	Arsenous trichloride	0.010
7784–42–1	Arsine	0.0019
10294–34–5	Boron trichloride [Borane, trichloro-]	0.010
7637–07–2	Boron trifluoride [Borane, trifluoro-]	0.028
353–42–4	Boron trifluoride compound with methyl ether (1:1) [Boron, trifluoro[oxybis[methane]]-, T-4	0.023
7726–95–6	Bromine	0.0065
75–15–0	Carbon disulfide	0.16
7782–50–5	Chlorine	0.0087
10049–04–4	Chlorine dioxide [Chlorine oxide (ClO_2)]	0.0028
67–66–3	Chloroform [Methane, trichloro-]	0.49
542–88–1	Chloromethyl ether [Methane, oxybis[chloro-]	0.00025
107–30–2	Chloromethyl methyl ether [Methane, chloromethoxy-]	0.0018
4170–30–3	Crotonaldehyde [2-Butenal]	0.029
123–73–9	Crotonaldehyde, (E)-, [2-Butenal, (E)-]	0.029
506–77–4	Cyanogen chloride	0.030
108–91–8	Cyclohexylamine [Cyclohexanamine]	0.16
19287–45–7	Diborane	0.0011
75–78–5	Dimethyldichlorosilane [Silane, dichlorodimethyl-]	0.026
57–14–7	1,1-Dimethylhydrazine [Hydrazine, 1,1-dimethyl-]	0.012
106–89–8	Epichlorohydrin [Oxirane, (chloromethyl)-]	0.076
107–15–3	Ethylenediamine [1,2-Ethanediamine]	0.49
151–56–4	Ethyleneimine [Aziridine]	0.018
75–21–8	Ethylene oxide [Oxirane]	0.090
7782–41–4	Fluorine	0.0039
50–00–0	Formaldehyde (solution)	0.012
110–00–9	Furan	0.0012
302–01–2	Hydrazine	0.011
7647–01–0	Hydrochloric acid (conc 30% or greater)	0.030
74–90–8	Hydrocyanic acid	0.011
7647–01–0	Hydrogen chloride (anhydrous) [Hydrochloric acid]	0.030
7664–39–3	Hydrogen fluoride/Hydrofluoric acid (conc 50% or greater) [Hydrofluoric acid]	0.016
7783–07–5	Hydrogen selenide	0.00066
7783–06–4	Hydrogen sulfide	0.042
13463–40–6	Iron, pentacarbonyl- [Iron carbonyl ($Fe(CO)_5$), (TB–5–11)-]	0.00044
78–82–0	Isobutyronitrile [Propanenitrile, 2-methyl-]	0.14
108–23–6	Isopropyl chloroformate [Carbonochloride acid, 1-methylethyl ester]	0.10
126–98–7	Methacrylonitrile [2-Propenenitrile, 2-methyl-]	0.0027
74–87–3	Methyl chloride [Methane, chloro-]	0.82
79–22–1	Methyl chloroformate [Carbonochloridic acid, methylester]	0.0019
60–34–4	Methyl hydrazine [Hydrazine, methyl-]	0.0094
624–83–9	Methyl isocyanate [Methane, isocyanato-]	0.0012
74–93–1	Methyl mercaptan [Methanethiol]	0.049
556–64–9	Methyl thiocyanate [Thiocyanic acid, methyl ester]	0.085
75–79–6	Methyltrichlorosilane [Silane, trichloromethyl-]	0.018
13463–39–3	Nickel carbonyl	0.00067
7697–37–2	Nitric acid (conc 80% or greater)	0.026

APPENDIX A TO PART 68—TABLE OF TOXIC ENDPOINTS—Continued

[As defined in §68.22 of this part]

CAS No.	Chemical name	Toxic endpoint (mg/L)
10102-43-9	Nitric oxide [Nitrogen oxide (NO)]	0.031
8014-95-7	Oleum (Fuming Sulfuric acid) [Sulfuric acid, mixture with sulfur trioxide]	0.010
79-21-0	Peracetic acid [Ethaneperoxoic acid]	0.0045
594-42-3	Perchloromethylmercaptan [Methanesulfenyl chloride, trichloro-]	0.0076
75-44-5	Phosgene [Carbonic dichloride]	0.00081
7803-51-2	Phosphine	0.0035
10025-87-3	Phosphorus oxychloride [Phosphoryl chloride]	0.0030
7719-12-2	Phosphorus trichloride [Phosphorous trichloride]	0.028
110-89-4	Piperidine	0.022
107-12-0	Propionitrile [Propanenitrile]	0.0037
109-61-5	Propyl chloroformate [Carbonochloridic acid, propylester]	0.010
75-55-8	Propyleneimine [Aziridine, 2-methyl-]	0.12
75-56-9	Propylene oxide [Oxirane, methyl-]	0.59
7446-09-5	Sulfur dioxide (anhydrous)	0.0078
7783-60-0	Sulfur tetrafluoride [Sulfur fluoride (SF4), (T-4)-]	0.0092
7446-11-9	Sulfur trioxide	0.010
75-74-1	Tetramethyllead [Plumbane, tetramethyl-]	0.0040
509-14-8	Tetranitromethane [Methane, tetranitro-]	0.0040
7750-45-0	Titanium tetrachloride [Titanium chloride (TiCl4) (T-4)-]	0.020
584-84-9	Toluene 2,4-diisocyanate [Benzene, 2,4-diisocyanato-1-methyl-]	0.0070
91-08-7	Toluene 2,6-diisocyanate [Benzene, 1,3-diisocyanato-2-methyl-]	0.0070
26471-62-5	Toluene diisocyanate (unspecified isomer) [Benzene, 1,3-diisocyanatomethyl-]	0.0070
75-77-4	Trimethylchlorosilane [Silane, chlorotrimethyl-]	0.050
108-05-4	Vinyl acetate monomer [Acetic acid ethenyl ester]	0.26

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Appendix D

Facsimile of TJAG Opinion on Applicability of OSHA PSM for EPA RMP

DEPARTMENT OF THE ARMY
OFFICE OF THE JUDGE ADVOCATE GENERAL
901 NORTH STUART STREET
ARLINGTON, VA 22203-1837

REPLY TO ATTENTION OF

DAJA-EL

9 September 1996

MEMORANDUM FOR Dr. Dave Reed, USACHPPM, Building E-1675, Aberdeen Proving Grounds, Maryland, 21010-5401

SUBJECT: 112r Rule - Program 3 Eligibility Requirements

1. You asked for a legal opinion as to whether DOD facilities are "subject to the OSHA process safety management (PSM) standard, 29 CFR 1910.119" that is specified in 40 CFR § 68.10(d)(2). For the reasons articulated below, Army facilities with processes that are subject to the requirements consistent with those specified in 29 CFR 1910.119, are required to meet the Program 3 requirements for those processes that are not eligible for Program 1.

2. 29 USC § 652(5) specifies that the federal government is not an employer for purposes of OSHA. 29 USC § 668 specifies that the federal government will establish and maintain an effective and comprehensive occupational safety and health program, and provide safe conditions of employment, consistent with the standards promulgated by OSHA. The PSM standard is one of these OSHA standards. E.O. 12196, with limited exceptions, requires federal agencies to comply with OSHA standards. The Army adopted OSHA standards as part of the Army's occupational safety and health program. The gist of the above cited authority is that private company employees are protected by OSHA standards; Army employees are protected by occupational health standards that are consistent with OSHA standards.

3. There are several reasons why this distinction is moot under 40 CFR § 68.10. First, the Army adopted OSHA PSM standards, and Army facilities currently must meet the pollution prevention requirements specified in 29 CFR § 1910.119. Thus, Army facilities have processes that are "subject to OSHA PSM standards" or their equivalent. Second, nothing in the CAA, EPA rulemaking, or DOD discussions with EPA concerning this rule, indicates that Congress or EPA intended to treat federal facilities differently than private entities under the CAA § 112r and 40 CFR § 68. Instead, this language is merely EPA's shorthand description of the processes that EPA thought merited the most protective risk management plans because they pose the greatest risk to the public and the environment if there was an accidental release.

4. The same rational would apply to all DOD facilities that are required to meet the OSHA PSM standards or their equivalent.

5. This opinion was coordinated with Major Craig Teller (SAGC), Major John Smith (AFLSA/JACE), and Ms. Allison Ling (OAGC(I&E)).

6. I can be reached at 696-1569 if there are any questions regarding this matter.

Mel Olmscheid

MELVIN G. OLMSCHEID
LTC, JA
Chief, Compliance Branch

CF:
Major Teller (SAGC)
Major Smith (AFLSA/JACE)
Ms. Ling (OAGC(I&E))

Facsimile of TJAG Opinion on Applicability of OSHA PSM for EPA RMP

Appendix E

EPA Offsite Consequence Analysis Guidance

RMP
OFFSITE CONSEQUENCE ANALYSIS
GUIDANCE

May 24, 1996

This document guides the owner or operator of processes covered by the Risk Management Program rule in the analysis of offsite consequences of accidental releases of substances regulated under section 112(r) of the Clean Air Act. This document does not substitute for EPA's regulations, nor is it a regulation itself. Thus, it cannot impose legally binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future, as appropriate.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF EXHIBITS

Roadmap to Consequence Analysis Guidance by Type of Chemical

Type of Chemical and Release Scenario	Applicable Sections and Appendices
Toxic Gas	
Worst-Case Scenario	
1) Define Worst Case	Section 2.1
2) Select Scenario	Sections 2.2 & 2.3
Unmitigated	
Refrigerated	Section 3.1.1
4) Find Toxic Endpoint	Section 3.1.2
5) Determine Reference Table and Distance	Section 3.1.3
Dense or Neutrally Buoyant Plume	Appendix B (Exhibit B-1)
Urban or Rural	Section 3.1.3, 3.2.3
Release Duration	Section 4 & Appendix B (Exhibit B-1)
	Sections 2.1 & 4
	Section 2.1
Alternative Scenario	
1) Define Alternative Scenario	Section 6
2) Select Scenario	Section 7
3) Calculate Release Rates	
Unmitigated (from tanks and pipes)	Section 8.1.1
Active or Passive Mitigation	Section 8.1.2
4) Find Toxic Endpoint	Appendix B (Exhibit B-1)
5) Determine Reference Table and Distance	
Dense or Neutrally Buoyant Plume	Section 9 & Appendix B (Exhibit B-1)
Urban or Rural	Sections 2.1 & 9
Release Duration	Section 8.1.1
Toxic Liquid	

Worst-Case Scenario	
1) Define Worst Case	Section 2.1
2) Select Scenario	Sections 2.2 & 2.3
3) Calculate Release Rates	
Releases from pipes	Section 3.2.1
Unmitigated Pool Evaporation	Section 3.2.2
Passive Mitigation (dikes, buildings)	Section 3.2.3
Release at Ambient Temperature	Section 3.2.2
Release at Elevated Temperature	Section 3.2.2
Releases of Solutions	Section 3.3 & Appendix B (Exhibit B-3)
Releases of Mixtures	Section 3.2.4 and Appendix B (Section B.2)
4) Find Toxic Endpoint	
For Liquids/Mixtures	Appendix B (Exhibit B-2)
For Solutions	Appendix B (Exhibit B-3)
5) Determine Reference Table and Distance	
Dense or Neutrally Buoyant Plume (liquids)	Section 4 and Appendix B (Exhibit B-2)
Dense or Neutrally Buoyant Plume (solutions)	Section 4 and Appendix B (Exhibit B-3)
Urban or Rural	Section 2.1 and 4
Release Duration (liquids)	Section 3.2.2
Release Duration (solutions)	Section 4
Toxic Liquid	
Alternative Scenario	
1) Define Alternative Scenario	Section 6
2) Select Scenario	Section 7
3) Calculate Release Rates	Section 8.2
Unmitigated (from tanks and pipes)	Section 8.2.1
Active or Passive Mitigation	Section 8.2.2
Release at ambient temperature	Section 8.2.3
Release at elevated temperature	Section 8.2.3
Release of solution	Sections 8.2.4 and 3.3 and Appendix B (Exhibit B-3)
4) Find Toxic Endpoint	
For liquids/mixtures	Appendix B (Exhibit B-2)

For solutions	Appendix B (Exhibit B-3)
5) Determine Reference Table and Distance	
Dense or Neutrally Buoyant Plume (liquids/mixtures)	Section 9 and Appendix B (Exhibit B-2)
Dense or Neutrally Buoyant Plume (solutions)	Section 9 and Appendix B (Exhibit B-3)
Urban or Rural	Sections 2.1 and 9
Release Duration (liquids/mixtures)	Section 3.2.2
Release Duration (liquids/mixtures)	Section 9
Flammable Substances	
Worst-Case Scenario	
1) Define Worst Case	Sections 5.1 and 2.1
2) Select Scenario	Section 5.1 and 2.2 and 2.3
3) Determine Distance to Overpressure Endpoint	
For Pure Flammable Substances	Section 5.1
For Flammable Mixtures	Section 5.2
Alternative Scenario	
1) Define Alternative Scenario	Section 10
2) Select Scenario	Section 10
3) For Vapor Cloud Fires	Section 12.1
Calculate Release Rates (gases)	Section 11.1 and Appendix C (Exhibit C-2)
Calculate Release Rates (liquids)	Section 11.2
Find Lower Flammability Limit (gases)	Appendix C (Exhibit C-2)
Find Lower Flammability Limit (liquids)	Appendix C (Exhibit C-3)
Dense or Neutrally Buoyant (gases)	Appendix C (Exhibit C-2)
Dense or Neutrally Buoyant (liquids)	Appendix C (Exhibit C-3)
Urban or Rural	Section 2.1 and 9
Release Duration	Section 12.1
Determine Distance	Section 9
4) For Pool Fires	Section 12.2 and Appendix C (Exhibit C-3)
5) For BLEVEs	Section 12.3
6) For Vapor Cloud Explosions	Section 12.4

OFFSITE CONSEQUENCE ANALYSIS GUIDANCE

1.0 Overview

Under the accidental release provisions of the Clean Air Act, regulated sources are required to conduct hazard assessments, including offsite consequence analyses. This guidance is intended to assist sources to conduct such offsite consequence analyses for worst-case release scenarios involving regulated substances and alternative release scenarios. The worst-case consequence analyses and the analyses for alternative scenarios are to be reported in the risk management plan (RMP). Consult Chapters 13 and 14 of this document for information on what you will need to report.

If your site has Program 1 processes, you must submit information on a worst-case release scenario for <u>each</u> toxic and flammable substance held above the threshold quantity in a Program 1 process. If your site has Program 2 or Program 3 processes, you must provide information on <u>one</u> worst-case release for all toxic regulated substances present above the threshold quantity and <u>one</u> worst-case release scenario for all flammable regulated substances present above the threshold quantity. You may need to submit an additional worst-case scenario if a worst-case release from another process at the source would potentially affect public receptors different from those potentially affected by the initial worst-case scenario(s) for flammable and toxic regulated substances.

In addition to a worst-case release scenario, sources with Program 2 and Program 3 processes must also provide information on alternative release scenarios. Alternative release scenarios are should be those that may result in concentrations, overpressures, or radiant heat that reach the endpoints specified for these effects offsite. You must present information on one alternative release scenario for <u>each</u> regulated toxic substance, including the substance used for the worst-case release, held above the threshold quantity and <u>one</u> alternative release scenario to represent all flammable substances held above the threshold quantity.

The rule for risk management programs for accidental release prevention can be found at the end of this document as Appendix E. Consult the rule for details of the requirements for regulated sources.

This guidance provides simple methods and reference tables for determining consequence distances for worst-case and alternative release scenarios. Results obtained using these methods are expected to be conservative. Conservative assumptions have been introduced to compensate for high levels of uncertainty. The methodology provided is optional. If you use this guidance to derive your distances to endpoints, you will be considered to be in compliance with the requirements for offsite consequence analyses. You may, however, use other air dispersion models or computation methods provided that:

- They are publicly or commercially available or they are proprietary models that you are willing to share with the implementing agency;
- They are appropriate for the chemicals and conditions being modeled;
- You use the applicable definitions of worst-case scenarios; and
- You use the applicable parameters specified in the rule.

Exhibit 1 (next page) briefly presents the required parameters for modeling both worst-case and alternative scenarios. If you do your own modeling, you may consider some site-specific conditions for the worst-case analysis, as noted in the exhibit, and use site-specific conditions for the alternative scenario analysis. For this guidance, a number of assumptions had to be made for broad applicability and simplicity of use. These assumptions, which are noted in Exhibit 1 and in the text, are built into and chemical-specific tables of data to be used in carrying out the release rate calculations and the reference tables of distances.

Appendix A of this guidance provides some information on public domain models and references that may be consulted for other methods of analysis. You are not limited to the models and references included in the appendix, but may use any applicable model or method. This appendix does not include details on the capabilities of the models listed. You will find that modeling results may sometimes vary greatly from model to model.

In addition to this generic guidance, EPA is providing specific guidance for several industry sectors, including:

- Ammonia refrigeration, *Model Risk Management Program and Plan for Ammonia Refrigeration* (currently available);
- Propane distribution (currently in development); and
- Water treatment (currently in development).

2.0 Determining Worst-Case Scenario

2.1 Definition of Worst-Case Scenario

EPA has defined a worst-case release as the release of the largest quantity of a regulated substance from a vessel or process line failure that results in the greatest distance to a specified endpoint. The largest quantity should be determined taking into account administrative controls. Administrative controls are procedures that limit the quantity of a substance that can be stored or processed in a vessel or pipe at any one time, or, alternatively, procedures that occasionally allow the vessel or pipe to store larger than usual quantities (e.g., during shutdown/turnaround). For the worst-case analysis, you do not need to consider the possible causes of the worst-case release or the probability that such a release might occur; the release is simply assumed to take place. All releases are assumed to take place at ground level for the worst-case analysis.

Meteorological conditions for the worst-case scenario are defined for this guidance as atmospheric stability class F (stable atmosphere), wind speed of 1.5 meters per second (3.4 miles per hour), and ambient air temperature of 25° C (77° F).

Two choices are provided for topography for the worst-case scenario. If your site is located in an area with few buildings or other obstructions, you should assume open (rural) conditions. If your site is in an urban location, or is in an area with many obstructions, you should assume urban conditions.

Exhibit 1
Required Parameters for Modeling

WORST CASE	ALTERNATIVE SCENARIO
Endpoints	
Endpoints for toxic substances are specified in Appendix B.	Endpoints for toxic substances are specified in Appendix B.
For flammable substances, endpoint is overpressure of 1 pound per square inch (psi) for vapor cloud explosions.	For flammable substances, endpoint is overpressure of 1 psi for vapor cloud explosions, or
	Radiant heat level of 5 kilowatts per square meter (kW/m^2) for 40 seconds for heat from fires (or equivalent dose), or
	Lower flammability limit (LFL) as specified in NFPA documents or other generally recognized sources.
Wind speed/stability	
Use wind speed of 1.5 meters per second and F stability class unless you can demonstrate that local meteorological data applicable to the site show a higher minimum wind speed or less stable atmosphere at all times during the previous three years. If you can so demonstrate, these minimums may be used. This guidance assumes 1.5 meters per second and F stability.	For site-specific modeling, use typical meteorological conditions for your site. If you use this guidance, you assume wind speed of 3 meters per second and D stability.
Ambient temperature/humidity	
For toxic substances, use the highest daily maximum temperature and average humidity for the site during the past three years. If you are using this guidance, 25°C (77°F) and 50 percent humidity are assumed.	You may use average temperature/humidity data gathered at the site or at a local meteorological station. If you are using this guidance, 25°C and 50 percent humidity are assumed.
Height of release	
For toxic substances, assume a ground level release.	Release height may be determined by the release scenario. For this guidance, a ground-level release is assumed.
Topography	
Use urban or rural topography, as appropriate.	Use urban or rural topography, as appropriate.
Dense or neutrally buoyant gases	
Tables or models used for dispersion of regulated toxic substances must appropriately account for gas density. If you use this guidance, see Tables 1-4 for buoyant gases and Tables 5-8 for dense gases.	Tables or models used for dispersion must appropriately account for gas density. If you use this guidance, see Tables 10-13 for buoyant gases and Tables 14-17 for dense gases.
Temperature of released substance	
Consider liquids (other than gases liquefied by refrigeration) to be released at the highest daily maximum temperature, based on data for the previous three years, or at process temperature, whichever is higher. Assume gases liquefied by refrigeration at atmospheric pressure are released at their boiling points. If you are using this guidance, 25°C or the boiling point of the released substance may be used.	Substances may be considered to be released at a process or ambient temperature that is appropriate for the scenario. If you are using this guidance, 25°C or the boiling point of the released substance may be used.

<u>Toxic gases</u>. Toxic gases include all regulated toxic substances that are gases at ambient temperature (temperature 25° C, 77° F), with the exception of gases liquefied by refrigeration under

atmospheric pressure. For the consequence analysis, a gaseous release of the total quantity is assumed to occur in 10 minutes. Passive mitigation measures (e.g., enclosure) may be taken into account in the analysis of the worst-case scenario. Gases liquefied by refrigeration alone and released into diked areas may be modeled as liquids at their boiling points and assumed to be released from a pool by evaporation.

The endpoint for air dispersion modeling to estimate the consequence distance for a release of a toxic gas is presented for each regulated toxic gas in Exhibit B-1 of Appendix B. The toxic endpoint is, in order of preference: (1) the Emergency Response Planning Guideline 2 (ERPG-2), developed by the American Industrial Hygiene Association (AIHA), or (2) the Level of Concern (LOC) for extremely hazardous substances (EHSs) regulated under section 302 of the Emergency Planning and Community Right-to-Know Act (EPCRA). This endpoint was chosen as the threshold for serious injury from exposure to a toxic substance in the air. (See Appendix D, Section D.3, for additional information on the toxic endpoint.)

Toxic liquids. For toxic liquids, the total quantity in a vessel is assumed to be spilled onto a flat, non-absorbing surface. For toxic liquids carried in pipelines, the quantity that might be released from the pipeline is assumed to form a pool. Passive mitigation systems (e.g., dikes) may be taken into account in consequence analysis. The total quantity spilled is assumed to spread instantaneously to a depth of 0.39 inch (one centimeter) in an undiked area or to cover a diked area instantaneously. The release rate to air is estimated as the rate of evaporation from the pool. If liquids at your site might be spilled onto a surface that could rapidly absorb the spilled liquid (e.g., porous soil), the methods presented in this guidance may greatly overestimate the consequences of a release. Consider using another method in such a case.

The endpoint for air dispersion modeling to estimate the consequence distance for a release of a toxic liquid is presented for each regulated toxic liquid in Exhibit B-2 of Appendix B. The toxic endpoint is, in order of preference: (1) the ERPG-2 or (2) the LOC for EHSs, as for toxic gases.

Flammable substances. For regulated flammable substances, including both flammable gases and volatile flammable liquids, the worst-case release is assumed to result in a vapor cloud containing the total quantity of the substance that could be released from a vessel or pipeline. The entire quantity in the cloud is assumed to be between the upper and lower flammability limits of the substance. For the worst-case consequence analysis, the vapor cloud is assumed to detonate.

The endpoint for the consequence analysis of a vapor cloud explosion of a regulated flammable substance is an overpressure of 1 pound per square inch (psi). This endpoint was chosen as the threshold for potential serious injuries to people as a result of property damage caused by an explosion (e.g., injuries from flying glass from shattered windows or falling debris from damaged houses). (See Appendix D, Section D.5 for additional information on this endpoint.)

2.2 Determination of Quantity for the Worst-Case Scenario

For the analysis of the worst-case scenario, you must consider the largest quantity of a regulated substance handled on site in a single vessel at any one time, taking into account administrative controls. For example, if you have written procedural restrictions that limit vessel inventories to less than the maximum, you would not consider the maximum possible vessel inventory. If the vessel normally contains only a small quantity, but may contain a much greater quantity under special circumstances, such as a turnaround, you must use the larger quantity for the worst case. You also must consider the quantity that might be released if a pipeline were sheared.

2.3 Selecting Single Worst-Case Scenario

The hazard assessment requires a single offsite consequence analysis of the worst-case scenario for substances in each hazard category (i.e., one for regulated toxic substances and one for regulated flammable substances). Only the hazard for which the substance is listed needs to be considered (i.e., substances on the list of regulated toxic substances that are also flammable should be analyzed only for their toxic hazard; substances on the list of regulated flammable substances should be considered only for flammability).

The substance chosen for the consequence analysis for each hazard should be the substance that has the potential to cause the greatest offsite consequences. Choosing the toxic substance that might lead to the greatest offsite consequences may require a screening analysis of the toxic substances on site, because the potential consequences are dependent on a number of factors, including quantity, toxicity, and volatility. Location (distance to the fenceline) and conditions of processing or storage (e.g., a high temperature process) also should be considered.

For flammable substances, the consequences of a vapor cloud explosion must be considered in the analysis. The severity of the consequences of a vapor cloud explosion depends on the quantity of the released substance in the vapor cloud and its heat of combustion. In most cases, the analysis probably should be based on the regulated flammable substance present in the greatest quantity; however, a substance with a high heat of combustion may have a greater potential offsite impact than a larger quantity of a substance with a lower heat of combustion. In some cases, a regulated flammable substance that is close to the fenceline might have a greater potential offsite impact than a larger quantity farther from the fenceline.

3.0 Release Rates for Toxic Substances

This section describes a simple method for estimating release rates for regulated toxic substances for the worst-case scenario. The estimated release rates may be used to estimate dispersion distances to the toxic endpoint for regulated toxic gases and liquids, as discussed in Section 4.

3.1 Release Rates for Toxic Gases

Regulated substances that are gases at ambient temperature (temperature 25° C, 77° F) should be considered gases for consequence analysis, with the exception of gases liquefied by refrigeration at atmospheric pressure. Gases liquefied under pressure should be treated as gases. Gases liquefied by refrigeration alone and released into diked areas may be treated as liquids at their boiling points. You may consider passive mitigation for gaseous releases and releases of gases liquefied by refrigeration. For regulated toxic gases, you may estimate a release rate as described below. Sections 3.1.1 and 3.1.2 describe methods for estimating release rates for unmitigated and mitigated gaseous releases, and Section 3.1.3 describes the estimation of the release rate of a refrigerated liquefied gas from a diked pool.

EPA is providing guidance, including guidance on offsite consequence analysis, specifically for ammonia refrigeration facilities in *Model Risk Management Program and Plan for Ammonia*

Refrigeration. The ammonia-specific guidance takes into account the conditions encountered in ammonia refrigeration; modeling results are somewhat less conservative than the results obtained using this off-site consequence analysis guidance. If you are conducting a worst-case analysis for ammonia used for refrigeration, you should consult the guidance for ammonia refrigeration facilities.

3.1.1 Unmitigated Releases of Gas

If no passive mitigation system is in place, estimate the release rate for the release over a 10-minute period of the largest quantity resulting from a pipe or vessel failure. For a release from a vessel, calculate the release rate as follows:

$$QR = \frac{QS}{10} \qquad (1)$$

where: QR = Release rate (pounds per minute)
QS = Quantity released (pounds)

For a gas pipeline, assume the pipeline is sheared and use the usual flow rate through the pipe as the release rate for the consequence analysis.

Example 1. Gas Release (Diborane)

You have a tank containing 2,500 pounds of diborane gas. Assuming the total quantity in the tank is released over a 10-minute period, the release rate (QR), from Equation 1, is:

QR = 2,500 pounds/10 minutes = 250 pounds per minute

3.1.2 Releases of Gas in Enclosed Space

If a gas is released in an enclosure such as a building or shed, the release rate to the outside air may be lessened considerably. The dynamics of this type of release are complex; however, you may use the simplified method presented here to estimate an approximate release rate to the outside air from a release in an enclosed space. The enclosed space is assumed to be in direct contact with the outside air; i.e., this method does not apply to a release in a room that is enclosed within a building. For the worst case, assume as before that the largest quantity resulting from a pipe or vessel failure is released over a 10-minute period. Determine the unmitigated worst-case scenario release rate of the gas as the quantity released divided by 10 (Equation 1). The release rate from the building will be approximately 55 percent of the worst case scenario release rate (see Appendix D, Section D.1.1 for the derivation of this factor), as follows:

$$QR = \frac{QS}{10} \times 0.55 \qquad (2)$$

where: QR = Release rate (pounds per minute)
QS = Quantity released (pounds)
0.55 = Mitigation factor (discussed in Appendix D, Section D.1.2)

Example 2. Gas Release in Enclosure (Diborane)

Suppose the diborane gas from Example 1 is released inside a building at the rate of 250 pounds per minute. The mitigated release to the outside air from the building would be:

$$QR = 250 \text{ pounds/minute} \times 0.55 = 138 \text{ pounds per minute}$$

3.1.3 Releases of Liquefied Refrigerated Gas in Diked Area

If you have a toxic gas that is liquefied by refrigeration alone, and it will be released into an area where it will be contained by dikes to form a pool more than 0.033 feet (1 centimeter) in depth, you can carry out the worst-case analysis assuming evaporation from a liquid pool. First compare the diked area to the maximum area of the pool that could be formed. You can use Equation 6 in Section 3.2.3 to estimate the maximum size of the pool. Density factors (DF) for toxic gases at their boiling points are listed in Exhibit B-1 of Appendix B. If the pool formed by the released liquid would be smaller than the diked area, assume a ten-minute gaseous release, and estimate the release rate as described in Section 3.1.1. If the dikes prevent the liquid from spreading out to form a pool of maximum size (assuming a depth of 0.033 feet (one centimeter)), you may use the method described in Section 3.2.3 for mitigated liquid releases to estimate a release rate from a pool at the boiling point of the released substance. Use Equation 8 in Section 3.2.3 for the release rate. The Liquid Factor Boiling (LFB) for each toxic gas is listed in Exhibit B-1 of Appendix B.

After you have estimated the release rate, estimate the duration of the vapor release from the pool by dividing the total quantity spilled by the release rate.

Example 3. Mitigated Release of Gases Liquefied by Refrigeration (Chlorine)

You have a refrigerated tank containing 50,000 pounds of liquid chlorine. A diked area around the chlorine tank of 275 square feet is sufficient to hold all of the spilled liquid chlorine. Once the liquid spills into the dike, it is then assumed to evaporate at its boiling point (-29° F or 239 Kelvin). The evaporation rate at the boiling point is determined from Equation 8. For the calculation, wind speed is assumed to be 1.5 meters per second and the wind speed factor is 1.4, LFB for chlorine (from Exhibit B-1) is 0.19, and A is 275 square feet. The release rate is:

$$QR = 1.4 \times 0.19 \times 275 = 73 \text{ pounds per minute}$$

The duration of the release would be:

$$t = 50{,}000 \text{ pounds}/73 \text{ pounds per minute} = 685 \text{ minutes}$$

3.2 Release Rates for Toxic Liquids

The release rate to air for toxic liquids is assumed to be the rate of evaporation from the pool formed by the released liquid. Assume the total quantity in a vessel is released into the pool, or estimate the quantity that might be released from a pipe as discussed in Section 3.2.1 below. Passive mitigation measures (e.g., dikes) may be considered in determining the area of the pool and the release rate. If the substance on site is always at ambient temperature, the evaporation rate may be determined assuming the pool and surroundings are at 25° C (77° F); this guidance provides data for this calculation. This guidance also provides data for estimating the evaporation rate at the boiling point of the substance, for cases where the substance may be at elevated temperatures.

The calculation methods provided in this section apply only to substances that are liquids under ambient conditions. For substances that are gases under ambient conditions, but are liquefied under pressure or refrigeration, see Section 3.1 above.

3.2.1 Releases of Liquids from Pipes

To consider a liquid release from a broken pipe, estimate the maximum quantity that could be released assuming that the pipe is full of liquid. To estimate the quantity in the pipe, you need to know the length of the pipe (in feet) and cross-sectional area of the pipe (in square feet). Note also that liquid may be released from both directions at a pipe shear (both in the direction of operational flow and the reverse direction, depending on the location of the shear). Therefore, the length would be the full length of pipe carrying the liquid on the facility grounds. Then, the volume of the liquid in the pipe (in cubic feet) is the length of the pipe times the cross-sectional area. The quantity in the pipe (in pounds) is the volume divided by the Density Factor (DF) times 0.033. (1/(DF times 0.033) is equal to density in pounds per cubic foot). Assume the estimated quantity (in pounds) is released into a pool and use the method and equations described below in Section 3.2.2 (unmitigated releases) or 3.2.3 (releases with passive mitigation) to determine the evaporation rate of the liquid from the pool.

3.2.2 Unmitigated Releases of Liquids

If no passive mitigation measures are in place, the liquid is assumed to form a pool 0.39 inch (one centimeter) deep instantaneously. You may calculate the release rate to air from the pool (the evaporation rate) as discussed below for releases at ambient or elevated temperature.

Ambient temperature. If the liquid is always at ambient temperature, find the Liquid Factor Ambient (LFA) and the Density Factor (DF) in Exhibit B-2 of Appendix B (see Appendix D, Section D.2.2 for the derivation of these factors). Calculate the release rate of the liquid from the following equation:

$$QR = QS \times 1.4 \times LFA \times DF \qquad (3)$$

where: QR = Release rate (pounds per minute)
QS = Quantity released (pounds)
1.4 = Wind speed factor = $1.5^{0.78}$, where 1.5 meters per second (3.4 miles per hour) is the wind speed for the worst case
LFA = Liquid Factor Ambient

DF = Density Factor

Example 4. Unmitigated Liquid Release at Ambient Temperature (Acrylonitrile)

You have a tank containing 20,000 pounds of acrylonitrile at ambient temperature. The total quantity in the tank is spilled onto the ground in an undiked area, forming a pool. Assume the pool spreads out to a depth of one centimeter. The release rate from the pool (QR) is calculated from Equation 3. For the calculation, the wind speed is assumed to be 1.5 meters per second and the wind speed factor is 1.4. From Exhibit B-2, Appendix B, LFA is for acrylonitrile is 0.018 and DF is 0.61. Then:

QR = 20,000 x 1.4 x 0.018 x 0.61 = 307 pounds per minute

The duration of the release (from Equation 5) would be:

t = 20,000 pounds/307 pounds per minute = 65 minutes

Elevated temperature. If the liquid is at an elevated temperature (any temperature above 25° C), find the Liquid Factor Boiling (LFB) and the Density Factor (DF) in Exhibit B-2 of Appendix B (see Appendix D, Section D.2.2, for the derivation of these factors). Calculate the release rate of the liquid from the following equation:

$$QR = QS \times 1.4 \times LFB \times DF \qquad 4$$

where: QR = Release rate (pounds per minute)
QS = Quantity released (pounds)
1.4 = Wind speed factor = $1.5^{0.78}$, where 1.5 meters per second (3.4 miles per hour) is the wind speed for the worst case
LFB = Liquid Factor Boiling
DF = Density Factor

Example 5. Unmitigated Release at Elevated Temperature (Acrylonitrile)

You have a tank containing 20,000 pounds of acrylonitrile at an elevated temperature. The total quantity in the tank is spilled onto the ground in an undiked area, forming a pool. Assume the pool spreads out to a depth of 0.033 feet (one centimeter). The release rate from the pool is calculated from Equation 4. For the calculation, the wind speed factor for 1.5 meters per second is 1.4. From Exhibit, B-2, Appendix B, LFB for acrylonitrile is 0.11 and DF is 0.61. Then:

QR = 20,000 × 1.4 × 0.11 × 0.61 = 1,880 pounds per minute

The duration of the release (from Equation 5) would be:

t = 20,000 pounds/1880 pounds per minute = 11 minutes

Duration of Release. After you have estimated a release rate as described above, determine the duration of the vapor release from the pool (the time it will take for the liquid pool to evaporate completely). To estimate the time in minutes, divide the total quantity released (in pounds) by the release rate (in pounds per minute) as follows:

$$t = \frac{QS}{QR} \tag{5}$$

where: t = Duration of the release (minutes)
QR = Release rate (pounds per minute)
QS = Quantity released (pounds)

You will use the duration of the vapor release from the pool to decide which table is appropriate for estimating distance, as discussed in Section 4 below.

3.2.3 Releases of Liquids with Passive Mitigation

Diked Areas. If the toxic liquid will be released into an area where it will be contained by dikes, compare the diked area to the maximum area of the pool that could be formed; the smaller of the two areas should be used in determination of the evaporation rate. The maximum area of the pool (assuming a depth of 0.033 feet (1 centimeter)) is:

$$A = QS \times DF \tag{6}$$

where: A = Area (square feet)
QS = Quantity released (pounds)
DF = Density Factor (listed in Exhibit B-2, Appendix B)

If the maximum area of the pool is smaller than the diked area, calculate the release rate as described for "no mitigation" above. If the diked area is smaller, go to Exhibit B-2 in Appendix B to find the Liquid Factor Ambient (LFA), if the liquid is at ambient temperature, or the Liquid Factor Boiling (LFB), if the liquid is at a temperature above ambient. Calculate the release rate from the diked area as follows:

$$QR = 1.4 \times LFA \times A \qquad 7$$

or

$$QR = 1.4 \times LFB \times A \qquad 8$$

where: QR = Release rate (pounds per minute)
1.4 = Wind speed factor = $1.5^{0.78}$, where 1.5 meters per second (3.4 miles per hour) is the wind speed for the worst case
LFA = Liquid Factor Ambient (listed in Exhibit B-2, Appendix B)
LFB = Liquid Factor Boiling (listed in Exhibit B-2, Appendix B)
A = Diked area (square feet)

In case of a large liquid spill, you also need to consider whether the liquid could overflow the diked area. Follow these steps:

- Determine the volume of the diked area in cubic feet from length times width times depth (in feet).
- Determine the volume of liquid spilled in cubic feet from QS x DF x 0.033 (DF x 0.033 is equal to 1/density in pounds per cubic foot).
- Compare the volume of the diked area to the volume of liquid spilled. If the volume of liquid is greater than the volume of the diked area:
    - Subtract the volume of the diked area from the total volume spilled to determine the volume that might overflow the diked area.
    - Estimate the maximum size of the pool formed by the overflowing liquid (in square feet) by dividing the overflow volume (in cubic feet) by 0.033 (the depth of the pool in feet).
    - Add the surface area of the diked area and the area of the pool formed by the overflow to estimate the total pool area (A).
    - Estimate the evaporation rate from Equation 7 or 8 above.

After you have estimated the release rate, estimate the duration of the vapor release from the pool by dividing the total quantity spilled by the release rate (Equation 5 above).

Example 6. Mitigated Liquid Release at Ambient Temperature (Bromine)

You have a tank containing 20,000 pounds of bromine at ambient temperature. Assume that the total quantity in the tank is spilled into a diked area 10 feet by 10 feet (area 100 square feet). The area (A) that would be covered to a depth of 0.033 feet (one centimeter) by the spilled liquid is given by Equation 6 as the quantity released (QR) times the Density Factor (DF). From Exhibit B-2, Appendix B, DF for bromine is 0.16. Then:

A = 20,000 x 0.16, or 3,200 square feet

The diked area is smaller than the maximum pool area; therefore, the diked area should be used to determine the evaporation rate from Equation 7. For the calculation, wind speed is 1.5 meters per second, the wind speed factor is 1.4, LFA for bromine (from Exhibit B-2) is 0.073, and A is 100 square feet. The release rate is:

QR = 1.4 x 0.073 x 100 = 10 pounds per minute

The duration of the release would be:

t = 20,000 pounds/10 pounds per minute = 2,000 minutes

Other containment. If the toxic liquid will be contained by other means (e.g., enclosed catch basins or trenches), consider the total quantity that could be spilled and estimate the surface area of the released liquid that potentially would be exposed to the air. Look at the dimensions of trenches or other areas where spilled liquids would be exposed to the air to determine the surface area of pools that could be formed. Use the instructions above to estimate a release rate from the total surface area.

Releases Into Buildings. If the toxic liquid is released inside a building, compare the area of the building floor to the maximum area of the pool that could be formed; the smaller of the two areas should be used in determining the evaporation rate. The maximum area of the pool is determined as described above in releases into diked areas, using Equation 6. The area of the building floor is:

$$A = L \times W \qquad \mathbf{9}$$

where: A = Area (square feet)
L = Length (feet)
W = Width (feet)

The evaporation rate is then determined for a worst case scenario (i.e., wind speed is 1.5 meters per second (3.4 miles per hour)). The maximum rate of evaporated liquid exiting the building is taken to be 10 percent of the calculated worst case scenario evaporation rate (see Appendix D, Section D.2.4 for the derivation of this factor), as follows:

$$QR_B = 0.1 \times QR \qquad \mathbf{10}$$

where: QR_B = Release rate from building
QR = Release rate from pool, estimated as discussed above
0.1 = Mitigation factor, discussed in Appendix D, Section D.2.4

Example 7. Liquid Release Inside Building (Bromine)

Suppose that your tank of bromine from Example 6 is contained inside a storage shed 10 feet by 10 feet (area 100 square feet). From Example 6, you see that the area covered by the bromine in an unenclosed space would be 3,200 square feet. The building area is smaller than the maximum pool area; therefore, the building area should be used to determine the evapcration rate from Equation 7. For the calculation, first determine the worst case scenario evaporation rate:

$$QR = 1.4 \times 0.073 \times 100 = 10 \text{ pounds per minute}$$

The release rate to the outside air of the evaporated liquid leaving the building would then be:

$$QR_B = 0.1 \times 10 \text{ pounds per minute} = 1 \text{ pound per minute}$$

3.2.4 Mixtures Containing Toxic Liquids

In case of a spill of a liquid mixture containing a regulated toxic substance (with the exception of common water solutions, discussed in the next section), you have several options for estimating a release rate:

- Carry out the analysis as described above in Sections 3.2.2 or 3.2.3 using the quantity of the regulated substance in the mixture and the liquid factor (LFA or LFB) and density factor for the regulated substance in pure form. This is a simple approach that will likely give conservative results.

- If you know the partial pressure of the regulated substance in the mixture, you may estimate a more realistic evaporation rate. An equation for the evaporation rate is given at the end of Section B.2 in Appendix B.

  -- In this case, estimate a pool size for the entire quantity of the mixture, for an unmitigated release. If you know the density of the mixture, you may use it in estimating the pool size; otherwise, you may assume the density is the same as the pure regulated substance (in most cases, this assumption is unlikely to have a large effect on the results).

- You may estimate the partial pressure of the regulated substance in the mixture by the method described in Section B.2 in Appendix B and use the equation presented there to estimate an evaporation rate. As discussed above, use the pool size for the entire quantity of the mixture for an unmitigated release.

Example 8. Mixture Containing Toxic Liquid (Acrylonitrile)

You have a tank containing 50,000 pounds of a mixture of acrylonitrile (a regulated substance) and N,N-dimethylformamide (not regulated). The weight of each of the components of the mixture is known (acrylonitrile = 20,000 pounds; N,N-dimethylformamide = 30,000 pounds.) The molecular weight of acrylonitrile, from Exhibit B-2, is 53.06, and the molecular weight of N,N-dimethylformamide is 73.09. Using Equation B-3, Appendix B, calculate the mole fraction of acrylonitrile in the solution as follows:

$$X_r = \frac{(20{,}000/53.06)}{(20{,}000/53.06) + (30{,}000/73.09)}$$

$$X_r = \frac{377}{377 + 410}$$

$$X_r = 0.48$$

Estimate the partial vapor pressure of acrylonitrile using Equation B-4 as follows (using the vapor pressure of acrylonitrile in pure form at 25°C, 108 mm Hg, from Exhibit B-2, Appendix B):

$$VP_m = 0.48 \times 108 = 51.8 \text{ mm Hg}$$

Before calculating evaporation rate for acrylonitrile in the mixture, you must determine the surface area of the pool formed by the entire quantity of the mixture, using Equation 6. The quantity released is 50,000 pounds and the Density Factor for acrylonitrile is 0.61 in Exhibit B-2; therefore:

$$A = 50{,}000 \times 0.61 = 30{,}500 \text{ square feet}$$

Now calculate the evaporation rate for acrylonitrile in the mixture from Equation B-5 using the VP_m and A calculated above:

$$QR = \frac{0.0035 \times 1.0 \times (53.06)^{-} \times 30{,}500 \times 51.8}{298}$$

$$QR = 262 \text{ pounds per minute}$$

3.3 Release Rates for Common Water Solutions of Toxic Substances

This section presents a simple method of estimating the release rate from spills of water solutions of several substances. Oleum (a solution of sulfur trioxide in sulfuric acid) also is discussed in this section.

The vapor pressure and evaporation rate of a substance in solution depends on its concentration in the solution. If a concentrated water solution containing a volatile toxic substance is spilled, the toxic substance initially will evaporate more quickly than water from the spilled solution, and the vapor pressure and evaporation rate will decrease as the concentration of the toxic substance in the solution decreases. At much lower concentrations, water may evaporate more quickly than the toxic substance. There is one concentration at which the composition of the solution does not change as evaporation occurs. For most situations of interest, the concentration exceeds this concentration, and the toxic substance evaporates more quickly than water.

For estimating release rates from solutions, this guidance lists liquid factors (ambient) for several common water solutions at several concentrations that take into account the decrease in evaporation rate with decreasing concentration. Exhibit B-3 in Appendix B provides LFA and DF values for several concentrations of ammonia, formaldehyde, hydrochloric acid, hydrofluoric acid, and nitric acid in water solution. Factors for oleum are also included in the exhibit. These factors may be used to estimate an average release rate for the listed substances from a pool formed by a spill of solution. Liquid factors are provided for two different wind speeds, because the wind speed affects the rate of evaporation.

For the worst case, the factor for a wind speed of 1.5 meter per second (3.4 miles per hour) should be used. You need to consider only the first 10 minutes of the release for solutions under ambient conditions in estimating the consequence distance, because the toxic component in a solution evaporates fastest during the first few minutes of a spill, when its concentration is highest. Therefore, you do not need to take the duration of the release into account. Estimate release rates as follows:

- Unmitigated. If no passive mitigation measures are in place, and the solution is at ambient temperature, find the LFA at 1.5 meters per second (3.4 miles per hour) and DF for the solution in Appendix B, Exhibit B-3. Follow the instructions for liquids presented in Section 3.2.2 above to estimate the release rate of the listed substance in solution. Use the total quantity of the solution as the quantity released (QS) in carrying out the calculation of release rate.

- Mitigated. If passive mitigation is in place, and the solution is at ambient temperature, find the LFA at 1.5 meters per second (3.4 miles per hour) in Appendix B, Exhibit B-3, and follow the instructions for liquids in Section 3.2.3 above. Use the total quantity of the solution to estimate the maximum pool area for comparison with the diked area.

Example 9. Evaporation Rate for Water Solution at Ambient Temperature (Hydrochloric Acid)

You have a tank containing 50,000 pounds of 37 percent hydrochloric acid solution, at ambient temperature. For the worst-case analysis, you assume the entire contents of the tank is released, forming a pool. The release occurs in a diked area of 9,000 square feet.

From Exhibit B-3, Appendix B, the Density Factor (DF) for 37 percent hydrochloric acid is 0.42. From Equation 6, the maximum area of the pool would be 50,000 times 0.42, or 21,000 square feet. The diked area is smaller; therefore, the diked area should be used in the evaporation rate (release rate) calculation, using Equation 7.

For the calculation using Equation 7, you need the pool area (9,000 square feet) and the Liquid Factor Ambient (LFA) for 37 percent hydrochloric acid; you assume a wind speed of 1.5 meters per second, so the wind speed factor is 1.4. From Exhibit B-3, Appendix B, the LFA is 0.0085. From Equation 7, the release rate (QR) of hydrogen chloride from the pool is:

$$QR = 1.4 \times 9{,}000 \times 0.0085 = 107 \text{ pounds per minute}$$

You do not need to consider the duration of the release, because only the first ten minutes are considered.

- Elevated temperature. If the solution is at an elevated temperature, the vapor pressure of the regulated substance and its release rate from the solution will be much higher. If you know the vapor pressure of the solution at the relevant temperature, you can carry out the calculation of the release rate using the equations in Appendix D, Sections D.2.1 and D.2.2. If you do not know the vapor pressure, as a conservative approach for the worst case analysis, use the appropriate instructions, as follows:

  -- Solutions containing substances that are gases under ambient conditions. The list of regulated substances includes several substances that, in their pure form, are gases under ambient conditions, but that may commonly be found in water solutions. These substances include ammonia, formaldehyde, hydrogen chloride, and hydrogen fluoride. For a release of a solution of ammonia, formaldehyde, hydrochloric acid, or hydrofluoric acid above ambient temperature, assume the quantity of the hydrogen chloride, hydrogen fluoride, or ammonia in the solution is released as a gas over 10 minutes, as discussed in Section 3.1 above. You may determine the amount of pure substance in the solution from the concentration (e.g., a solution of 30 percent hydrochloric acid by weight would contain a quantity of hydrogen chloride equal to 0.3 times the total weight of the solution).

Example 10. Evaporation Rate for Water Solution at Elevated Temperature (Hydrochloric Acid)

You have 50,000 pounds of 37 percent hydrochloric acid solution in a high-temperature process. For the worst-case analysis, you assume the entire contents of the process vessel is released. In this case, because the solution is at an elevated temperature, you consider the release of gaseous hydrogen chloride from the hot solution.

The solution would contain 50,000 x 0.37 pounds of hydrogen chloride, or 18,500 pounds. You assume the entire 18,500 pounds is released over 10 minutes. From Equation 1, the release rate is 18,500 divided by 10, or 1,850 pounds per minute.

-- Liquids in solution. For a release of nitric acid solution at a temperature above ambient, determine the quantity of pure nitric acid in the solution from the concentration. Assume the quantity of pure nitric acid is released at an elevated temperature and use the LFB to estimate a release rate as discussed in Section 3.2 above. Similarly, for a release of oleum at an elevated temperature, determine the quantity of free sulfur trioxide in the oleum from the concentration and assume the sulfur trioxide is released at an elevated temperature. Use the LFB to estimate a release rate as discussed in Section 3.2.

Example 11. Evaporation Rate for Liquids in Solution at Elevated Temperature (Nitric Acid)

You have 18,000 pounds of 90% nitric acid solution in a high temperature process. The solution would contain 18,000 x 0.90 pounds of nitric acid, or 16,200 pounds. You assume 16,200 pounds of pure nitric acid is released at an elevated temperature.

For the calculation using Equation 4, you need the quantity released (16,200); the Liquid Factor Boiling (LFB) for nitric acid (0.12 found in Exhibit B-2); the Density Factor (DF) for nitric acid (0.32 found in Exhibit B-2); and you assume a wind speed of 1.5 meter per second, so the wind speed factor is 1.4. From Equation 4, the release rate (QR) of hot nitric acid is:

$$QR = 16{,}200 \times 1.4 \times 0.12 \times 0.32 = 870 \text{ pounds per minute}$$

The duration of release (from Equation 5) would be:

$$t = 16{,}200 \text{ pounds}/870 \text{ pounds per minute} = 19 \text{ minutes}$$

4.0 Estimation of Distance to Toxic Endpoint

This guidance provides reference tables giving worst-case distances for neutrally buoyant gases and vapors and for dense gases and vapors for both rural (open) and urban (congested) areas. The tables were developed assuming a wind speed of 1.5 meters per second (3.4 miles per hour) and F stability. To use the reference tables, you need the worst-case release rates estimated as described in the previous sections. For liquid pool evaporation, you also need the duration of the release. In addition, you will need to determine the appropriate toxic endpoint and whether the gas or vapor is neutrally buoyant or dense, using the exhibits in Appendix B.

Tables are provided for both for 10-minute releases and for 60-minute releases. You should use the tables for 10-minute releases if the duration of your release is 10 minutes or less; use the tables for 60-minute releases if the duration of your release is more than 10 minutes. For the worst case analysis, all releases of toxic gases are assumed to last for 10 minutes; you need to consider the estimated duration of the release (from Equation 5) for evaporation of pools of toxic liquids. For evaporation of water solutions of toxic liquids, you should always use the tables for 10-minute releases.

The tables for distances (Reference Tables 1-8) are found at the end of Section 5. The conditions for which each table is applicable are summarized below.

Reference Table Number	Applicable Conditions		
	Release Duration (minutes)	**Topography**	**Gas or Vapor Density**
1	10	Rural	Neutrally buoyant
2	60		
3	10	Urban	
4	60		
5	10	Rural	Dense
6	60		
7	10	Urban	
8	60		

To use the reference tables, follow these steps:

- Find the toxic endpoint for the substance in Appendix B (Exhibit B-1 for toxic gases or Exhibit B-2 for toxic liquids).

- Determine whether the table for neutrally buoyant or dense gases and vapors is appropriate from Appendix B (Exhibit B-1 for toxic gases or Exhibit B-2 for toxic liquids).

- Determine whether the table for rural or urban conditions is appropriate.

  -- Use the rural table if your site is in an open area with few obstructions.

  -- Use the urban table if your site is in an urban or obstructed area

- Determine whether the 10-minute table or the 60-minute table is appropriate.

  -- Always use the 10-minute table for worst-case releases of toxic gases.

  -- If you estimated the release duration for an evaporating toxic liquid pool to be 10 minutes or less, use the 10-minute table.

  -- If you estimated the release duration for an evaporating toxic liquid pool to be more than 10 minutes, use the 60-minute table.

Neutrally Buoyant Gases or Vapors

- If Exhibit B-1 or B-2 indicates the gas or vapor should be considered neutrally buoyant, divide the estimated release rate (pounds per minute) by the toxic endpoint (milligrams per liter).

- Find the range of release rate/toxic endpoint values that includes your calculated release rate/toxic endpoint in the first column of the appropriate table (Reference Table 1, 2, 3, or 4), then find the corresponding distance to the right.

Dense Gases or Vapors

- If Exhibit B-1 or B-2 indicates the substance should be considered a dense gas or vapor (heavier than air), find the distance in the appropriate table (Reference Table 5, 6, 7, or 8) as follows;

  -- Find the toxic endpoint closest to that of the substance by reading across the top of the table. If the endpoint of the substance is halfway between two values on the table, choose the value on the table that is smaller (to the left).

  -- Find the release rate closest to the release rate estimated for the substance at the left of the table. If the calculated release rate is halfway between two values on the table, choose the release rate that is larger (farther down on the table).

  -- Read across from the release rate and down from the endpoint to find the distance corresponding to the toxic endpoint and release rate for your substance.

The development of Reference Tables 1-8 is discussed in Appendix D, Section D.4. These tables generally give conservative results. If you think the results of the method presented here overstate the potential consequences of a worst-case release at your site, you may choose to use other methods or models that take additional site-specific factors into account.

Example 12. Gas Release (Diborane)

In Example 1, you estimated a release rate for diborane gas of 250 pounds per minute. From Exhibit B-1, the toxic endpoint for diborane is 0.0011 mg/L; the appropriate reference table for diborane is a neutrally buoyant gas table. Your facility and the surrounding area have many buildings, pieces of equipment, and other obstructions; therefore, you assume urban conditions. The appropriate reference table is Reference Table 3, for a 10-minute release of a neutrally buoyant gas in an urban area.

The release rate divided by toxic endpoint for this example is 250/0.0011 = 230,000.

From Reference Table 3, release rate divided by toxic endpoint falls between 221,000 and 264,000, corresponding to about 8.1 miles.

Example 13. Gas Release (Ethylene Oxide)

You have a tank containing 10,000 pounds of ethylene oxide gas. Assuming the total quantity in the tank is released over a 10-minute period, the release rate (QR) from Equation 1 is:

$$QR = 10{,}000 \text{ pounds}/10 \text{ minutes} = 1{,}000 \text{ pounds per minute}$$

From Exhibit B-1, the toxic endpoint for ethylene oxide is 0.09 mg/L; the appropriate reference table for ethylene oxide is the dense gas table. Your facility is in an open, rural area with few obstructions; therefore, you use the table for rural areas.

Using Reference Table 5 for 10-minute releases of dense gases in rural areas, the toxic endpoint of 0.09 mg/L is closer to 0.1 than 0.075 mg/L. For a release rate of 1,000 pounds per minute, the distance to 0.1 mg/L is 3.6 miles.

Example 14. Liquid Evaporation from Pool (Acrylonitrile)

You estimated an evaporation rate of 307 pounds per minute for acrylonitrile from a pool formed by the release of 20,000 pounds into an undiked area (Example 4). You estimated the time for evaporation of the pool as 65 minutes. From Exhibit B-2, the appropriate reference table for a worst-case release of acrylonitrile is the dense gas table, and the toxic endpoint for acrylonitrile is 0.076 mg/L. Your facility is in an urban area. You use Reference Table 8 for 60-minute releases of dense gases in urban areas.

From Reference Table 8, the toxic endpoint closest to 0.076 mg/L is 0.075 mg/L, and the closest release rate to 307 pounds per minute is 250 pounds per minute. Using these values, the table gives a worst-case consequence distance of 2.9 miles.

5.0 Estimation of Distance to Overpressure Endpoint for Flammable Substances

5.1 Flammable Substances Not in Mixtures

For the worst-case scenario involving a release of flammable gases and volatile flammable liquids, the total quantity of the flammable substance is assumed to form a vapor cloud within the upper and lower flammability limits, and the cloud is assumed to detonate. As a conservative assumption, 10 percent of the flammable vapor in the cloud is assumed to participate in the explosion. You need to estimate the consequence distance to an overpressure level of 1 pound per square inch (psi) from the explosion of the vapor cloud. An overpressure of 1 psi may cause partial demolition of houses, which can result in serious injuries to people, and shattering of glass windows, which may cause skin laceration from flying glass.

You may estimate the consequence distance for a given quantity of a regulated flammable substances using Reference Table 9. This table provides distances to 1 psi overpressure for vapor cloud explosions of quantities from 10,000 to 500,000 pounds. These distances were estimated from Equation C-1 in Appendix C, Section C.1, using data provided in Exhibit C-1, Appendix C. If you prefer, you may calculate your worst-case consequence distance for flammable substances directly, using Equation C-1.

> **Example 15. Vapor Cloud Explosion (Propane)**
>
> You have a tank containing 50,000 pounds of propane. From Reference Table 9, the distance to 1 psi overpressure is 0.30 miles for 50,000 pounds of propane.
>
> Alternatively, you can calculate the distance to 1 psi using Equation C-1 from Appendix C:
>
> $$D = 17 \times [\ 0.1 \times (50{,}000/2.2) \times (46{,}333/4{,}680)\ ]^{-}$$
>
> D = 480 meters; converted to miles, 480 x 0.00062 = 0.30 miles

For the worst-case analysis of propane at propane distribution facilities, you should consult the guidance developed specifically for this industry segment, when it becomes available.

The method presented here for analysis of vapor cloud explosions is based on a TNT-equivalent model. Other methods are available for analysis of vapor cloud explosions, including methods that consider site-specific conditions. You may use other methods for your worst-case analysis if you so choose, provided you assume the total quantity of flammable substance is in the cloud and the yield factor is 10 percent and use an endpoint of 1 psi. Appendix A includes references to documents and journal articles on vapor cloud explosions that may be useful.

5.2 Flammable Mixtures

If you have more than 10,000 pounds of a mixture of flammable substances that meets the criteria for listing under CAA section 112(r) (flash point below 22.8° C (73° F), boiling point below 37.8° C (100° F), National Fire Protection Association (NFPA) flammability hazard rating of 4), you may need to carry out a worst-case consequence analysis for the mixture. For simplicity, you may carry out the worst-case analysis based on the predominant flammable component of the mixture or a major component of the mixture with the highest heat of combustion (see Exhibit C-1, Appendix C for data on heat of combustion). Estimate the consequence distance from Reference Table 9 for the major component with the highest heat of combustion, assuming that the quantity in the cloud is the total quantity of the mixture.

Example 16. Vapor Cloud Explosion of Flammable Mixture (Ethylene and Isobutane)

You have 10,000 pounds of a mixture of ethylene (the reactant) and isobutane (a catalyst carrier). To carry out the worst-case analysis, assume the quantity in the cloud is the total quantity of the mixture. Use data for ethylene because it is the component with the highest heat of combustion. (Ethylene heat of combustion = 47,145 kilojoules per kilogram; isobutane heat of combustion = 45,576, from Exhibit C-1, Appendix C). From Reference Table 9, the distance to 1 psi overpressure is 0.18 miles for 10,000 pounds of ethylene; this distance would also apply to the 10,000-pound mixture of ethylene and isobutane.

Calculating the worst-case consequence distance from Equation C-1, Appendix C:

$$D = 17 \times [\ 0.1 \times (10{,}000/2.2) \times (47{,}145/4{,}680)\ ]^{-}$$

D = 283 meters; converted to miles, 283 x 0.00062 = 0.18 miles

Alternatively, you may estimate the heat of combustion of the mixture from the heats of combustion of the components of the mixture using the method described in Appendix C, Section C.2, and then use the Equation C-1 in Appendix C to determine the vapor cloud explosion distance.

Example 17. Estimating Heat of Combustion of Mixture for Vapor Cloud Explosion Analysis

You have a mixture of 8,000 pounds of ethylene (the reactant) and 2,000 pounds of isobutane (a catalyst carrier). To carry out the worst-case analysis, estimate the heat of combustion of the mixture from the heats of combustion of the components of the mixture. (Ethylene heat of combustion = 47,145 kilojoules per kilogram; isobutane heat of combustion = 45,576). Using Equation C-2, Appendix C:

$$HC_m = \left[\frac{(8{,}000/2.2)}{(10{,}000/2.2)} \times 47{,}145 \right] + \left[\frac{(2{,}000/2.2)}{(10{,}000/2.2)} \times 45{,}576 \right]$$

$$HC_m = (37{,}716) + (9{,}115)$$

$$HC_m = 46{,}831 \text{ kilojoules per kilogram}$$

Now use the calculated heat of combustion for the mixture in Equation C-1 to calculate the distance to 1 psi overpressure for vapor cloud explosion.

$$D = 17 \times [\, 0.1 \times (10{,}000/2.2) \times (46{,}831/4{,}680)\,]^{-}$$

$$D = 282 \text{ meters} = 0.18 \text{ miles}$$

Reference Table 1
Neutrally Buoyant Plume Distances to Toxic Endpoint for Release Rate Divided by Endpoint
10-Minute Release, Rural Conditions, F Stability, Wind Speed 1.5 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 4.4	0.06
4.4 - 37	0.19
37 - 97	0.31
97 - 180	0.43
180 - 340	0.62
340 - 530	0.81
530 - 760	0.99
760 - 1,000	1.2
1,000 - 1,500	1.4
1,500 - 1,900	1.6
1,900 - 2,400	1.8
2,400 - 2,900	2.0
2,900 - 3,500	2.2
3,500 - 4,400	2.4
4,400 - 5,100	2.6
5,100 - 5,900	2.8
5,900 - 6,800	3.0
6,800 - 7,700	3.2
7,700 - 9,000	3.4
9,000 - 10,000	3.6
10,000 - 11,000	3.8
11,000 - 12,000	4.0
12,000 - 14,000	4.2
14,000 - 15,000	4.4
15,000 - 16,000	4.6

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
16,000 - 18,000	4.8
18,000 - 19,000	5.0
19,000 - 21,000	5.2
21,000 - 23,000	5.4
23,000 - 24,000	5.6
24,000 - 26,000	5.8
26,000 - 28,000	6.0
28,000 - 29,600	6.2
29,600 - 35,600	6.8
35,600 - 42,000	7.5
42,000 - 48,800	8.1
48,800 - 56,000	8.7
56,000 - 63,600	9.3
63,600 - 71,500	9.9
71,500 - 88,500	11
88,500 - 107,000	12
107,000 - 126,000	14
126,000 - 147,000	15
147,000 - 169,000	16
169,000 - 191,000	17
191,000 - 215,000	19
215,000 - 279,000	22
279,000 - 347,000	25
>347,000	>25

Reference Table 2
Neutrally Buoyant Plume Distances to Toxic Endpoint for Release Rate Divided by Endpoint
60-Minute Release, Rural Conditions, F Stability, Wind Speed 1.5 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 5.5	0.06
5.5 - 46	0.19
46 - 120	0.31
120 - 220	0.43
220 - 420	0.62
420 - 650	0.81
650 - 910	0.99
910 - 1,200	1.2
1,200 - 1,600	1.4
1,600 - 1,900	1.6
1,900 - 2,300	1.8
2,300 - 2,600	2.0
2,600 - 2,900	2.2
2,900 - 3,400	2.4
3,400 - 3,700	2.6
3,700 - 4,100	2.8
4,100 - 4,400	3.0
4,400 - 4,800	3.2
4,800 - 5,200	3.4
5,200 - 5,600	3.6
5,600 - 5,900	3.8
5,900 - 6,200	4.0
6,200 - 6,700	4.2
6,700 - 7,000	4.4
7,000 - 7,400	4.6

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
7,400 - 7,700	4.8
7,700 - 8,100	5.0
8,100 - 8,500	5.2
8,500 - 8,900	5.4
8,900 - 9,200	5.6
9,200 - 9,600	5.8
9,600 - 10,000	6.0
10,000 - 10,400	6.2
10,400 - 11,700	6.8
11,700 - 13,100	7.5
13,100 - 14,500	8.1
14,500 - 15,900	8.7
15,900 - 17,500	9.3
17,500 - 19,100	9.9
19,100 - 22,600	11
22,600 - 26,300	12
26,300 - 30,300	14
30,300 - 34,500	15
34,500 - 38,900	16
38,900 - 43,600	17
43,600 - 48,400	19
48,400 - 61,500	22
61,500 - 75,600	25
>75,600	>25

Reference Table 3
Neutrally Buoyant Plume Distances to Toxic Endpoint for Release Rate Divided by Endpoint
10-minute Release, Urban Conditions, F Stability, Wind Speed 1.5 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 21	0.06
21 - 170	0.19
170 - 420	0.31
420 - 760	0.43
760 - 1,400	0.62
1,400 - 2,100	0.81
2,100 - 3,100	0.99
3,100 - 4,200	1.2
4,200 - 6,100	1.4
6,100 - 7,800	1.6
7,800 - 9,700	1.8
9,700 - 12,000	2.0
12,000 - 14,000	2.2
14,000 - 18,000	2.4
18,000 - 22,000	2.6
22,000 - 25,000	2.8
25,000 - 29,000	3.0
29,000 - 33,000	3.2
33,000 - 39,000	3.4
39,000 - 44,000	3.6
44,000 - 49,000	3.8
49,000 - 55,000	4.0
55,000 - 63,000	4.2
63,000 - 69,000	4.4
69,000 - 76,000	4.6

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
76,000 - 83,000	4.8
83,000 - 90,000	5.0
90,000 - 100,000	5.2
100,000 - 110,000	5.4
110,000 - 120,000	5.6
120,000 - 130,000	5.8
130,000 - 140,000	6.0
140,000 - 148,000	6.2
148,000 - 183,000	6.8
183,000 - 221,000	7.5
221,000 - 264,000	8.1
264,000 - 310,000	8.7
310,000 - 361,000	9.3
361,000 - 415,000	9.9
415,000 - 535,000	11
535,000 - 671,000	12
671,000 - 822,000	14
822,000 - 990,000	15
990,000 - 1,170,000	16
1,170,000 - 1,370,000	17
1,370,000 - 1,590,000	19
1,590,000 - 2,190,000	22
2,190,000 - 2,890,000	25
>2,890,000	>25

Reference Table 4
Neutrally Buoyant Plume Distances to Toxic Endpoint for Release Rate Divided by Endpoint
60-Minute Release, Urban Conditions, F Stability, Wind Speed 1.5 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 26	0.06
26 - 210	0.19
210 - 530	0.31
530 - 940	0.43
940 - 1,700	0.62
1,700 - 2,600	0.81
2,600 - 3,700	0.99
3,700 - 4,800	1.2
4,800 - 6,400	1.4
6,400 - 7,700	1.6
7,700 - 9,100	1.8
9,100 - 11,000	2.0
11,000 - 12,000	2.2
12,000 - 14,000	2.4
14,000 - 16,000	2.6
16,000 - 17,000	2.8
17,000 - 19,000	3.0
19,000 - 21,000	3.2
21,000 - 23,000	3.4
23,000 - 24,000	3.6
24,000 - 26,000	3.8
26,000 - 28,000	4.0
28,000 - 30,000	4.2
30,000 - 32,000	4.4
32,000 - 34,000	4.6

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
34,000 - 36,000	4.8
36,000 - 38,000	5.0
38,000 - 41,000	5.2
41,000 - 43,000	5.4
43,000 - 45,000	5.6
45,000 - 47,000	5.8
47,000 - 50,000	6.0
50,000 - 52,200	6.2
52,200 - 60,200	6.8
60,200 - 68,900	7.5
68,900 - 78,300	8.1
78,300 - 88,400	8.7
88,400 - 99,300	9.3
99,300 - 111,000	9.9
111,000 - 137,000	11
137,000 - 165,000	12
165,000 - 197,000	14
197,000 - 232,000	15
232,000 - 271,000	16
271,000 - 312,000	17
312,000 - 357,000	19
357,000 - 483,000	22
483,000 - 629,000	25
>629,000	>25

Reference Table 5
Dense Gas Distances to Toxic Endpoint
10-minute Release, Rural Conditions, F Stability, Wind Speed 1.5 Meters per Second

Release Rate (lbs/min)	Toxic Endpoint (mg/L)															
	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
	Distance (Miles)															
1	2.2	1.7	1.5	1.1	0.81	0.68	0.53	0.46	0.31	0.23	0.19	0.15	0.12	0.06	#	#
2	3.0	2.4	2.1	1.5	1.1	0.93	0.74	0.68	0.45	0.33	0.27	0.21	0.18	0.11	<0.06	<0.06
5	4.8	3.7	3.0	2.2	1.7	1.5	1.2	0.99	0.74	0.53	0.43	0.34	0.29	0.16	0.11	0.07
10	6.8	5.0	4.2	3.0	2.4	2.1	1.7	1.4	0.99	0.74	0.62	0.50	0.42	0.24	0.15	0.12
30	11	8.7	6.8	5.2	3.9	3.4	2.8	2.4	1.7	1.3	1.1	0.87	0.74	0.42	0.27	0.20
50	14	11	9.3	6.8	5.0	4.2	3.5	3.0	2.2	1.7	1.4	1.1	0.93	0.56	0.35	0.27
100	19	15	12	8.7	6.8	5.8	4.8	4.2	2.9	2.2	1.9	1.6	1.3	0.81	0.51	0.38
150	24	18	15	11	8.1	6.8	5.7	5.0	3.6	2.7	2.3	1.9	1.6	0.93	0.61	0.47
250	>25	22	19	14	11	8.7	7.4	6.2	4.5	3.4	2.8	2.3	2.0	1.2	0.81	0.60
500	*	>25	>25	19	14	12	9.9	8.7	6.2	4.7	3.8	3.1	2.7	1.6	1.1	0.87
750	*	*	*	23	17	15	12	11	7.4	5.5	4.5	3.7	3.2	1.9	1.3	0.99
1000	*	*	*	>25	20	17	14	12	8.1	6.2	5.2	4.2	3.6	2.2	1.4	1.1
1500	*	*	*	*	24	20	16	14	9.9	7.4	6.2	5.0	4.3	2.5	1.7	1.3
2000	*	*	*	*	>25	23	19	16	11	8.7	6.8	5.6	4.8	2.9	1.9	1.5
2500	*	*	*	*	*	>25	20	18	12	9.3	8.1	6.2	5.3	3.2	2.1	1.6
3000	*	*	*	*	*	*	23	20	14	9.9	8.7	6.8	5.6	3.4	2.2	1.7
4000	*	*	*	*	*	*	>25	22	16	11	9.3	7.4	6.2	3.8	2.5	2.0
5000	*	*	*	*	*	*	*	25	17	13	11	8.7	6.8	4.2	2.7	2.1
7500	*	*	*	*	*	*	*	>25	20	15	12	9.9	8.7	4.9	3.2	2.5
10000	*	*	*	*	*	*	*	*	24	17	14	11	9.3	5.5	3.6	2.8
15000	*	*	*	*	*	*	*	*	>25	20	17	13	11	6.2	4.2	3.2
20000	*	*	*	*	*	*	*	*	*	23	19	15	12	7.4	4.7	3.7

* > 25 miles

\# <0.06 miles

Reference Table 6
Dense Gas Distances to Toxic Endpoint
60-minute Release, Rural Conditions, F Stability, Wind Speed 1.5 Meters per Second

Release Rate (lbs/min)	Toxic Endpoint (mg/L)															
	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
	Distance (Miles)															
1	3.7	2.7	2.2	1.4	0.99	0.81	0.62	0.53	0.34	0.24	0.19	0.14	0.12	<0.06	#	#
2	5.3	4.0	3.2	2.2	1.6	1.2	0.99	0.81	0.53	0.37	0.29	0.22	0.18	0.09	<0.06	<0.06
5	8.7	6.8	5.3	3.7	2.7	2.2	1.7	1.4	0.93	0.62	0.51	0.39	0.32	0.17	0.10	0.07
10	12	9.3	8.1	5.3	4.0	3.3	2.7	2.2	1.4	0.99	0.81	0.60	0.50	0.26	0.16	0.11
30	22	16	14	9.9	7.4	6.1	4.9	4.1	2.9	2.1	1.6	1.2	0.99	0.52	0.31	0.22
50	>25	21	18	12	9.3	8.1	6.2	5.4	3.8	2.7	2.2	1.7	1.4	0.74	0.43	0.31
100	*	>25	>25	18	13	11	9.3	7.4	5.5	4.0	3.2	2.5	2.1	1.1	0.68	0.48
150	*	*	*	22	17	14	11	9.9	6.8	4.9	4.0	3.1	2.7	1.4	0.87	0.61
250	*	*	*	>25	22	18	14	12	8.7	6.2	5.2	4.1	3.5	1.9	1.2	0.87
500	*	*	*	*	>25	25	20	17	12	9.3	7.4	5.8	5.0	2.9	1.8	1.3
750	*	*	*	*	*	>25	25	22	15	11	9.3	7.4	6.1	3.5	2.2	1.7
1000	*	*	*	*	*	*	>25	25	17	12	11	8.1	6.8	4.0	2.6	2.0
1500	*	*	*	*	*	*	*	>25	20	16	12	9.9	8.7	5.0	3.2	2.5
2000	*	*	*	*	*	*	*	*	24	17	14	11	9.9	5.7	3.7	2.9
2500	*	*	*	*	*	*	*	*	>25	20	16	13	11	6.2	4.2	3.2
3000	*	*	*	*	*	*	*	*	*	21	17	14	12	6.8	4.5	3.5
4000	*	*	*	*	*	*	*	*	*	24	20	16	14	8.1	5.2	4.0
5000	*	*	*	*	*	*	*	*	*	>25	22	17	15	8.7	5.7	4.4
7500	*	*	*	*	*	*	*	*	*	*	>25	21	18	11	6.8	5.2
10000	*	*	*	*	*	*	*	*	*	*	*	24	20	12	7.4	6.0
15000	*	*	*	*	*	*	*	*	*	*	*	>25	24	14	9.3	6.8
20000	*	*	*	*	*	*	*	*	*	*	*	*	>25	16	9.9	8.1

* > 25 miles

<0.06 miles

Reference Table 7
Dense Gas Distances to Toxic Endpoint
10-minute Release, Urban Conditions, F Stability, Wind Speed 1.5 Meters per Second

Release Rate (lbs/min)	Toxic Endpoint (mg/L)															
	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
	Distance (Miles)															
1	1.6	1.2	1.1	0.74	0.55	0.45	0.36	0.31	0.21	0.15	0.13	0.10	0.07	#	#	#
2	2.2	1.7	1.4	1.1	0.81	0.62	0.50	0.44	0.29	0.20	0.17	0.13	0.11	<0.06	#	#
5	3.5	2.7	2.2	1.6	1.2	0.99	0.81	0.68	0.48	0.35	0.27	0.21	0.17	0.10	<0.06	#
10	4.9	3.8	3.1	2.2	1.7	1.4	1.2	0.99	0.68	0.50	0.40	0.31	0.25	0.14	0.09	<0.06
30	8.1	6.2	5.3	3.7	2.9	2.4	2.0	1.7	1.2	0.87	0.74	0.56	0.45	0.24	0.14	0.11
50	11	8.1	6.8	4.8	3.7	3.1	2.5	2.1	1.5	1.1	0.93	0.74	0.61	0.33	0.19	0.14
100	15	11	9.3	6.8	5.2	4.2	3.5	3.0	2.1	1.6	1.3	0.99	0.87	0.47	0.28	0.20
150	19	14	12	8.1	6.1	5.2	4.3	3.6	2.5	1.9	1.6	1.2	1.1	0.58	0.35	0.25
250	24	18	15	11	8.1	6.8	5.4	4.6	3.3	2.4	2.0	1.6	1.4	0.74	0.47	0.33
500	>25	>25	21	15	11	9.3	7.4	6.2	4.5	3.4	2.8	2.2	1.9	1.1	0.68	0.48
750	*	*	>25	18	14	11	9.3	8.1	5.5	4.1	3.3	2.6	2.2	1.3	0.81	0.60
1000	*	*	*	21	16	13	11	9.3	6.2	4.6	3.8	3.0	2.5	1.5	0.93	0.68
1500	*	*	*	>25	19	16	12	11	7.4	5.6	4.6	3.7	3.0	1.7	1.1	0.81
2000	*	*	*	*	22	18	15	12	8.7	6.2	5.2	4.1	3.5	2.0	1.3	0.93
2500	*	*	*	*	24	20	16	14	9.9	6.8	5.8	4.7	3.8	2.2	1.4	1.1
3000	*	*	*	*	>25	22	18	16	11	7.4	6.2	5.0	4.2	2.4	1.6	1.2
4000	*	*	*	*	*	25	20	17	12	8.7	6.8	5.6	4.8	2.7	1.7	1.3
5000	*	*	*	*	*	>25	23	20	14	9.9	8.1	6.2	5.3	3.0	1.9	1.4
7500	*	*	*	*	*	*	>25	24	16	12	9.9	7.4	6.2	3.6	2.3	1.7
10000	*	*	*	*	*	*	*	>25	19	14	11	8.7	7.4	4.1	2.6	2.0
15000	*	*	*	*	*	*	*	*	22	16	13	11	8.7	4.9	3.1	2.3
20000	*	*	*	*	*	*	*	*	>25	19	15	12	9.9	5.5	3.5	2.7

* > 25 miles

\# <0.06 miles

Reference Table 8
Dense Gas Distances to Toxic Endpoint
60-minute Release, Urban Conditions, F Stability, Wind Speed 1.5 Meters per Second

Release Rate (lbs/min)	Toxic Endpoint (mg/L)															
	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
	Distance (Miles)															
1	2.6	1.9	1.5	1.1	0.68	0.55	0.43	0.35	0.22	0.16	0.12	0.09	0.07	#	#	#
2	3.8	2.9	2.3	1.5	1.1	0.87	0.68	0.55	0.35	0.24	0.19	0.14	0.11	<0.06	#	#
5	6.2	4.7	3.9	2.6	1.9	1.5	1.2	0.93	0.61	0.42	0.33	0.25	0.20	0.10	<0.06	#
10	9.3	6.8	5.6	3.9	2.9	2.3	1.8	1.5	0.93	0.68	0.51	0.38	0.31	0.16	0.09	<0.06
30	16	12	9.9	7.4	5.3	4.3	3.4	2.9	1.9	1.3	0.99	0.74	0.62	0.31	0.17	0.12
50	22	16	14	9.3	6.8	5.7	4.5	3.8	2.6	1.8	1.4	1.1	0.87	0.43	0.24	0.17
100	>25	24	20	14	9.9	8.1	6.8	5.7	3.8	2.7	2.2	1.7	1.4	0.68	0.38	0.26
150	*	>25	24	17	12	11	8.1	6.8	4.8	3.5	2.8	2.2	1.8	0.87	0.49	0.34
250	*	*	>25	22	16	14	11	9.3	6.2	4.5	3.7	2.9	2.4	1.2	0.68	0.47
500	*	*	*	>25	24	19	16	13	9.3	6.8	5.4	4.2	3.5	1.9	1.1	0.74
750	*	*	*	*	>25	24	19	16	11	8.1	6.8	5.2	4.3	2.4	1.4	0.99
1000	*	*	*	*	*	>25	22	19	13	9.3	7.4	6.0	5.0	2.8	1.6	1.2
1500	*	*	*	*	*	*	>25	24	16	12	9.3	7.4	6.2	3.4	2.1	1.5
2000	*	*	*	*	*	*	*	>25	19	13	11	8.7	7.4	4.0	2.5	1.8
2500	*	*	*	*	*	*	*	*	20	15	12	9.3	8.1	4.5	2.8	2.1
3000	*	*	*	*	*	*	*	*	22	16	13	11	8.7	4.9	3.0	2.2
4000	*	*	*	*	*	*	*	*	>25	19	16	12	9.9	5.6	3.5	2.6
5000	*	*	*	*	*	*	*	*	*	21	17	14	11	6.2	4.0	3.0
7500	*	*	*	*	*	*	*	*	*	>25	20	16	14	7.4	4.8	3.6
10000	*	*	*	*	*	*	*	*	*	*	24	19	16	8.7	5.5	4.2
15000	*	*	*	*	*	*	*	*	*	*	>25	22	19	11	6.8	5.1
20000	*	*	*	*	*	*	*	*	*	*	*	>25	21	12	7.4	5.8

* > 25 miles

\# <0.06 miles

Reference Table 9
Distance to Overpressure of 1.0 psi for Vapor Cloud Explosions of 10,000 - 500,000 Pounds of Regulated Flammable Substances Based on TNT Equivalent Method, 10 Percent Yield Factor

	Quantity in Cloud (pounds)	10,000	20,000	30,000	50,000	100,000	150,000	200,000	300,000	500,000
CAS No.	Chemical Name	Distance (Miles) to 1 psi Overpressure								
75-07-0	Acetaldehyde	0.14	0.18	0.20	0.24	0.31	0.35	0.39	0.44	0.52
74-86-2	Acetylene	0.18	0.22	0.25	0.30	0.38	0.44	0.48	0.55	0.65
598-73-2	Bromotrifluoroethylene	0.061	0.077	0.088	0.10	0.13	0.15	0.17	0.19	0.22
106-99-0	1,3-Butadiene	0.17	0.22	0.25	0.29	0.37	0.42	0.47	0.53	0.63
106-97-8	Butane	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
25167-67-3	Butene	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
590-18-1	2-Butene-cis	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
624-64-6	2-Butene-trans	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
106-98-9	1-Butene	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
107-01-7	2-Butene	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
463-58-1	Carbon oxysulfide	0.10	0.13	0.15	0.17	0.22	0.25	0.28	0.32	0.37
7791-21-1	Chlorine monoxide	0.049	0.061	0.070	0.083	0.10	0.12	0.13	0.15	0.18
590-21-6	1-Chloropropylene	0.14	0.17	0.20	0.24	0.30	0.34	0.37	0.43	0.51
557-98-2	2-Chloropropylene	0.14	0.17	0.20	0.24	0.30	0.34	0.37	0.43	0.51
460-19-5	Cyanogen	0.13	0.17	0.19	0.23	0.29	0.33	0.36	0.42	0.49
75-19-4	Cyclopropane	0.17	0.22	0.25	0.30	0.38	0.43	0.47	0.54	0.64
4109-96-0	Dichlorosilane	0.10	0.12	0.14	0.17	0.21	0.24	0.27	0.30	0.36
75-37-6	Difluoroethane	0.11	0.14	0.16	0.19	0.24	0.27	0.30	0.34	0.40
124-40-3	Dimethylamine	0.16	0.20	0.23	0.27	0.34	0.39	0.43	0.50	0.59
463-82-1	2,2-Dimethylpropane	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
74-84-0	Ethane	0.18	0.22	0.25	0.30	0.38	0.43	0.48	0.55	0.65
107-00-6	Ethyl acetylene	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
75-04-7	Ethylamine	0.16	0.20	0.23	0.27	0.34	0.39	0.43	0.49	0.59

Reference Table 9 (continued)

	Quantity in Cloud (pounds)	10,000	20,000	30,000	50,000	100,000	150,000	200,000	300,000	500,000
CAS No.	Chemical Name	Distance (Miles) to 1 psi Overpressure								
75-00-3	Ethyl chloride	0.13	0.17	0.19	0.23	0.28	0.32	0.36	0.41	0.48
74-85-1	Ethylene	0.18	0.22	0.25	0.30	0.38	0.43	0.48	0.55	0.65
60-29-7	Ethyl ether	0.16	0.20	0.23	0.27	0.34	0.39	0.43	0.49	0.58
75-08-1	Ethyl mercaptan	0.15	0.19	0.21	0.25	0.32	0.36	0.40	0.46	0.54
109-95-5	Ethyl nitrite	0.13	0.16	0.18	0.22	0.27	0.31	0.35	0.40	0.47
1333-74-0	Hydrogen	0.24	0.30	0.35	0.41	0.52	0.59	0.65	0.74	0.88
75-28-5	Isobutane	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
78-78-4	Isopentane	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
78-79-5	Isoprene	0.17	0.22	0.25	0.29	0.37	0.42	0.46	0.53	0.63
75-31-0	Isopropylamine	0.16	0.20	0.23	0.28	0.35	0.40	0.44	0.50	0.59
75-29-6	Isopropyl chloride	0.14	0.18	0.20	0.24	0.30	0.34	0.38	0.43	0.51
74-82-8	Methane	0.18	0.23	0.26	0.31	0.39	0.44	0.49	0.56	0.66
74-89-5	Methylamine	0.15	0.19	0.22	0.26	0.33	0.38	0.42	0.48	0.56
563-45-1	3-Methyl-1-butene	0.17	0.22	0.25	0.29	0.37	0.42	0.47	0.53	0.63
563-46-2	2-Methyl-1-butene	0.17	0.22	0.25	0.29	0.37	0.42	0.47	0.53	0.63
115-10-6	Methyl ether	0.15	0.19	0.21	0.25	0.32	0.37	0.40	0.46	0.55
107-31-3	Methyl formate	0.12	0.15	0.17	0.21	0.26	0.30	0.33	0.37	0.44
115-11-7	2-Methylpropene	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
504-60-9	1,3-Pentadiene	0.17	0.22	0.25	0.29	0.37	0.42	0.46	0.53	0.63
109-66-0	Pentane	0.17	0.22	0.25	0.29	0.37	0.42	0.47	0.54	0.63
109-67-1	1-Pentene	0.17	0.22	0.25	0.29	0.37	0.42	0.47	0.54	0.63
646-04-8	2-Pentene, (E)-	0.17	0.22	0.25	0.29	0.37	0.42	0.47	0.53	0.63
627-20-3	2-Pentene, (Z)-	0.17	0.22	0.25	0.29	0.37	0.42	0.47	0.53	0.63
463-49-0	Propadiene	0.17	0.22	0.25	0.30	0.38	0.43	0.47	0.54	0.64
74-98-6	Propane	0.17	0.22	0.25	0.30	0.38	0.43	0.47	0.54	0.64

Reference Table 9 (continued)

	Quantity in Cloud (pounds)	10,000	20,000	30,000	50,000	100,000	150,000	200,000	300,000	500,000
CAS No.	Chemical Name	Distance (Miles) to 1 psi Overpressure								
115-07-1	Propylene	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
74-99-7	Propyne	0.17	0.22	0.25	0.30	0.38	0.43	0.47	0.54	0.64
7803-62-5	Silane	0.17	0.22	0.25	0.29	0.37	0.42	0.47	0.53	0.63
116-14-3	Tetrafluoroethylene	0.053	0.066	0.076	0.090	0.11	0.13	0.14	0.16	0.19
75-76-3	Tetramethylsilane	0.17	0.21	0.24	0.29	0.36	0.42	0.46	0.52	0.62
10025-78-2	Trichlorosilane	0.075	0.10	0.11	0.13	0.16	0.19	0.20	0.23	0.28
79-38-9	Trifluorochloroethylene	0.059	0.075	0.086	0.10	0.13	0.15	0.16	0.18	0.22
75-50-3	Trimethylamine	0.16	0.21	0.24	0.28	0.35	0.40	0.44	0.51	0.60
689-97-4	Vinyl acetylene	0.17	0.22	0.25	0.30	0.37	0.43	0.47	0.54	0.64
75-01-4	Vinyl chloride	0.13	0.16	0.19	0.22	0.28	0.32	0.35	0.40	0.48
109-92-2	Vinyl ethyl ether	0.16	0.20	0.22	0.27	0.34	0.38	0.42	0.48	0.57
75-02-5	Vinyl fluoride	0.063	0.079	0.091	0.11	0.14	0.16	0.17	0.20	0.23
75-35-4	Vinylidene chloride	0.11	0.13	0.15	0.18	0.23	0.26	0.29	0.33	0.39
75-38-7	Vinylidene fluoride	0.11	0.14	0.15	0.18	0.23	0.26	0.29	0.33	0.40
107-25-5	Vinyl methyl ether	0.15	0.19	0.22	0.26	0.33	0.37	0.41	0.47	0.56

6.0 Determining Alternative Release Scenarios

You are required to analyze at least one alternative release scenario for each listed toxic substance you have in a Program 2 or Program 3 process above its threshold quantity. You also are required to analyze one alternative release scenario for flammable substances in Program 2 or 3 processes as a class. You do not need to analyze an alternative scenario for each flammable substance. For example, if you have five listed substances – chlorine, ammonia, hydrogen chloride, propane, and acetylene – above the threshold in Program 2 or 3 processes, you will need to analyze one alternative scenario each for chlorine, ammonia, and hydrogen chloride and a single alternative scenario to cover propane and acetylene (listed flammable substances). Even if you have a substance above the threshold in several processes or locations, you need only analyze one alternative scenario for it.

Alternative release scenarios for toxic substances should be those that lead to concentrations above the toxic endpoint beyond your fenceline. Scenarios for flammable substances should have the potential to cause substantial damage, including on-site damage. Those releases that have the potential to reach the public are of the greatest concern.

For alternative release scenarios, you are allowed to consider active mitigation systems, such as interlocks, shutdown systems, pressure relieving devices, flares, emergency isolation systems, and fire water and deluge systems, as well as passive mitigation systems, as described in Sections 3.1.2 and 3.2.3.

For alternative release scenarios for ammonia used for refrigeration, consult EPA's *Model Risk Management Program and Plan for Ammonia Refrigeration*. For toxic substances at water treatment facilities, see the guidance for this industry segment.

7.0 Analysis of Alternative Scenarios for Toxic Substances

You have a number of options for selecting release scenarios for toxic substances.

- You may use your worst-case release scenario and apply your active mitigation system to limit the quantity released and the duration of the release.

- You may use information from your process hazards analysis, if you have conducted one, to select a scenario.

- You may review your accident history and choose an actual event as the basis of your scenario.

- If you have not conducted a process hazards analysis, you may review your operations and identify possible events and failures.

Whichever approach you select, the key information you need to define is the quantity to be released and the time over which it will be released; together, these allow you to estimate the release rate and use essentially the same methods you used for the worst-case analysis.

Section 8 below provides detailed information on calculating release rates for alternative release scenarios. If you can estimate release rates for the toxic gases and liquids you have on site based on readily available information, you may skip Section 8 and go to Section 9. Section 9 describes how to estimate distances to the toxic endpoint for alternative scenarios for toxic substances.

8.0 Estimation of Release Rates for Alternative Release Scenarios for Toxic Substances

8.1 Release Rates for Toxic Gases

8.1.1 Unmitigated Releases of Gases

Gaseous Release from Tank. Instead of assuming release of the entire contents of a vessel containing a toxic gas, you may decide to consider a release from a hole in a vessel or pipe. To estimate a hole size you might assume, for example, the hole size that would result from shearing off a valve or pipe from a vessel containing a regulated substance. If you have a gas leak from a tank, you may use the following simplified equation to estimate a release rate based on hole size, tank pressure, and the properties of the gas. (See Appendix D, Section D.6 for the derivation of this equation.)

$$QR = HA \times P_t \times \frac{1}{\sqrt{T_t}} \times GF \qquad (11)$$

where:
- QR = Release rate (pounds per minute)
- HA = Hole or puncture area (square inches) (from hazard evaluation or best estimate)
- P_t = Tank pressure (pounds per square inch - absolute (psia)) (from process information)
- T_t = Tank temperature (K)
- GF = Gas Factor, incorporating discharge coefficient, ratio of specific heats, molecular weight, and conversion factors (listed for each regulated toxic gas in Exhibit B-1, Appendix B)

This equation will give an estimate of the initial release rate. It will overestimate the overall release rate, because it does not take into account the decrease in the release rate as the pressure in the tank decreases. You may use a computer model or another calculation method if you want a more realistic estimate of the release rate.

Example 18. Release of Toxic Gas from Tank (Diborane)

You have a tank that contains diborane gas at a pressure of 30 pounds per square inch - absolute (psia). The temperature of the tank and its contents is 298 K (25°C). A valve on the side of the tank shears off, leaving a hole in the tank wall 5 square inches. From Exhibit B-1, the Gas Factor for diborane is 17. Therefore, the release rate is:

$$QR = 5 \times 30 \times 1/(298)^{1/2} \times 17 = 148 \text{ pounds per minute}$$

Gaseous Release from Pipe. If shearing of a pipe may be an alternative scenario for a toxic gas at your site, you could use the usual flow rate through the pipe as the release rate and carry out the estimation of distance as discussed in Section 9.

If you want to consider a release of toxic gas through a hole in a pipe as an alternative scenario, you may use the method described above for a gas release from a hole in a tank. This method neglects the effects of friction along the pipe and, therefore, provides a conservative estimate of the release rate.

Duration of Release. The duration of the release is used in choosing the appropriate reference table for distances (Section 9 below). You may calculate the maximum duration by dividing the quantity in the tank or the quantity that may be released from pipes by your calculated release rate. You may use 60 minutes as a default value for maximum release duration. If you know how long it is likely to take to stop the leak, you may use that time as the release duration.

If a gaseous release from a hole in a tank or pipe is likely to be stopped very quickly (e.g., by a block valve), resulting in a puff of toxic gas that forms a vapor cloud rather than a plume, you may want to consider other methods for determining a consequence distance. The behavior of a cloud of toxic gas resulting from a puff release will not exhibit the same behavior as a plume resulting from a longer release (e.g., a release over 10 minutes).

Gases Liquefied Under Pressure. Gases stored under pressure as liquids may be released very rapidly in case of tank or pipe damage or failure. Such releases may involve rapid vaporization of a fraction of the liquified gas and possibly aerosolization. The methods presented in this guidance are not appropriate for this type of release. If you think release of a liquefied gas under pressure is a potential release scenario at your site, you may want to consider other models or methods to carry out a consequence analysis.

8.1.2 Mitigated Releases of Gases

For gases, passive mitigation may include enclosed spaces, as discussed in Section 3.1.2. Active mitigation for gases, which may be considered in analyzing alternative release scenarios, may include an assortment of techniques including automatic shutoff valves, rapid transfer systems (emergency deinventory), and water/chemical sprays. These mitigation techniques have the effect of reducing either the release rate or the duration of the release, or both.

Active Mitigation to Reduce Release Duration. An example of a mitigation technique to reduce the release duration is automatic shutoff valves. If you have an estimate of the rate at which the gas will be released and the time it will take to shut off the release, you may estimate the quantity potentially released (release rate times time). If the release will take place over a period of 10 minutes or more, you may use the release rate to estimate the distance to the toxic endpoint, as discussed in Section 9. For releases stopped in less than 10 minutes, multiply the initial release rate by the duration of release to estimate the quantity released, then divide the new quantity by 10 minutes to estimate a mitigated release rate that you may apply to the reference tables in Section 9 to estimate the consequence distance. If the release would be stopped very quickly, you might want to consider other methods that will estimate consequence distances for a puff release.

Active Mitigation to Directly Reduce Release Rate to Air. Examples of mitigation techniques to directly reduce the release rate include scrubbers and flares. Use test data, manufacturer design specifications, or past experience to determine the fractional reduction of the release rate by the mitigation technique. Apply this fraction to the release rate that would have occurred without the mitigation technique. The initial release rate, without mitigation, may be the release rate for the alternative scenario (e.g., a release rate estimated from the equations presented earlier in this section) or the worst-case release rate. The mitigated release rate is:

$$QR_R = (1 - FR) \times QR \qquad 12$$

where: QR_R = Reduced release rate (pounds per minute)
FR = Fractional reduction resulting from mitigation
QR = Release rate without mitigation (pounds per minute)

Example 19. Water Spray Mitigation (Hydrogen Fluoride)

A bleeder valve on a hydrogen fluoride (HF) tank opens, releasing 660 pounds per minute of HF. Water sprays are applied almost immediately. Experimental field and laboratory test data indicate that HF vapors could be reduced by 90 percent. The reduced release rate is:

QR_R = (1 - 0.9) x (660 pounds per minute)
= 66 pounds per minute

Passive Mitigation. The same simplified method used for worst-case releases may be used for alternative release scenarios to estimate the release rate to the outside air from a release in an enclosed space. For alternative scenarios, you may use a modified release quantity, if appropriate. Use the equations presented in Section 3.1.2 to estimate the release rate to the outside air.

Duration of Release. You should estimate the duration of the release either from your knowledge of the length of time it may take to stop the release or by dividing the quantity that may be released by your estimated release rate.

8.2 Release Rates for Toxic Liquids

This section describes methods for estimating liquid release rates from tanks and pipes. The released liquid is assumed to form a pool, and the evaporation rate from the pool is estimated as for the worst-case scenario. For the alternative scenario, you may assume the average wind speed in your area in the calculation of evaporation rate, instead of a wind speed of 1.5 meters per second (3.4 miles per hour). For the reference tables in this guidance, the wind speed for alternative scenarios is assumed to be 3.0 meters per second (6.7 miles per hour).

If you have sufficient information to estimate the quantity of liquid that might be released to an undiked area under an alternative scenario, you may go directly to Section 8.2.3 to estimate the the evaporation rate from the pool and the release duration. After you have estimated the evaporation rate and release duration, go to Section 9 for instructions on estimating distance to the toxic endpoint.

8.2.1 Liquid Release Rate and Quantity Released for Unmitigated Releases

Liquid Release from Tank under Atmospheric Pressure. If you have a liquid stored in a tank at atmospheric pressure, you may use the following simple equation to estimate the liquid release rate from a hole in the tank below the liquid level. (See Appendix D, Section D.7.1, for the derivation of this equation.)

$$QR_L = HA \times \sqrt{LH} \times LLF \qquad (13)$$

where: QR_L = Liquid release rate (pounds per minute)
HA = Hole or puncture area (square inches) (from hazard evaluation or best estimate)
LH = Height of liquid column above hole (inches) (from hazard evaluation or best estimate)
LLF = Liquid Leak Factor incorporating discharge coefficient and liquid density (listed for each toxic liquid in Exhibit B-2, Appendix B).

This equation will give an overestimate of the release rate, because it does not take into account the decrease in the release rate as the height of the liquid above the hole decreases. You may use a computer model or another calculation method if you want a more realistic estimate of the liquid release rate.

You may estimate the quantity that might be released by multiplying the liquid release rate from the above equation by the time (in minutes) that likely would be needed to stop the release. Alternatively, you may assume the release would stop when the level of liquid in the tank drops to the level of the hole. You may estimate the quantity of liquid above that level in the tank from the dimensions of the tank, the liquid level at the start of the leak, and the level of the hole. Assume the estimated quantity is released into a pool and use the method and equations in Section 8.2.3 below to determine the evaporation rate of the liquid from the pool and the duration of the release.

Example 20. Liquid Release from Atmospheric Tank (Acrylonitrile)

You have a tank that contains 20,000 pounds of acrylonitrile at ambient temperature and pressure. A valve on the side of the tank shears, leaving a hole in the tank wall 5 square inches in area. The liquid column is 23 inches above the hole in the tank. From Exhibit B-2, the Liquid Leak Factor for acrylonitrile is 39. Therefore, the release rate is:

$$QR = 5 \times (23)^{1/2} \times 39 = 936 \text{ pounds per minute}$$

It takes 10 minutes to stop the release so that 10 minutes × 936 pounds per minute = 9,360 pounds of acrylonitrile is released. From Exhibit B-2, the Density Factor for acrylonitrile is 0.61, and the Liquid Factor Ambient is 0.018. Assuming that the liquid is not released into a diked area or inside a building, the evaporation rate from the pool of acrylonitrile, from Equation 3, using a wind speed factor of 2.4 for wind speed 3 meters per second, is:

$$QR = 9{,}360 \times 2.4 \times 0.018 \times 0.61 = 247 \text{ pounds per minute}$$

<u>Release from Pressurized Tank</u>. If you have a liquid stored in a tank under pressure, you may estimate a release rate using the equations presented in Appendix D, Section D.7.1.

<u>Release from Pipe</u>. To consider a liquid release from a broken pipe, you may use the equations below (see Appendix D, Section D.7.2 for more information on these equations.) First estimate the initial operational flow velocity of the substance through the pipe using the initial operational flow rate as follows:

$$V_a = \frac{FR \times DF \times 0.033}{A_p} \qquad 14$$

where: V_a = Initial operational flow velocity (feet per minute)
FR = Initial operational flow rate (pounds per minute)
DF = Density Factor (from Exhibit B-2, Appendix B)
A_p = Cross-sectional area of pipe (square feet)

The release velocity is then calculated based on the initial operational flow, any gravitational acceleration or deceleration effects, and the pressure difference between the hole/shear and tank using a form of the Bernoulli equation:

$$V_b = \sqrt{\frac{(77,500 \times P_a - 7.85 \times 10^9)}{D} + (77,460 \times g \times Z) + V_a^2} \qquad \textbf{(15)}$$

where: V_b = Release velocity (feet per minute)
P_a = Operational pipe pressure (Pascals)
Z = Change in pipe elevation, inlet to outlet (meters)
g = Gravitational acceleration (9.8 meters per second^2)
V_a = Operational velocity (feet per minute)
D = Density of liquid (kilograms per cubic meter)

Please note that if the height of the pipe at the release point is higher than the initial pipe height, then Z is negative and the release rate is actually lower than the operational rate.

The release velocity can then be used to calculate a release rate as follows:

$$QR_L = \frac{V_b \times A_p}{DF \times 0.033} \qquad \textbf{(16)}$$

where: QR_L = Release rate (pounds per minute)
V_b = Release velocity (feet per minute)
DF = Density Factor
A_p = Cross-sectional area of pipe (square feet)

You may estimate the quantity released into a pool from the broken pipe by multiplying the liquid release rate (QR_L) from the equation above by the time (in minutes) that likely would be needed to stop the release. Assume the estimated quantity is released into a pool and use the method and equations described in Section 8.2.3 below to determine the evaporation rate of the liquid from the pool.

In the case of very long pipes, estimated release rates from a sheer or hole will be lower due pipe roughness and frictional head loss. If this effect is deemed considerable, an established method for calculating frictional head loss such as the Darcy formula may be used.

8.2.2 Liquid Release Rate and Quantity Released for Mitigated Releases

For alternative release scenarios, you are permitted to take credit for both passive and active mitigation systems, or a combination if both are in place. For liquids, passive mitigation may include techniques already discussed in Section 3.2.3 such as dikes and trenches. Active mitigation for liquids may include an assortment of techniques including automatic shutoff valves, emergency deinventory, foam or tarp coverings, and water or chemical spravs. These mitigation techniques have the effect of reducing either the quantity released into the pool or the evaporation rate from the pool. Some methods of accounting for active mitigation are discussed below.

Active Mitigation to Reduce Quantity Released. Examples of mitigation techniques to reduce the quantity released into the pool include automatic shutoff valves and emergency deinventory. You may use the equations in Section 8.2.1 above for calculating liquid release rate, if applicable. Estimate the approximate time needed to stop the release by the mitigation technique. Multiply the release rate times the duration of release to estimate quantity released. Assume the estimated quantity is released into a pool and use the method and equations described in Section 8.2.3 below to determine the evaporation rate of the liquid from the pool. You should also consider mitigation of evaporation from the pool, if applicable; see the discussion of active mitigation below or passive mitigation in Section 3.2.3.

Example 21. Mitigated Liquid Release

A bromine injection system suffers a hose failure; the greatly lowered system pressure triggers an automatic shutoff valve within 30 seconds of the release. The flow rate out of the ruptured hose is approximately 330 pounds per minute. Because the release occurred for only 30 seconds (0.5 minutes), the total quantity spilled was 330 x 0.5, or 165 pounds.

Active Mitigation to Reduce Evaporation Rate. Examples of active mitigation techniques to reduce the evaporation rate from the pool include water sprays and foam or tarp covering. Use test data, manufacturer design specifications, or past experience to determine the fractional reduction of the release rate by the mitigation technique. Apply this fraction to the release rate (evaporation rate from the pool) that would have occurred without the mitigation technique, as follows:

$$QR_{RV} = (1-FR) \times QR \qquad \textbf{(17)}$$

where: QR_{RV} = Reduced evaporation rate from pool or release rate to air (pounds per minute)
FR = Fractional reduction resulting from mitigation
QR = Evaporation rate from pool without mitigation (pounds per minute)

Relea[illegible] Into Buildings. If a toxic liquid is released inside a building, compare the area of the building floor to the maximum area of the pool that could be formed; the smaller of the two areas should be used in determining the evaporation rate, as for the worst case scenario. The maximum area of the pool is determined from Equation 6 in Section 3.2.3 for releases into diked areas. The area of the building floor is the length times width of the floor (in feet) (Equation 9).

If the floor area is smaller than the maximum pool size, estimate the outdoor evaporation rate from a pool the size of the floor area from Equation 20 in the next section (Section 8.2.3). If the maximum pool area is smaller, estimate the outdoor evaporation rate from a pool of maximum size from Equation 18 in the next section. Estimate the rate of release of the toxic vapor from the building as five percent of the calculated outdoor evaporation rate (multiply your evaporation rate by 0.05). See Appendix D, Section D.2.4 for more information on releases into buildings.

8.2.3 Evaporation Rate from Liquid Pool

Ambient temperature. For pools with no mitigation, if the liquid is always at ambient temperature, find the Liquid Factor Ambient (LFA) and the Density Factor (DF) in Exhibit B-2 of Appendix B (see Appendix D, Section D.2.2 for the derivation of these factors). Calculate the release rate of the liquid from the following equation:

$$QR = QS \times 2.4 \times LFA \times DF \tag{18}$$

where: QR = Release rate (pounds per minute)
QS = Quantity released (pounds)
2.4 = Wind speed factor = $3.0^{0.78}$, where 3.0 meters per second (6.7 miles per hour) is the wind speed for the alternative scenario for purposes of this guidance
LFA = Liquid Factor Ambient
DF = Density Factor

Elevated temperature. For pools with no mitigation, if the liquid is at an elevated temperature (any temperature above 25° C), find the Liquid Factor Boiling (LFB) and the Density Factor (DF) in Exhibit B-2 of Appendix B (see Appendix D, Section D.2.2, for the derivation of these factors). Calculate the release rate of the liquid from the following equation:

$$QR = QS \times 2.4 \times LFB \times DF \tag{19}$$

where: QR = Release rate (pounds per minute)
QS = Quantity released (pounds)
2.4 = Wind speed factor = $3.0^{0.78}$, where 3.0 meters per second (6.7 miles per hour) is the wind speed for the alternative scenario for purposes of this guidance
LFB = Liquid Factor Boiling
DF = Density Factor

Diked Areas. If the toxic liquid will be released into an area where it will be contained by dikes, compare the diked area to the maximum area of the pool that could be formed, as described in Section 3.2.3 (see Equation 6). The smaller of the two areas should be used in determination of the evaporation rate. If the maximum area of the pool is smaller than the diked area, calculate the release rate as described for pools with no mitigation (above). If the diked area is smaller, go to Exhibit B-2 in Appendix B to find the Liquid Factor Ambient (LFA), if the liquid is at ambient temperature, or the Liquid Factor Boiling (LFB), if the liquid is at a temperature above ambient. Calculate the release rate from the diked area as follows:

$$QR = 2.4 \times LFA \times A \tag{20}$$

or

$$QR = 2.4 \times LFB \times A \tag{21}$$

where: QR = Release rate (pounds per minute)
2.4 = Wind speed factor = $3.0^{0.78}$, where 3.0 meters per second (6.7 miles per hour) is the wind speed for the alternative scenario for purposes of this guidance
LFA = Liquid Factor Ambient (listed in Exhibit B-2, Appendix B)
LFB = Liquid Factor Boiling (listed in Exhibit B-2, Appendix B)
A = Diked area (square feet)

Duration of Release. After you have estimated a release rate as described above, determine the duration of the vapor release from the pool (the time it will take for the liquid pool to evaporate completely). To estimate the time in minutes, divide the total quantity released (in pounds) by the release rate (in pounds per minute) (see Equation 5 in Section 3.2.2).

8.2.4 Common Water Solutions of Toxic Substances

You may use the methods described above for pure liquids to estimate the quantity of a solution of a toxic substance that may be spilled into a pool. LFA and DF values for several concentrations of ammonia, formaldehyde, hydrochloric acid, hydrofluoric acid, and nitric acid in water solution and for oleum are listed in Appendix B, Exhibit B-3. The LFA for a wind speed of 3.0 meters per second (6.7 miles per hour) should be used in the release rate calculations for alternative scenarios for pools of solutions at ambient temperature. For unmitigated releases or releases with passive mitigation, follow the instructions in Section 8.2.3. If active mitigation measures are in place, you may estimate a reduced release rate from the instructions in 8.2.2 above. Use the total quantity of the solution as the quantity released from the vessel or pipeline (QS) in carrying out the calculation of the release rate to the atmosphere. If the solution is at an elevated temperature, you may treat the substance in solution as a pure substance and follow the instructions in Section 3.3, or use a method that accounts for increased volatilization of the toxic regulated substance.

9.0 Estimating Impact Distances for Alternative Release Scenarios for Toxic Substances

If you do your own modeling for analysis of alternative release scenarios, you should consider typical weather conditions at your site. If you do not keep weather data for your site (most sources do not), you may call another nearby source, such as an airport, or a compiler, such as the National Weather Service, to determine the average wind speed for your area. Atmospheric stability classes are described in Exhibit 2. Select one that describes your typical weather. Your airport or other source will be able to tell you average percent of cloud cover.

Exhibit 2. Atmospheric Stability Classes

Surface Wind Speed at 10 Meters		Day			Night	
Meters per second	Miles per hour	Incoming Solar Radiation			Thinly Overcast or ≥4/8 low cloud	≤ 3/8 Cloud
		Strong*	Moderate	Slight**		
<2	<4.5	A	A-B	B		
2-3	4.5-5	A-B	B	C	E	F
3-5	5-11	B	B-C	C	D	E
5-6	11-13	C	C-D	D	D	D
>6	>13	C	D	D	D	D

Class A is the most unstable, class D is neutral, class F is the most stable.

The neutral class, D, should be assumed for overcast conditions during day or night.

* Sun high in the sky with no clouds. Solar radiation would be reduced to moderate with broken middle clouds (5/8 to 7/8 cloud cover) and to slight with broken low clouds.

** Sun low in the sky with no clouds.

Source: D. Bruce Turner, *Workbook of Atmospheric Dispersion Estimates*, U.S. Department of Health, Education and Welfare. Cincinnati: 1970.

For estimating distances for toxic substances, this guidance provides four reference tables for neutrally buoyant plumes and four for dense gases. These tables were developed assuming D stability and a wind speed of 3.0 meters per second (6.7 miles per hour) as representative of likely conditions for many sites. Many wind speed and atmospheric stability combinations may be possible at different times in different parts of the country. If D stability and 3.0 meters per second are not reasonable conditions for your site, you may want to use other methods to estimate distances.

To use the reference tables, you need to consider the release rates estimated for gases and evaporation from liquid pools and the duration of the release. For the alternative scenarios, the duration of toxic gas releases may be longer than the 10 minutes assumed for the worst-case analysis for gases. You need to determine the appropriate toxic endpoint and whether the gas or vapor is neutrally buoyant or dense, using the tables in Appendix B.

The reference tables for distances (Reference Tables 10-17) are found at the end of Section 12. The tables and the conditions for which each table is applicable are:

Reference Table Number	Applicable Conditions		
	Release Duration (minutes)	Topography	Gas or Vapor Density
10	10	Rural	Neutrally buoyant
11	60		
12	10	Urban	
13	60		
14	10	Rural	Dense
15	60		
16	10	Urban	
17	60		

For releases lasting 10 minutes or less, use the 10-minute tables. For releases lasting more than 10 minutes, use the 60-minute tables. You should always use the 10-minute tables for releases of water solutions of toxic substances. Follow the instructions in Section 4 to estimate distances to the toxic endpoint for toxic gases and liquids.

Example 22. Gas Release of Chlorine

Assume that you calculated a release rate of 500 pounds per minute of chlorine from a tank. From Exhibit B-1, Appendix B, the toxic endpoint for chlorine is 0.0087 mg/L, and chlorine is listed as a dense gas. Based on emergency response systems available, you have estimated that the release will last for 6 minutes. At a release rate of 500 pounds per minute, 3,000 pounds of chlorine would be released in 6 minutes. To derive a release rate applicable to the reference tables, you calculate a 10-minute release rate as 3,000 pounds/10 minutes, or 300 pounds per minute. The 10-minute reference tables are appropriate for estimating the distance. The topography of your site is urban. For a 10-minute release of a dense gas under average meteorology (D stability and 3 meters per second wind speed) and urban topography, Reference Table 16 is appropriate. The toxic endpoint of 0.0087 mg/L is approximately halfway between 0.0075 and 0.01; you go to the lower endpoint of 0.0075 mg/L. The estimated release rate of 300 pounds per minute is closer to 250 pounds per minute on the table than to 500 pounds per minute, so you use 250 pounds per minute. Then the consequence distance for the alternative scenario is 2.0 miles.

10.0 Analysis of Alternative Release Scenarios for Flammable Substances

Alternative release scenarios for flammable substances are somewhat more complicated than for toxic substances because the consequences of a release and the endpoint of concern may vary. For the worst case, the consequence of concern is a vapor cloud explosion, with an overpressure endpoint. For alternative scenarios (e.g., fires), other endpoints (e.g., heat radiation) may need to be considered.

Possible scenarios involving flammable substances include:

- Vapor cloud fires (flash fires) may result from dispersion of a cloud of flammable vapor and ignition of the cloud following dispersion. Such a fire could flash back and could represent a severe heat radiation hazard to anyone in the area of the cloud. This guidance provides methods to estimate distances to a concentration equal to the lower flammability limit (LFL) for this type of fire. (See Sections 11 and 12.1.)

- A pool fire, with potential radiant heat effects, may result from a spill of a flammable liquid. This guidance provides a simple method for estimating the distance from a pool fire to a radiant heat level that could cause second degree burns from a 40-second exposure. (See Section 12.2).

- A boiling liquid, expanding vapor explosion (BLEVE), leading to a fireball that may produce intense heat, may occur if a vessel containing flammable material ruptures explosively as a result of exposure to fire. Heat radiation from the fireball is the primary hazard; vessel fragments and overpressure from the explosion also can result. BLEVEs are generally considered unlikely events; however, if you think a BLEVE is possible at your site, this guidance provides a method to estimate the distance at which radiant heat effects might lead to second degree burns. (See Section 12.3.) You also may want to consider models or calculation methods to estimate effects of vessel fragmentation.

- For a vapor cloud explosion to occur, rapid release of a large quantity, turbulent conditions (caused by a turbulent release or congested conditions in the area of the release, or both), and other factors are generally necessary. Vapor cloud explosions generally are considered unlikely events; however, if conditions at your site are conducive to vapor cloud explosions, you may want to consider a vapor cloud explosion as an alternative scenario. This guidance provides methods you may use to estimate the distance to 1 psi overpressure for a vapor cloud detonation, based on less conservative assumptions than the worst-case analysis. (See Section 12.4.) A vapor cloud deflagration, involving lower flame speeds than a detonation and resulting in less damaging blast effects, is more likely than a detonation. This guidance does not provide methods for estimating the effects of a deflagration, but you may use other methods of analysis if you want to consider such events.

- A jet fire may result from the puncture or rupture of a tank or pipeline containing a compressed or liquefied gas under pressure. The gas discharging from the hole can form a jet that "blows" into the air in the direction of the hole; the jet then may ignite. Jet fires could contribute to BLEVEs and fireballs if they impinge on tanks of flammable substances. A large horizontal jet fire may have the potential to pose an offsite hazard. This guidance does not include a method for estimating consequence distances for jet fires. If you want to consider a jet fire as an alternative scenario, you should consider other models or methods for the consequence analysis.

11.0 Estimation of Release Rates for Alternative Release Scenarios for Flammable Substances

This section describes methods to estimate a release rate that may be used in determination of dispersion distance to the LFL for a vapor cloud fire (Section 12.1).

11.1 Flammable Gases

An alternative scenario for a release of a flammable gas may involve a leak from a vessel or piping. To estimate a release rate for flammable gases from hole size and storage conditions, you may use the method described above in Section 8.1 for toxic gases. This release rate may be used to determine the dispersion distance to the lower flammability limit (LFL), as described in Section 12.1. Exhibit C-2 in Appendix C includes Gas Factors (GF) that may be used in carrying out the calculations for each of the regulated flammable gases.

Example 23. Release Rate of Flammable Gas from Hole in Tank

A pipe tears off a tank containing acetylene. The release rate from the hole can be estimated from Equation 11 in Section 8.1. You estimate that the pipe would leave a hole with an area (HA) of 5 square inches. The temperature inside the tank (T_t) is 282 K, 9°C, and the square root of the temperature is 16.8. The pressure in the tank (P_t) is approximately 481 psia. From Exhibit C-2, Appendix C, the gas factor (GF) for acetylene is 17. From Equation 11, the release rate (QR) is:

$$QR = 5 \times 481 \times (1/16.8) \times 17 = 2{,}400 \text{ pounds per minute}$$

11.2 Flammable Liquids

You may estimate a release rate for flammable liquids by estimating the evaporation rate from a pool. You first need to estimate the quantity in the pool.

You may use the method discussed in Section 8.2 to estimate a rate of liquid release for flammable liquids into a pool from a hole in a tank or from a pipe shear. Exhibit C-3 in Appendix C includes liquid leak factors (LLF) for calculating release rate from a hole. Note that the LLF is appropriate only for atmospheric tanks.

Once you have an estimate of the quantity of flammable liquid in a pool, you may use the methods presented in Section 3.2 to estimate the evaporation rate from the pool. Liquid factors at ambient and boiling temperature (LFA and LFB) for the calculation are listed in Exhibit C-3 in Appendix C. Assume a wind speed of 3.0 meters per second and use a value of 2.4 for the wind speed factor for the evaporation rate calculations. Both passive mitigation (discussed in Section 3.2.3) and active mitigation measures (discussed in Section 8.2.2) may be taken into account. You do not need to estimate the duration of the release, because this information is not used to estimate distance to the LFL, as discussed in the next section.

12.0 Estimating Impact Distances for Alternative Release Scenarios for Flammable Substances

12.1 Vapor Cloud Fires

The distance to the LFL represents the maximum distance at which the radiant heat effects of a vapor cloud fire might have serious consequences. Exhibit C-2, Appendix C, provides LFL data (in volume percent and milligrams per liter) for listed flammable gases; Exhibit B-3 provides these data for flammable liquids. To determine the distance to the LFL, find the LFL in milligrams per liter and identify the appropriate reference table (neutrally buoyant or dense gas) from Exhibit C-2 or C-3, Appendix C. Follow the steps described in Section 9 and Section 4 for toxic substances to find the distance to the LFL from the release rate, using the appropriate reference table for flammable substances, as discussed below.

Because LFL values are generally much larger than toxic endpoints for regulated toxic substances, and because vapor cloud fires are instantaneous events (in contrast to releases of toxic substances, where the duration of exposure to the toxic cloud is an important factor), the reference tables of distances for toxic substances are not applicable to vapor cloud fires. Therefore, additional reference tables for the alternative scenario conditions (D stability and wind speed 3.0 meters per second) are provided for estimating the distance to the LFL. Release duration does not need to be considered for estimating vapor cloud fire distances; the reference tables for flammable substances apply to both 10-minute and 60-minute releases. The reference tables for flammable substances (Reference Tables 18-21 at the end of Section 12) are:

Reference Table	Applicable Conditions

Number			
	Release Duration (minutes)	**Topography**	**Gas or Vapor Density**
18	10 - 60	Rural	Neutrally buoyant
19	10 - 60	Urban	
20	10 - 60	Rural	Dense
21	10 - 60	Urban	

The development of these tables is discussed in Appendix D, Section D.4.

Example 24. Vapor Cloud Fire from Evaporating Pool of Flammable Liquid

You have a tank containing 20,000 pounds of ethyl ether. A likely scenario for a release might be shearing of a pipe from the tank, with the released liquid forming a pool. You want to estimate the consequences of a vapor cloud fire that might result from evaporation of the pool and ignition of the vapor.

You first need to estimate the rate of release of the liquid from the tank. You can do this using Equation 13, Section 8.2.1. For this calculation, you need the area of the hole that would result from shearing the pipe (HA), the height of the liquid in the tank above the hole (LH), and the liquid leak factor (LLF) for ethyl ether, from Exhibit C-3 in Appendix C. The pipe diameter is 2 inches, so the cross sectional area of the hole would be 3.1 square inches. You estimate that the pipe is 2 feet, or 24 inches, below the level of the liquid when the tank is full. The square root of LH (24 inches) is 4.9. LLF for ethyl ether is 34. From Equation 13, the rate of release of the liquid from the hole is calculated as:

$$QR_L = 3.1 \times 4.9 \times 34$$
$$= 520 \text{ pounds per minute}$$

You estimate that the release of the liquid could be stopped in about 10 minutes. In 10 minutes, 10 x 520, or 5,200 pounds, would be released.

The liquid would be released into an area without dikes. To estimate the evaporation rate from the pool formed by the released liquid, you use Equation 3 from Section 3.2.2. To carry out the calculation, you need the Liquid Factor Ambient (LFA) and the Density Factor (DF) for ethyl ether. From Exhibit C-3, Appendix C, LFA for ethyl ether is 0.11 and DF is 0.69. Wind speed (U) is assumed to be 3.0 meters per second; 3 to the 0.78 power is 2.4. The release rate to air is:

$$QR = 5{,}200 \times 2.4 \times 0.11 \times 0.69$$
$$= 950 \text{ pounds per minute}$$

To estimate the maximum distance at which people in the area of the vapor cloud could suffer serious injury, you use the estimated release rate and the lower flammability limit (LFL) (in milligrams per liter) for ethyl ether, and find the distance on the appropriate reference table. From Exhibit C-3, Appendix C, LFL for ethyl ether is 57 mg/L, and the appropriate reference table is a dense gas table. Your site is in a rural area with few obstructions, so you use Reference Table 20.

From Reference Table 20, the closest LFL is 60 mg/L. The lowest release rate on the table is 1,500 pounds per minute, which is higher than the evaporation rate estimated for the pool of ethyl ether. For a release rate less than 1,500 pounds per minute, the distance to the LFL is less than 0.06 miles.

Example 25. Flammable Gas Release (Acetylene)

In Example 23, you estimated a release rate for acetylene from a hole in a tank of 2,400 pounds per minute. You want to estimate the distance to the LFL for a vapor cloud fire resulting from this release.

From Exhibit C-2, Appendix C, the LFL for acetylene is 27 mg/L, and the appropriate table for distance estimation is a neutrally buoyant gas table for flammable substances. Your site is in a rural area, so you would use Reference Table 18.

To use the neutrally buoyant gas tables, you need to calculate release rate/endpoint. In this case, release rate/LFL = 2,400/27 or 89. On Reference Table 18, 89 falls in the range of release rate/LFL values corresponding to 0.20 miles.

12.2 Pool Fires

A "Pool Fire Factor" (PFF) has been derived for each of the regulated flammable substances to aid in the consequence analysis. This factor, listed in Appendix C, Exhibits C-2 and C-3 for each regulated flammable substance, may be used to estimate a distance from the center of a pool fire where people could potentially receive second degree burns from a 40-second exposure. The heat radiation endpoint for this analysis is 5 kilowatts per square meter (kW/m^2). Ambient temperature is assumed to be 25° C (77° F) for calculation of the PFF for flammable liquids.

To estimate a distance using the PFF, you first need to estimate the size of the pool, in square feet, that might be formed by the release of a flammable substance. You may use the methods described above for toxic liquids to estimate pool size (density factors (DF) for the estimation of pool size in undiked areas may be found for flammable liquids in Exhibit C-3 of Appendix C). Distances may be estimated from the PFF and the pool area as follows:

$$d = PFF \, x \sqrt{A} \qquad \textbf{(22)}$$

where: d = Distance (feet)
PFF = Pool Fire Factor (listed for each flammable substance in Appendix C, Exhibits C-2 and C-3)
A = Pool area (square feet)

The derivation of these factors is discussed in Appendix D, Section D.9.

Example 26. Pool Fire of Flammable Liquid

For the tank containing 20,000 pounds of ethyl ether, discussed in Example 24, you want to estimate the consequences of a pool fire, for comparison with the vapor cloud fire results.

In Example 25, you estimated that 15,000 pounds would be released into an area without dikes, forming a pool. Assuming the liquid spreads to a depth of 1 centimeter (0.39 inches), you estimate the area of the pool formed from Equation 6, Section 3.2.3. For this calculation, you need the density factor (DF) for ethyl ether; from Exhibit C-3, Appendix C, DF for ethyl ether is 0.69. From Equation 6, the area of the pool is:

A = 15,000 x 0.69 = 10,400 square feet

You can use Equation 18 to estimate the distance from the center of the burning pool where the heat radiation level would reach 5 kW/m^2. For the calculation, you need the square root of the pool area (A) and the pool fire factor (PFF) for ethyl ether. The square root of A, 10,400 square feet, is 102 feet. From Exhibit C-3, Appendix C, PFF for ethyl ether is 4.3. From Equation 18, the distance (d) to 5 kW/m^2 is:

d = 4.3 x 102 = 440 feet (about 0.08 miles)

12.3 BLEVEs

If a fireball from a BLEVE is a potential release scenario at your site, you may use Reference Table 22 to estimate the distance to a potentially harmful radiant heat level. The table shows distances for a range of quantities to the radiant heat level that potentially could cause second degree burns to a person exposed for the duration of the fire. The quantity you use should be the total quantity in a tank that might be involved in a BLEVE. The equations used to derive this table of distances are presented in Appendix D, Section D.10. If you prefer, you may use the equations to estimate a distance for BLEVEs, or you may use a different calculation method or model.

12.4 Vapor Cloud Explosion

If you have the potential at your site for the rapid release of a large quantity of a flammable vapor, particularly into a congested area, a vapor cloud explosion may be an appropriate alternative release scenario. For the consequence analysis, you may use the same methods as for the worst case to estimate consequence distances to an overpressure endpoint of 1 psi (see Section 5.1 and the equation in Appendix C). Instead of assuming the total quantity of flammable substance released is in the vapor cloud, you may estimate a smaller quantity in the cloud. You could base your estimate of the quantity in the cloud on the release rate estimated as described above for gases and liquids multiplied by the time required to stop the release.

To estimate the quantity in the cloud for a gas liquefied under pressure (not refrigerated), you may use the following equation, incorporating a "flash fraction factor" (FFF), listed in Appendix C, Exhibit C-2 for regulated flammable gases, to estimate the quantity that could be immediately flashed into vapor upon release plus the quantity that might be carried along as spray or aerosol (see Appendix D, Section D.11 for the derivation of this equation):

$$QF = FFF \times QS \times 2 \qquad \textbf{(23)}$$

where: QF = Quantity flashed into vapor plus aerosol (pounds) (cannot be larger than QS)
QS = Quantity spilled (pounds)
FFF = Flash fraction factor (unitless) (listed in Appendix C, Exhibit C-2)
2 = Factor to account for spray and aerosol

For derivation of the FFF, the temperature of the stored gas was assumed to be 25° C (77° F). You may estimate the flash fraction under other conditions using the equation presented in Appendix D, Section D.11.

You may estimate the distance to 1 psi for a vapor cloud explosion from the quantity in the cloud using Reference Table 9 (at the end of the worst-case analysis discussion) or from Equation C-1 in Appendix C. For the alternative scenario analysis, you may use a yield factor of 3 percent, instead of the yield factor of 10 percent used in the worst-case analysis. If you use the equation in Appendix C, use 0.03 instead of 0.1 in the calculation. If you use Reference Table 9, you can incorporate the lower yield factor by multiplying the distance you read from Reference Table 9 by 0.67.

Example 27. Vapor Cloud Explosion (Propane)

You have a tank containing 50,000 pounds of propane liquefied under pressure at ambient temperature. You want to estimate the consequence distance for a vapor cloud explosion resulting from rupture of the tank.

You use Equation 19 to estimate the quantity that might be released to form a cloud. You base the calculation on the entire contents of the tank (QS = 50,000 pounds). From Exhibit C-2 of Appendix C, the Flash Fraction Factor (FFF) for propane is 0.38. From Equation 19, the quantity flashed into vapor, plus the quantity that might be carried along as aerosol, (QF) is:

$$QF = 0.38 \times 50{,}000 \times 2 = 38{,}000 \text{ pounds}$$

You assume 38,000 pounds of propane is in the flammable part of the vapor cloud. This quantity falls between 30,000 pounds and 50,000 pounds in Reference Table 9; 30,000 pounds is the quantity closest to your quantity. From the table, the distance to 1 psi overpressure is 0.33 miles for 30,000 pounds of propane for a 10 percent yield factor. To change the yield factor to 3 percent, you multiply this distances by 0.67; then the distance becomes 0.22 miles.

Reference Table 10
Neutrally Buoyant Plume Distances to Toxic Endpoint for Release Rate Divided by Endpoint
10-Minute Release, Rural Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 64	0.06
64 - 510	0.19
510 - 1,300	0.31
1,300 - 2,300	0.43
2,300 - 4,100	0.62
4,100 - 6,300	0.81
6,300 - 8,800	0.99
8,800 - 12,000	1.2
12,000 - 16,000	1.4
16,000 - 19,000	1.6
19,000 - 22,000	1.8
22,000 - 26,000	2.0
26,000 - 30,000	2.2
30,000 - 36,000	2.4
36,000 - 42,000	2.6
42,000 - 47,000	2.8
47,000 - 54,000	3.0
54,000 - 60,000	3.2
60,000 - 70,000	3.4
70,000 - 78,000	3.6
78,000 - 87,000	3.8
87,000 - 97,000	4.0
97,000 - 110,000	4.2
110,000 - 120,000	4.4
120,000 - 130,000	4.6

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
130,000 - 140,000	4.8
140,000 - 160,000	5.0
160,000 - 180,000	5.2
180,000 - 190,000	5.4
190,000 - 210,000	5.6
210,000 - 220,000	5.8
220,000 - 240,000	6.0
240,000 - 261,000	6.2
261,000 - 325,000	6.8
325,000 - 397,000	7.5
397,000 - 477,000	8.1
477,000 - 566,000	8.7
566,000 - 663,000	9.3
663,000 - 769,000	9.9
769,000 - 1,010,000	11
1,010,000 - 1,280,000	12
1,280,000 - 1,600,000	14
1,600,000 - 1,950,000	15
1,950,000 - 2,340,000	16
2,340,000 - 2,770,000	17
2,770,000 - 3,240,000	19
3,240,000 - 4,590,000	22
4,590,000 - 6,190,000	25
>6,190,000	>25

Reference Table 11
Neutrally Buoyant Plume Distances to Toxic Endpoint for Release Rate Divided by Endpoint
60-Minute Release, Rural Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 79	0.06
79 - 630	0.19
630 - 1,600	0.31
1,600 - 2,800	0.43
2,800 - 5,200	0.62
5,200 - 7,900	0.81
7,900 - 11,000	0.99
11,000 - 14,000	1.2
14,000 - 19,000	1.4
19,000 - 23,000	1.6
23,000 - 27,000	1.8
27,000 - 32,000	2.0
32,000 - 36,000	2.2
36,000 - 42,000	2.4
42,000 - 47,000	2.6
47,000 - 52,000	2.8
52,000 - 57,000	3.0
57,000 - 61,000	3.2
61,000 - 68,000	3.4
68,000 - 73,000	3.6
73,000 - 79,000	3.8
79,000 - 84,000	4.0
84,000 - 91,000	4.2
91,000 - 97,000	4.4
97,000 - 100,000	4.6

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
100,000 - 110,000	4.8
110,000 - 110,000	5.0
110,000 - 120,000	5.2
120,000 - 130,000	5.4
130,000 - 130,000	5.6
130,000 - 140,000	5.8
140,000 - 150,000	6.0
150,000 - 151,000	6.2
151,000 - 171,000	6.8
171,000 - 191,000	7.5
191,000 - 212,000	8.1
212,000 - 233,000	8.7
233,000 - 256,000	9.3
256,000 - 280,000	9.9
280,000 - 332,000	11
332,000 - 390,000	12
390,000 - 456,000	14
456,000 - 529,000	15
529,000 - 610,000	16
610,000 - 699,000	17
699,000 - 796,000	19
796,000 - 1,080,000	22
1,080,000 - 1,410,000	25
>1,410,000	>25

Reference Table 12
Neutrally Buoyant Plume Distances to Toxic Endpoint for Release Rate Divided by Endpoint
10-Minute Release, Urban Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 160	0.06
160 - 1,400	0.19
1,400 - 3,600	0.31
3,600 - 6,900	0.43
6,900 - 13,000	0.62
13,000 - 22,000	0.81
22,000 - 31,000	0.99
31,000 - 42,000	1.2
42,000 - 59,000	1.4
59,000 - 73,000	1.6
73,000 - 88,000	1.8
88,000 - 100,000	2.0
100,000 - 120,000	2.2
120,000 - 150,000	2.4
150,000 - 170,000	2.6
170,000 - 200,000	2.8
200,000 - 230,000	3.0
230,000 - 260,000	3.2
260,000 - 310,000	3.4
310,000 - 340,000	3.6
340,000 - 390,000	3.8
390,000 - 430,000	4.0
430,000 - 490,000	4.2
490,000 - 540,000	4.4
540,000 - 600,000	4.6

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
600,000 - 660,000	4.8
660,000 - 720,000	5.0
720,000 - 810,000	5.2
810,000 - 880,000	5.4
880,000 - 950,000	5.6
950,000 - 1,000,000	5.8
1,000,000 - 1,100,000	6.0
1,100,000 - 1,220,000	6.2
1,220,000 - 1,530,000	6.8
1,530,000 - 1,880,000	7.5
1,880,000 - 2,280,000	8.1
2,280,000 - 2,710,000	8.7
2,710,000 - 3,200,000	9.3
3,200,000 - 3,730,000	9.9
3,730,000 - 4,920,000	11
4,920,000 - 6,310,000	12
6,310,000 - 7,890,000	14
7,890,000 - 9,660,000	15
9,660,000 - 11,600,000	16
11,600,000 - 13,800,000	17
13,800,000 - 16,200,000	19
16,200,000 - 23,100,000	22
23,100,000 - 31,300,000	25
>31,300,000	>25

Reference Table 13
Neutrally Buoyant Plume Distances to Toxic Endpoint for Release Rate Divided by Endpoint
60-Minute Release, Urban Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 200	0.06
200 - 1,700	0.19
1,700 - 4,500	0.31
4,500 - 8,600	0.43
8,600 - 17,000	0.62
17,000 - 27,000	0.81
27,000 - 39,000	0.99
39,000 - 53,000	1.2
53,000 - 73,000	1.4
73,000 - 90,000	1.6
90,000 - 110,000	1.8
110,000 - 130,000	2.0
130,000 - 150,000	2.2
150,000 - 170,000	2.4
170,000 - 200,000	2.6
200,000 - 220,000	2.8
220,000 - 240,000	3.0
240,000 - 270,000	3.2
270,000 - 300,000	3.4
300,000 - 320,000	3.6
320,000 - 350,000	3.8
350,000 - 370,000	4.0
370,000 - 410,000	4.2
410,000 - 430,000	4.4
430,000 - 460,000	4.6

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
460,000 - 490,000	4.8
490,000 - 520,000	5.0
520,000 - 550,000	5.2
550,000 - 580,000	5.4
580,000 - 610,000	5.6
610,000 - 640,000	5.8
640,000 - 680,000	6.0
680,000 - 705,000	6.2
705,000 - 804,000	6.8
804,000 - 905,000	7.5
905,000 - 1,010,000	8.1
1,010,000 - 1,120,000	8.7
1,120,000 - 1,230,000	9.3
1,230,000 - 1,350,000	9.9
1,350,000 - 1,620,000	11
1,620,000 - 1,920,000	12
1,920,000 - 2,250,000	14
2,250,000 - 2,620,000	15
2,620,000 - 3,030,000	16
3,030,000 - 3,490,000	17
3,490,000 - 3,980,000	19
3,980,000 - 5,410,000	22
5,410,000 - 7,120,000	25
>7,120,000	>25

Reference Table 14
Dense Gas Distances to Toxic Endpoint
10-minute Release, Rural Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate (lbs/min)	Toxic Endpoint (mg/L)															
	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
	Distance (Miles)															
1	0.60	0.44	0.36	0.24	0.17	0.14	0.11	0.09	<0.06	<0.06	#	#	#	#	#	#
2	0.87	0.62	0.50	0.37	0.26	0.22	0.17	0.14	0.09	0.07	<0.06	<0.06	#	#	#	#
5	1.4	1.1	0.87	0.60	0.44	0.36	0.29	0.24	0.17	0.12	0.09	0.07	<0.06	#	#	#
10	2.0	1.5	1.2	0.87	0.62	0.54	0.43	0.36	0.25	0.18	0.14	0.11	0.09	<0.06	<0.06	#
30	3.7	2.7	2.2	1.5	1.1	0.93	0.74	0.68	0.47	0.34	0.28	0.22	0.19	0.11	0.07	<0.06
50	5.0	3.7	3.0	2.1	1.9	1.2	0.99	0.87	0.62	0.45	0.37	0.30	0.25	0.15	0.10	0.08
100	7.4	5.3	4.3	3.0	2.3	1.7	1.4	1.2	0.87	0.62	0.56	0.43	0.37	0.23	0.15	0.12
150	8.7	6.8	5.5	3.8	2.8	2.3	1.9	1.6	1.1	0.81	0.68	0.56	0.47	0.29	0.19	0.15
250	12	8.7	7.4	5.0	3.7	3.0	2.4	2.1	1.4	1.1	0.87	0.74	0.51	0.38	0.26	0.20
500	17	13	11	7.4	5.3	4.5	3.6	3.0	2.1	1.6	1.3	1.1	0.87	0.56	0.37	0.30
750	22	16	13	9.3	6.8	5.6	4.5	3.8	2.7	1.9	1.6	1.3	1.1	0.68	0.47	0.37
1000	>25	19	16	11	8.1	6.8	5.2	4.5	3.1	2.3	2.2	1.5	1.3	0.81	0.56	0.44
1500	*	23	19	13	9.9	8.1	6.8	5.6	3.9	2.9	2.4	1.9	1.6	0.99	0.68	0.55
2000	*	>25	22	15	12	9.3	7.4	6.8	4.5	3.4	2.7	2.2	1.9	1.2	0.81	0.62
2500	*	*	25	17	13	11	8.7	7.4	5.2	3.8	3.2	2.5	2.1	1.3	0.87	0.74
3000	*	*	>25	19	14	12	9.3	8.1	5.7	4.2	3.5	2.8	2.4	1.4	0.99	0.81
4000	*	*	*	22	17	14	11	9.3	6.8	4.9	4.1	3.3	2.8	1.7	1.1	0.93
5000	*	*	*	>25	19	16	12	11	7.4	5.6	4.7	3.7	3.1	2.1	1.3	1.1
7500	*	*	*	*	24	19	16	13	9.3	6.8	5.8	4.7	4.0	2.4	1.6	1.3
10000	*	*	*	*	>25	22	18	16	11	8.1	6.8	5.3	4.6	2.8	1.9	1.5
15000	*	*	*	*	*	>25	22	19	13	9.9	8.1	6.8	5.7	3.5	2.4	1.9
20000	*	*	*	*	*	*	>25	22	16	11	9.3	7.4	6.8	4.0	2.8	2.2

* > 25 miles

<0.06 miles

Reference Table 15
Dense Gas Distances to Toxic Endpoint
60-minute Release, Rural Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate (lbs/min)	Toxic Endpoint (mg/L)															
	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
	Distance (Miles)															
1	0.53	0.39	0.32	0.22	0.16	0.13	0.10	0.09	<0.06	#	#	#	#	#	#	#
2	0.81	0.57	0.47	0.32	0.23	0.19	0.15	0.13	0.09	<0.06	<0.06	<0.06	#	#	#	#
5	1.6	0.99	0.81	0.54	0.39	0.32	0.25	0.22	0.15	0.11	0.09	0.07	<0.06	#	#	#
10	2.0	1.4	1.2	0.81	0.58	0.47	0.38	0.32	0.22	0.16	0.13	0.11	0.09	<0.06	<0.06	#
30	4.0	2.8	2.2	1.5	1.1	0.87	0.68	0.61	0.42	0.30	0.25	0.20	0.17	0.10	0.07	<0.06
50	5.5	3.9	3.1	2.1	1.5	1.2	0.99	0.81	0.56	0.41	0.34	0.27	0.23	0.14	0.09	0.07
100	8.7	6.1	4.8	3.2	2.2	1.8	1.4	1.2	0.81	0.61	0.50	0.40	0.34	0.20	0.14	0.11
150	12	8.1	6.2	4.1	2.9	2.3	1.8	1.6	1.1	0.74	0.62	0.51	0.43	0.26	0.18	0.14
250	17	11	8.7	5.6	4.0	3.2	2.5	2.1	1.4	1.1	0.87	0.68	0.57	0.35	0.24	0.19
500	>25	19	14	9.3	6.2	5.0	3.9	3.3	2.2	1.6	1.3	0.99	0.87	0.51	0.35	0.28
750	*	25	19	12	8.7	6.8	5.1	4.2	2.8	2.0	1.6	1.3	1.1	0.62	0.44	0.35
1000	*	>25	24	15	11	8.1	6.1	5.2	3.4	2.4	1.9	1.5	1.3	0.74	0.52	0.42
1500	*	*	>25	20	14	11	8.1	6.8	4.3	3.0	2.5	1.9	1.7	0.99	0.68	0.52
2000	*	*	*	24	17	13	9.9	8.1	5.2	3.7	2.9	2.3	1.9	1.2	0.74	0.61
2500	*	*	*	>25	19	15	12	9.3	6.0	4.3	3.4	2.7	2.2	1.3	0.87	0.68
3000	*	*	*	*	22	17	13	11	6.8	4.8	3.8	3.0	2.5	1.5	0.99	0.81
4000	*	*	*	*	>25	21	16	14	8.7	5.8	4.7	3.6	3.0	1.7	1.2	0.9
5000	*	*	*	*	*	25	19	16	9.9	6.8	5.3	4.1	3.5	2.0	1.4	1.1
7500	*	*	*	*	*	>25	25	20	13	9.3	6.8	5.4	4.5	2.6	1.7	1.4
10000	*	*	*	*	*	*	>25	25	16	11	8.7	6.8	5.4	3.1	2.1	1.6
15000	*	*	*	*	*	*	*	>25	21	14	11	8.7	7.4	4.0	2.6	2.1
20000	*	*	*	*	*	*	*	*	25	17	14	11	8.7	4.8	3.1	2.5

* > 25 miles

\# <0.06 miles

Reference Table 16
Dense Gas Distances to Toxic Endpoint
10-minute Release, Urban Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate (lbs/min)	Toxic Endpoint (mg/L)															
	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
	Distance (Miles)															
1	0.49	0.34	0.24	0.19	0.12	0.11	0.08	0.06	<0.06	#	#	#	#	#	#	#
2	0.68	0.50	0.43	0.28	0.22	0.17	0.12	0.11	0.07	<0.06	<0.06	#	#	#	#	#
5	1.1	0.81	0.62	0.47	0.33	0.28	0.21	0.19	0.12	0.09	0.07	<0.06	<0.06	#	#	#
10	2.1	1.2	0.99	0.68	0.50	0.42	0.31	0.28	0.19	0.13	0.11	0.08	0.06	<0.06	#	#
30	3.0	2.2	1.9	1.2	0.93	0.81	0.62	0.56	0.37	0.27	0.22	0.17	0.14	0.08	<0.06	#
50	4.1	3.0	2.5	1.6	1.2	0.99	0.81	0.68	0.50	0.30	0.29	0.23	0.19	0.11	0.07	<0.06
100	5.8	4.3	3.5	2.7	1.8	1.4	1.2	0.99	0.74	0.56	0.45	0.36	0.29	0.17	0.11	0.08
150	7.4	5.5	4.5	3.1	2.2	1.9	1.4	1.2	0.87	0.68	0.56	0.44	0.37	0.22	0.17	0.11
250	9.9	7.4	5.8	4.1	3.0	2.5	2.0	1.7	1.1	0.87	0.68	0.58	0.50	0.29	0.19	0.14
500	14	11	8.7	5.9	4.3	3.6	2.9	2.5	1.7	1.2	0.99	0.81	0.68	0.45	0.28	0.21
750	17	13	11	7.4	5.5	4.5	3.6	3.1	2.1	1.6	1.2	0.99	0.87	0.54	0.35	0.27
1000	20	15	12	8.7	6.2	5.3	4.3	3.5	2.5	1.8	1.5	1.2	0.99	0.62	0.42	0.32
1500	>25	19	16	11	8.1	6.2	5.2	4.5	3.0	2.2	1.8	1.5	1.2	0.74	0.52	0.40
2000	*	22	18	12	9.3	7.4	6.2	5.2	3.7	2.7	2.2	1.7	1.4	0.87	0.60	0.47
2500	*	24	20	14	11	8.7	6.8	6.0	3.8	3.0	2.2	1.9	1.7	0.99	0.68	0.55
3000	*	>25	22	16	11	9.3	7.4	6.8	4.5	3.3	2.7	2.1	1.9	1.1	0.74	0.57
4000	*	*	>25	18	14	11	8.7	7.4	5.3	4.0	3.2	2.6	2.1	1.2	0.87	0.68
5000	*	*	*	20	15	12	9.9	8.7	5.8	4.4	3.6	2.9	2.4	1.4	0.93	0.74
7500	*	*	*	>25	19	16	12	11	7.4	5.5	4.5	3.6	3.0	1.8	1.2	0.93
10000	*	*	*	*	22	18	14	12	8.7	6.2	5.2	4.2	3.6	2.1	1.4	1.1
15000	*	*	*	*	>25	22	18	16	11	8.1	6.8	5.2	4.4	2.6	1.7	1.3
20000	*	*	*	*	*	>25	20	18	12	9.3	7.4	6.0	5.2	3.0	2.0	1.6

* > 25 miles

<0.06 miles

Reference Table 17
Dense Gas Distances to Toxic Endpoint
60-minute Release, Urban Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate (lbs/min)	Toxic Endpoint (mg/L)															
	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
	Distance (Miles)															
1	0.43	0.31	0.25	0.17	0.12	0.09	0.07	<0.06	#	#	#	#	#	#	#	#
2	0.68	0.47	0.38	0.25	0.18	0.15	0.11	0.09	<0.06	<0.06	#	#	#	#	#	#
5	1.1	0.81	0.68	0.43	0.32	0.25	0.20	0.17	0.11	0.08	<0.06	<0.06	<0.06	#	#	#
10	1.7	1.2	0.99	0.68	0.47	0.38	0.30	0.26	0.17	0.12	0.10	0.07	0.06	<0.06	#	#
30	3.3	2.4	1.9	1.3	0.93	0.74	0.58	0.50	0.33	0.24	0.19	0.16	0.13	0.07	<0.06	#
50	4.7	3.3	2.6	1.7	1.2	0.99	0.81	0.68	0.45	0.33	0.27	0.21	0.17	0.10	0.06	<0.06
100	7.4	5.2	4.1	2.7	1.9	1.5	1.2	0.99	0.68	0.48	0.40	0.32	0.27	0.16	0.10	0.07
150	9.9	6.8	5.3	3.4	2.4	1.9	1.5	1.3	0.87	0.61	0.50	0.40	0.33	0.19	0.13	0.10
250	14	9.3	7.4	4.7	3.4	2.7	2.1	1.7	1.1	0.81	0.68	0.53	0.45	0.26	0.17	0.13
500	22	16	12	7.4	5.2	4.2	3.2	2.7	1.7	1.2	0.99	0.81	0.68	0.38	0.25	0.20
750	>25	20	16	9.9	6.8	5.4	4.2	3.5	2.2	1.6	1.3	0.99	0.87	0.49	0.32	0.27
1000	*	24	19	12	8.1	6.8	5.0	4.2	2.7	1.8	1.6	1.2	0.99	0.58	0.38	0.30
1500	*	>25	>25	16	11	8.7	6.8	5.5	3.5	1.9	2.0	1.6	1.3	0.74	0.48	0.37
2000	*	*	>25	19	14	11	8.1	6.8	4.2	3.0	2.2	1.9	1.6	0.87	0.56	0.44
2500	*	*	>25	23	16	12	9.3	7.4	4.9	3.4	2.7	2.1	1.7	0.99	0.62	0.50
3000	*	*	*	>25	18	14	11	8.7	5.5	3.8	3.0	2.4	2.0	1.1	0.74	0.56
4000	*	*	*	>25	22	17	13	11	6.8	4.7	3.1	2.8	2.4	1.3	0.87	0.68
5000	*	*	*	*	>25	20	16	12	8.1	5.3	4.3	3.3	2.7	1.5	0.99	0.74
7500	*	*	*	*	*	25	20	17	11	6.8	5.6	4.3	3.5	2.0	1.2	0.93
10000	*	*	*	*	*	>25	24	20	13	8.7	6.8	5.2	4.3	2.4	1.5	1.1
15000	*	*	*	*	*	*	>25	>25	17	11	8.7	6.8	5.6	3.0	1.9	1.5
20000	*	*	*	*	*	*	*	>25	20	14	11	8.1	6.8	3.6	2.3	1.7

Reference Table 18
Neutrally Buoyant Plume Distances to Lower Flammability Limit (LFL)
For Release Rate Divided by LFL
Rural Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 28	0.06
28 - 40	0.08
40 - 60	0.10
60 - 220	0.20
220 - 530	0.30
530 - 860	0.40
860 - 1,300	0.50
1,300 - 1,700	0.60
1,700 - 2,200	0.70
2,200 - 2,700	0.80

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
2,700 - 3,300	0.90
3,300 - 3,900	1.0
3,900 - 4,500	1.1
4,500 - 5,200	1.2
5,200 - 5,800	1.3
5,800 - 6,800	1.4
6,800 - 8,200	1.6
8,200 - 9,700	1.8
9,700 - 11,000	2.0
11,000 - 13,000	2.2

Reference Table 19
Neutrally Buoyant Plume Distances to Lower Flammability Limit (LFL)
For Release Rate Divided by LFL
Urban Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
0 - 68	0.06
68 - 100	0.08
100 - 150	0.10
150 - 710	0.20
710 - 1,500	0.30
1,500 - 2,600	0.40
2,600 - 4,000	0.50
4,000 - 5,500	0.60

Release Rate/Endpoint [(lbs/min)/(mg/L)]	Distance to Endpoint (miles)
5,500 - 7,300	0.70
7,300 - 9,200	0.80
9,200 - 11,000	0.90
11,000 - 14,000	1.0
14,000 - 18,000	1.2
18,000 - 26,000	1.4
26,000 - 31,000	1.6
31,000 - 38,000	1.8

Reference Table 20
Dense Gas Distances to Lower Flammability Limit
Rural Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate (lbs/min)	Lower Flammability Limit (mg/L)									
	27	30	35	40	45	50	60	70	100	>100
	Distance (Miles)									
<1500	#	#	#	#	#	#	#	#	#	#
1500	<0.06	<0.06	#	#	#	#	#	#	#	#
2000	0.07	0.06	<0.06	#	#	#	#	#	#	#
2500	0.08	0.07	0.07	<0.06	#	#	#	#	#	#
3000	0.09	0.08	0.07	0.07	<0.06	<0.06	#	#	#	#
4000	0.11	0.10	0.09	0.08	0.07	0.07	<0.06	#	#	#
5000	0.12	0.11	0.10	0.09	0.08	0.07	0.07	<0.06	#	#
7500	0.15	0.14	0.12	0.11	0.11	0.10	0.09	0.07	<0.06	#
10000	0.17	0.16	0.14	0.13	0.12	0.11	0.10	0.09	0.07	<0.06

< 0.06 mile

Reference Table 21
Dense Gas Distances to Lower Flammability Limit
Urban Conditions, D Stability, Wind Speed 3.0 Meters per Second

Release Rate (lbs/min)	Lower Flammability Limit (mg/L)				
	27	30	35	40	>40
	Distance (Miles)				
<5000	#	#	#	#	#
5000	<0.06	<0.06	#	#	#
7500	0.07	0.06	<0.06	#	#
10000	0.09	0.07	0.07	<0.06	#

< 0.06 miles

Reference Table 22
Distance to Radiant Heat Dose at Potential Second Degree Burn Threshold Assuming Exposure for Duration of Fireball
(Dose = $[5\ kW/m^2]^{4/3}$ x Exposure Time)

	Quantity in Fireball (pounds)	1,000	5,000	10,000	20,000	30,000	50,000	75,000	100,000	200,000	300,000	500,000
	Duration of Fireball (seconds)	3.5	5.9	7.5	9.4	10.8	12.7	14.8	15.5	17.4	18.7	20.3
CAS No.	Chemical Name	Distance (miles) at which Exposure for Duration of Fireball May Cause Second Degree Burns										
75-07-0	Acetaldehyde	0.036	0.076	0.10	0.14	0.17	0.22	0.26	0.30	0.39	0.46	0.56
74-86-2	Acetylene	0.050	0.11	0.14	0.20	0.24	0.30	0.37	0.41	0.54	0.64	0.78
598-73-2	Bromotrifluoroethylene	0.010	0.021	0.029	0.040	0.048	0.061	0.074	0.083	0.11	0.13	0.16
106-99-0	1,3-Butadiene	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.61	0.75
106-97-8	Butane	0.049	0.10	0.14	0.19	0.23	0.29	0.36	0.40	0.53	0.62	0.76
106-98-9	1-Butene	0.049	0.10	0.14	0.19	0.23	0.29	0.36	0.40	0.53	0.62	0.76
107-01-7	2-Butene	0.049	0.10	0.14	0.19	0.23	0.29	0.36	0.40	0.53	0.62	0.76
25167-67-3	Butene	0.048	0.10	0.14	0.19	0.23	0.29	0.36	0.40	0.52	0.62	0.76
590-18-1	2-Butene-cis	0.048	0.10	0.14	0.19	0.23	0.29	0.36	0.40	0.52	0.62	0.76
624-64-6	2-Butene-trans	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.62	0.75
463-58-1	Carbon oxysulfide	0.022	0.046	0.063	0.086	0.10	0.13	0.16	0.18	0.24	0.28	0.34
7791-21-1	Chlorine monoxide	0.007	0.015	0.021	0.029	0.035	0.044	0.053	0.060	0.078	0.092	0.11
557-98-2	2-Chloropropylene	0.035	0.073	0.10	0.14	0.17	0.21	0.25	0.28	0.37	0.44	0.54
590-21-6	1-Chloropropylene	0.035	0.073	0.10	0.14	0.17	0.21	0.25	0.28	0.37	0.44	0.54
460-19-5	Cyanogen	0.033	0.069	0.10	0.13	0.16	0.20	0.24	0.27	0.36	0.42	0.52
75-19-4	Cyclopropane	0.049	0.10	0.14	0.20	0.24	0.30	0.36	0.40	0.53	0.63	0.77
4109-96-0	Dichlorosilane	0.021	0.043	0.060	0.082	0.10	0.13	0.15	0.17	0.22	0.26	0.32
75-37-6	Difluoroethane	0.024	0.051	0.071	0.10	0.12	0.15	0.18	0.20	0.26	0.31	0.38
124-40-3	Dimethylamine	0.043	0.091	0.12	0.17	0.21	0.26	0.32	0.35	0.47	0.55	0.67
463-82-1	2,2-Dimethylpropane	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.62	0.75
74-84-0	Ethane	0.050	0.10	0.14	0.20	0.24	0.30	0.36	0.41	0.54	0.63	0.77
107-00-6	Ethyl acetylene	0.049	0.10	0.14	0.19	0.23	0.29	0.36	0.40	0.53	0.62	0.76
75-04-7	Ethylamine	0.043	0.090	0.12	0.17	0.20	0.26	0.31	0.35	0.46	0.54	0.67

Reference Table 22 (continued)

	Quantity in Fireball (pounds)	1,000	5,000	10,000	20,000	30,000	50,000	75,000	100,000	200,000	300,000	500,000
	Duration of Fireball (seconds)	3.5	5.9	7.5	9.4	10.8	12.7	14.8	15.5	17.4	18.7	20.3
CAS No.	Chemical Name	Distance (miles) at which Exposure for Duration of Fireball May Cause Second Degree Burns										
75-00-3	Ethyl chloride	0.032	0.068	0.093	0.13	0.15	0.19	0.24	0.26	0.35	0.41	0.50
74-85-1	Ethylene	0.050	0.10	0.14	0.20	0.24	0.30	0.36	0.41	0.54	0.63	0.77
60-29-7	Ethyl ether	0.042	0.088	0.12	0.17	0.20	0.25	0.31	0.34	0.45	0.53	0.65
75-08-1	Ethyl mercaptan	0.038	0.080	0.11	0.15	0.18	0.23	0.28	0.31	0.41	0.48	0.59
109-95-5	Ethyl nitrite	0.031	0.064	0.088	0.12	0.15	0.19	0.22	0.25	0.33	0.39	0.48
1333-74-0	Hydrogen	0.079	0.17	0.23	0.31	0.38	0.48	0.58	0.65	0.85	1.0	1.2
75-28-5	Isobutane	0.049	0.10	0.14	0.19	0.23	0.29	0.36	0.40	0.53	0.62	0.76
78-78-4	Isopentane	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.61	0.75
78-79-5	Isoprene	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.39	0.52	0.61	0.74
75-31-0	Isopropylamine	0.044	0.091	0.13	0.17	0.21	0.26	0.32	0.36	0.47	0.55	0.68
75-29-6	Isopropyl chloride	0.035	0.074	0.10	0.14	0.17	0.21	0.26	0.29	0.38	0.45	0.55
74-82-8	Methane	0.051	0.11	0.15	0.20	0.24	0.31	0.37	0.42	0.55	0.65	0.79
74-89-5	Methylamine	0.040	0.085	0.12	0.16	0.19	0.24	0.30	0.33	0.44	0.51	0.63
563-45-1	3-Methyl-1-butene	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.61	0.75
563-46-2	2-Methyl-1-butene	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.39	0.52	0.61	0.75
115-10-6	Methyl ether	0.039	0.081	0.11	0.15	0.19	0.23	0.28	0.32	0.42	0.49	0.60
107-31-3	Methyl formate	0.028	0.059	0.081	0.11	0.14	0.17	0.21	0.23	0.31	0.36	0.44
115-11-7	2-Methylpropene	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.62	0.75
504-60-9	1,3-Pentadiene	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.39	0.51	0.60	0.74
109-66-0	Pentane	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.61	0.75
109-67-1	1-Pentene	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.61	0.75
646-04-8	2-Pentene, (E)-	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.61	0.75
627-20-3	2-Pentene, (Z)-	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.40	0.52	0.61	0.75
463-49-0	Propadiene	0.049	0.10	0.14	0.19	0.23	0.30	0.36	0.40	0.53	0.62	0.76
74-98-6	Propane	0.049	0.10	0.14	0.19	0.23	0.30	0.36	0.40	0.53	0.62	0.76

Reference Table 22 (continued)

	Quantity in Fireball (pounds)	1,000	5,000	10,000	20,000	30,000	50,000	75,000	100,000	200,000	300,000	500,000
	Duration of Fireball (seconds)	3.5	5.9	7.5	9.4	10.8	12.7	14.8	15.5	17.4	18.7	20.3
CAS No.	Chemical Name	Distance (miles) at which Exposure for Duration of Fireball May Cause Second Degree Burns										
115-07-1	Propylene	0.049	0.10	0.14	0.19	0.23	0.30	0.36	0.40	0.53	0.62	0.76
74-99-7	Propyne	0.049	0.10	0.14	0.19	0.23	0.30	0.36	0.40	0.53	0.62	0.76
7803-62-5	Silane	0.048	0.10	0.14	0.19	0.23	0.29	0.35	0.39	0.52	0.61	0.75
116-14-3	Tetrafluoroethylene	0.008	0.017	0.024	0.032	0.039	0.049	0.060	0.067	0.088	0.10	0.13
75-76-3	Tetramethylsilane	0.047	0.098	0.13	0.18	0.22	0.28	0.34	0.38	0.50	0.59	0.73
10025-78-2	Trichlorosilane	0.014	0.029	0.040	0.055	0.067	0.085	0.10	0.11	0.15	0.18	0.22
79-38-9	Trifluorochloroethylene	0.010	0.020	0.028	0.039	0.047	0.059	0.072	0.080	0.11	0.12	0.15
75-50-3	Trimethylamine	0.044	0.093	0.13	0.18	0.21	0.27	0.33	0.37	0.48	0.57	0.69
689-97-4	Vinyl acetylene	0.049	0.10	0.14	0.19	0.23	0.29	0.36	0.40	0.53	0.62	0.76
75-01-4	Vinyl chloride	0.031	0.066	0.090	0.12	0.15	0.19	0.23	0.26	0.34	0.40	0.49
109-92-2	Vinyl ethyl ether	0.041	0.087	0.12	0.16	0.20	0.25	0.30	0.34	0.45	0.53	0.64
75-02-5	Vinyl fluoride	0.011	0.022	0.031	0.042	0.051	0.065	0.078	0.088	0.12	0.14	0.17
75-35-4	Vinylidene chloride	0.023	0.049	0.067	0.092	0.11	0.14	0.17	0.19	0.25	0.30	0.36
75-38-7	Vinylidene fluoride	0.024	0.050	0.068	0.094	0.11	0.14	0.17	0.19	0.26	0.30	0.37
107-25-5	Vinyl methyl ether	0.040	0.084	0.11	0.16	0.19	0.24	0.29	0.33	0.43	0.51	0.62

13.0 Estimating Offsite Receptors

The rule requires that you estimate residential populations within the circle of your worst-case and alternative release scenarios. In addition, you must report in the RMP whether types of public receptors and environmental receptors are within the circles.

To estimate residential populations, you may use the most recent Census data or any other source of data that you believe is more accurate. You are not required to update Census data or conduct any surveys to develop your estimates. Census data are available in public libraries and in the LANDVIEW system, which is available on CD-ROM. The rule requires that you estimate populations to two-significant digits. For example, if there are 1,260 people within the circle, you may report 1,300 people.

Census data are presented by Census tract. If your circle covers only a portion of the tract, you should develop an estimate for that portion. The easiest way to do this is to determine the population density per square mile (total population of the Census tract divided by the number of square miles in the tract) and apply that density figure to the number of square miles within your circle. Because there is likely to be considerable variation in actual densities within a Census tract, this number will be approximate. The rule, however, does not require you to correct the number.

Other public receptors must be noted in the RMP. If there are any schools, residences, hospitals, prisons, public recreational areas or arenas, or major commercial or industrial areas within the circle, you must report that. You are not required to develop a list of all institutions and areas; you must simply checkoff that one or more such areas are within the circle. Most of these institutions or areas can be identified from local street maps. Recreational areas include public swimming pools, public parks, and other areas that are used on a regular basis for recreational activities (e.g., baseball fields). Commercial and industrial areas include shopping malls, strip malls, downtown business areas, industrial parks, etc.

Environmental receptors are defined as national or state parks, forests, or monuments; officially designated wildlife sanctuaries, preserves, or refuges; and Federal wilderness areas. All of these can be identified on local U.S. Geological Survey maps. You are not required to locate each of these specifically. You are only required to checkoff in the RMP that these specific types of areas are within the circle. If any part of one of these receptors is within your circles, you must note that in the RMP.

The rule does not require you to assess the likelihood, type, or severity of potential impacts on either public or environmental receptors. Identifying them as within the circle indicates that they could be adversely affected by the release.

14.0 Submitting Offsite Consequence Analysis Information for Risk Management Plan

For the offsite consequence analysis (OCA) component of the RMP you must provide information on your worst-case and alternative release scenario(s) for toxic and flammable regulated chemicals held above the threshold quantity. The requirements for what information you must submit differs if your source has Program 1, Program 2, or Program 3 processes.

If your source has Program 1 processes, you must submit information on a worst-case release scenario for each toxic and flammable substance held above the threshold quantity in a Program 1 process. If your source has Program 2 or Program 3 processes, you must provide information on one worst-case release for all toxic regulated substances present above the threshold quantity and one worst-case release scenario for all flammable regulated substances present above the threshold quantity. You may need to submit an additional worst-case scenario if a worst-case release from another process at the source would potentially affect public receptors different from those potentially affected by the initial worst-case scenario(s) for flammable and toxic regulated substances.

In addition to a worst-case release scenario, sources with Program 2 and Program 3 processes must also provide information on alternative release scenarios. Alternative releases are releases that could occur, other than the worst-case, that may result in concentrations, overpressures, or radiant heat that reach endpoints offsite. You must present information on one alternative release scenario for each regulated toxic substance, including the substance used for the worst-case release, held above the threshold quantity and one alternative release scenario to represent all flammable substances held above the threshold quantity. The format of the information will be provided by EPA in general guidance to the Risk Management Program. The types of documentation to submit are presented below for worst-case scenarios involving toxic substances, alternative scenarios involving toxic substances, worst-case scenarios involving flammable substances, and alternative scenarios involving flammable toxic substances.

14.1 Documentation Required for Worst-Case Scenarios for Toxic Substances

For worst-case scenarios involving toxic substances, you will have to submit the following information. See the Risk Management Plan Data Elements Guide for complete instructions.

- Chemical name;
- Physical state of the chemical released (gas, liquid, refrigerated gas, refrigerated liquid);
- Basis of results (OCA reference tables or modeling; name of the model used);
- Scenario (toxic gas release or liquid spill and vaporization);
- Quantity released (pounds);
- Release rate (pounds per minute);
- Duration of release (minutes) (10 minutes for gases; if you used OCA guidance for liquids, indicate either 10 or 60 minutes);
- Wind speed (meters per second) and stability class (1.5 meters per second and F stability unless you can show higher minimum wind speed or less stable atmosphere at all times during the last three years);
- Topography (rural or urban);
- Distance to endpoint (miles);
- Population within distance (residential population rounded to two significant digits);

- Public receptors within the distance (schools, residences, hospitals, prisons, public recreation areas or arenas, major commercial or industrial areas);
- Environmental receptors within the distance (national or state parks, forests, or monuments; officially designated wildlife sanctuaries, preserves, or refuges; Federal wilderness areas); and
- Passive mitigation measures considered (dikes, enclosures, berms, drains, sumps, other).

14.2 Documentation Required for Alternative Scenarios for Toxic Substances

For alternative scenarios involving toxic substances held above the threshold quantity in a Program 2 or Program 3 process, you will have to submit the following information. See the Risk Management Plan Data Elements Guide for complete instructions.

- Chemical name;
- Physical state of the chemical released (gas, liquid, refrigerated gas, refrigerated liquid);
- Basis of results (OCA reference tables or modeling; name of model used);
- Scenario (transfer hose failure, pipe leak, vessel leak, overfilling, rupture disk/relief valve, excess flow valve, other);
- Quantity released (pounds);
- Release rate (pounds per minute);
- Duration of release (minutes) (if you used OCA guidance, indicate either 10 or 60 minutes);
- Wind speed (meters per second) and stability class (3.0 meters per second and D stability if you use OCA guidance, otherwise use typical meteorological conditions at your site);
- Topography (rural or urban);
- Distance to endpoint (miles);
- Population within distance (residential population rounded to two significant digits);
- Public receptors within the distance (schools, residences, hospitals, prisons, public recreation areas or arenas, major commercial or industrial areas);
- Environmental receptors within the distance (national or state parks, forests, or monuments; officially designated wildlife sanctuaries, preserves, or refuges; Federal wilderness areas);
- Passive mitigation measures considered (dikes, enclosures, berms, drains, sumps, other); and
- Active mitigation measures considered (sprinkler system, deluge system, water curtain, neutralization, excess flow valve, flares, scrubbers, emergency shutdown system, other).

14.3 Documentation Required for Worst-Case Scenarios for Flammable Substances

For worst-case scenarios involving flammable substances, you will have to submit the following information. See the Risk Management Plan Data Elements Guide for complete instructions.

- Chemical name;
- Basis of results (OCA reference tables or modeling; name of model used);
- Scenario (vapor cloud explosion; BLEVE if it produces worst-case consequences);
- Quantity released (pounds);
- Endpoint used (for vapor cloud explosions use 1 psi, for BLEVE use 5 kw/m^2 for 40 seconds (or thermal dose equivalent to receive second degree burns));
- Distance to endpoint (miles);
- Population within distance (residential population rounded to two significant digits);
- Public receptors within the distance (schools, residences, hospitals, prisons, public recreation areas, major commercial or industrial areas);
- Environmental receptors within the distance (national or state parks, forests, or monuments, officially designated wildlife sanctuaries, preserves, or refuges, Federal wilderness areas); and
- Passive mitigation measures considered (dikes, fire walls, blast walls, enclosures, other).

14.4 Documentation Required for Alternative Scenarios for Flammable Substances

For alternative scenarios involving flammable substances held above the threshold quantity in a Program 2 or Program 3 process, you will have to submit the following information. See the Risk Management Plan Data Elements Guide for complete instructions.

- Chemical name;
- Basis of results (OCA reference tables or modeling; name of the model used);
- Scenario (vapor cloud explosion, vapor cloud fire, BLEVE, pool fire, jet fire, other);
- Quantity released (pounds);
- Release rate (pounds per minute) (only for vapor cloud fires);
- Wind speed (meters per second) and stability class (only for vapor cloud fires; 3.0 meters per second and D stability if you use OCA guidance, otherwise use typical meteorological conditions at your site);
- Topography (rural, urban) (only for vapor cloud fires);
- Endpoint used (for vapor cloud explosions use 1 psi; for BLEVE, jet fire, pool fire, use 5 kw/m^2 for 40 seconds (or thermal dose equivalent to receive second degree burns); for vapor cloud fire use lower flammability limit);
- Distance to endpoint (miles);
- Population within distance (residential population rounded to two significant digits);
- Public receptors within the distance (schools, residences, hospitals, prisons, public recreation areas, major commercial or industrial areas);
- Environmental receptors within the distance (national or state parks, forests, or monuments, officially designated wildlife sanctuaries, preserves, or refuges, Federal wilderness areas);
- Passive mitigation measures considered (e.g., dikes, fire walls, blast walls, enclosures, other); and
- Active mitigation measures considered (e.g., sprinkler system, deluge system, water curtain, neutralization, excess flow valve, flares, scrubbers, emergency shutdown system, other).

APPENDIX A

PUBLICLY AVAILABLE MODELS AND REFERENCES FOR CALCULATION METHODS

This appendix provides information on some models that could be used for the offsite consequence analyses required under CAA section 112(r) and lists references that may provide useful information for modeling or calculation methods that could be used in the offsite consequence analyses. Exhibit A-1 summarizes information on some publicly available models. Exhibit A-2 lists references that provide information on consequence analysis methods. Neither of these exhibits is intended to be a complete listing of models or references that may be used in the consequence analysis; any appropriate model or method may be used.

Exhibit A-1
Summary of Several Public Domain Models

Identification	Description	Information on Acquiring Software
AIRTOX Modeling System Developed by ENSR	AIRTOX calculates concentrations of toxic or flammable chemicals for steady, instantaneous, or time-varying releases of volatile liquids or gases. A number of accompanying spreadsheet-based models are available for calculation of specific release profiles. AIRTOX has algorithms that address releases from various source configurations, including buoyant and heavier-than-air sources, jets, liquid pools, fires, and explosions. The model has been applied to offsite consequence assessments, response planning, and accident investigations.	**Address:** ENSR 35 Nagog Park Acton, MA 01720 **Phone:** 1-508-635-9500, ext. 3150 **Cost:** Dependent upon the modeling package selected; contact ENSR for information
ALOHA (Areal Locations of Hazardous Atmospheres) Developed by the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA)	ALOHA is an emergency response model, intended primarily for rapid deployment by responders as well as for use in emergency pre-planning. It incorporates source strength as well as Gaussian and heavy gas dispersion models and an extensive chemical library. Model output data is in both text and graphic form and includes a "footprint" plot of the area downwind of a release where concentrations may exceed a user-set threshold level. ALOHA can accept weather data transmitted from portable monitoring stations and can plot footprints on electronic maps displayed in a companion mapping application, MARPLOT™. ALOHA runs on a Macintosh or in Microsoft Windows.	**Address:** National Safety Council P.O. Box 558 Itasca, IL 60611 **Phone:** 1-800-621-7619 **Fax:** 1-708-285-0797 **Cost:** ALOHA: $215/Govt. & Non-profit $610/Commercial CAMEO MAC/ALOHA: $375/Govt. & Non-profit, $1050/Commercial
ARCHIE (Automated Resource for Chemical Hazard Incident Evaluation) Prepared for the Federal Emergency	ARCHIE estimates downwind dispersion of a chemical release to provide emergency planning personnel with the tools necessary to evaluate the nature and magnitude of chemical release threats at potentially hazardous sites. Includes methods to estimate the discharge rate and	**Contact/Address:** William Dorsey ARCHIE (DHM-15/Room 8104) U.S. Dept. of Transportation

Exhibit A-1 (continued)

Identification	Description	Information on Acquiring Software
Management Agency (FEMA), Department of Transportation (DOT), and Environmental Protection Agency (EPA)	duration of a gas or liquid release from a tank or pipeline, the size of a liquid pool, the rate at which a liquid pool will evaporate or boil, the overpressure and heat generated from explosions and fires, and the downwind chemical concentration and hazard zones.	400 7th St., SW Washington, DC 20590 **Phone:** (202)366-4900 **Cost:** Free
BP CIRRUS Developed by the Corporate Safety Services of British Petroleum, International	BP CIRRUS is a package of models to forecast the effects of a release of hydrocarbon or other chemical liquid or vapor. It is used for consequence modeling in relation to the design of new facilities, in risk assessment studies, and in developing emergency plans for currently operating facilities.	**HELPLINE** **Address:** Corporate Safety Services BP International Ltd. London **Phone:** (044) 71 920 3157 **Fax:** (044) 71 628 2709
DEGADIS (<u>De</u>nse <u>Gas</u> <u>Dis</u>persion) Developed by the United States Coast Guard	DEGADIS predicts contaminant movement for heavier-than-air gases for instantaneous and continuous ground level releases. It is used for emergency response planning and vulnerability analysis.	**Address:** National Technical Information Service (NTIS) 5285 Port Royal Rd. Springfield, VA 22161 **Phone:** (703)487-4600 **Cost:** $90 (Version 2.1) The FORTRAN source code for operation on a VAX or PC can be downloaded through the Support Center for Regulatory Air Models (SCRAM) Bulletin Board System, (919)541-5742.
HGSYSTEM Developed by the Industry Cooperative HF Mitigation / Assessment Program (20 companies from the chemical and petroleum	HGSYSTEM is a package of models for predicting the transient and steady-state release and dispersion behavior of hydrogen fluoride or ideal gases; incorporates the thermodynamic and cloud aerosol effects of hydrogen fluoride.	**Address:** Energy, Science & Technology Software Center P.O. Box 1020 Oak Ridge, TN 37831-1020 **Phone:** (615)576-2606

Exhibit A-1 (continued)

Identification	Description	Information on Acquiring Software
industries)		**Cost: $510**
SAFER System - **TRACE** and **SAFER Real-Time** System Developed by DuPont	TRACE can model ground level and elevated releases of dense, neutral, or buoyant gases and predict downwind chemical concentrations and impact on receptors. Methods are included to estimate the discharge rate and duration of releases from tanks or pipelines and size and evaporation rate of liquid pools. A high momentum jet model, special algorithms to model hydrogen fluoride and titanium tetrachloride, and models for a variety of fire and explosion scenarios are included. Output is presented in text and graphical forms. An optional enhancement allows in-depth evaluation of impact on population. SAFER Real-Time System is based on the same modeling algorithms as the TRACE model, but is designed for emergency preparedness and response activities. The model uses real-time meteorological data for modeling, has optional complex terrain modeling capabilities, and can interface with toxic gas sensors.	**Address:** DuPont SAFER Systems, Inc. 4165 E. Thousand Oaks Blvd., Suite 350 Westlake Village, CA 91362 **Phone:** (805) 446-2450 **FAX:** (805) 446-2470 **Cost:** TRACE (including Fire and Explosion models): $15,000 SAFER Real-Time System: $18,400
SLAB Developed by the Lawrence Livermore National Laboratory	SLAB is a dense gas model for various types of releases including a ground-level evaporating pool, an elevated horizontal jet, a stack or elevated vertical jet, and an instantaneous volume source; solves conservation equations of mass, momentum, energy, and species for continuous, finite duration, and instantaneous releases.	**Contact/Address:** BOWMAN Environmental Engineering, Inc. P.O. Box 59916 Dallas, TX 75229 **Phone:** (214)233-5463 FORTRAN version available on EPA Bulletin Board at no cost / (919)541-5742
TSCREEN Developed for EPA by Pacific Environmental Services, Inc.	TSCREEN is a model for screening toxic air pollutants to assist state and local agencies in analyzing toxic emissions and their subsequent dispersion from one of many different types of possible releases from Superfund sites. SCREEN, RVD, and PUFF are three air toxics	**Contact/Address:** Jawad Touma USEPA, OAQPS Maildrop 14 Research Triangle Park, NC 27711

Exhibit A-1 (continued)

Identification	Description	Information on Acquiring Software
	dispersion screening models imbedded within TSCREEN that are used to simulate the release and to calculate the dispersion characteristics and pollutant concentrations of the resulting plume.	**Phone:** (919)541-5381 TSCREEN can be acquired through the EPA Electronic Bulletin Board at no cost by means of a modem or via the Internet / (919)541-5742
WHAZAN II (World Bank Hazard Analysis) Developed by DNV Technica Ltd. and the World Bank	WHAZAN is a series of models to predict the consequences of accidental releases of toxic and flammable gases or liquids. The models provide information about outflow, behavior immediately after release, dispersion, and fires and explosion. WHAZAN includes a database containing the values of relevant properties for twenty hazardous chemicals.	**Contact/Address:** Mike Johnson DNV Technica Ltd. 40925 County Center Drive Suite 200 Temechula, CA 92591 **Phone:** (909)694-5790 **Cost:** $2500

Exhibit A-2
Selected References for Information on Consequence Analysis Methods

Center for Process Safety of the American Institute of Chemical Engineers (AIChE). *Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions. Flash Fires, and BLEVEs*. New York: AIChE, 1994.

Center for Process Safety of the American Institute of Chemical Engineers (AIChE). *Guidelines for Use of Vapor Cloud Dispersion Models*. New York: AIChE, 1987.

Center for Process Safety of the American Institute of Chemical Engineers (AIChE). *International Conference and Workshop on Modeling and Mitigating the Consequences of Accidental Releases of Hazardous Materials*, September 26-29, 1995. New York: AIChE, 1995.

Federal Emergency Management Agency, U.S. Department of Transportation, U.S. Environmental Protection Agency. *Handbook of Chemical Hazard Analysis Procedures*. 1989.

Madsen, Warren W. and Robert C. Wagner. "An Accurate Methodology for Modeling the Characteristics of Explosion Effects." *Process Safety Progress*, 13 (July 1994), 171-175.

Mercx, W.P.M., D.M. Johnson, and J. Puttock. "Validation of Scaling Techniques for Experimental Vapor Cloud Explosion Investigations." *Process Safety Progress*, 14 (April 1995), 120.

Mercx, W.P.M., R.M.M. van Wees, and G. Opschoor. "Current Research at TNO on Vapor Cloud Explosion Modelling." *Process Safety Progress*, 12 (October 1993), 222.

Prugh, Richard W. "Quantitative Evaluation of Fireball Hazards." *Process Safety Progress*, 13 (April 1994), 83-91.

Scheuermann, Klaus P. "Studies About the Influence of Turbulence on the Course of Explosions." *Process Safety Progress*, 13 (October 1994), 219.

TNO Bureau for Industrial Safety, Netherlands Organization for Applied Scientific Research. *Methods for the Calculation of the Physical Effects of the Escape of Dangerous Material (Liquids and Gases)*. Voorburg, the Netherlands: TNO (Commissioned by Directorate-General of Labour), 1980.

TNO Bureau for Industrial Safety, Netherlands Organization for Applied Scientific Research. *Methods for the Determination of Possible Damage to People and Objects Resulting from Releases of Hazardous Materials*. Rijswijk, the Netherlands: TNO (Commissioned by Directorate-General of Labour), 1992.

Touma, Jawad S., et al. "Performance Evaluation of Dense Gas Dispersion Models." *Journal of Applied Meteorology*, 34 (March 1995), 603-615.

U.S. Environmental Protection Agency, Federal Emergency Management Agency, U.S. Department of Transportation. *Technical Guidance for Hazards Analysis, Emergency Planning for Extremely Hazardous Substances*. December 1987.

U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*. EPA-450/4-88-009. September 1988.

U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. *Guidance on the Application of Refined Dispersion Models for Hazardous/Toxic Air Release*. EPA-454/R-93-002. May 1993.

U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxic Substances. *Flammable Gases and Liquids and Their Hazards*. EPA 744-R-94-002. February 1994.

APPENDIX B

TOXIC SUBSTANCES

B.1 Data for Toxic Substances

The exhibits in this section of Appendix B provide the data needed to carry out the calculations for regulated toxic substances using the methods presented in the text of this guidance. Exhibit B-1 presents data for toxic gases, Exhibit B-2 presents data for toxic gases, and Exhibit B-3 presents data for several toxic substances commonly found in water solution and for oleum.

Exhibit B-1
Data for Toxic Gases

CAS Number	Chemical Name	Molecular Weight	Ratio of Specific Heats	Toxic Endpoint		Liquid Factor Boiling (LFB)	Density Factor (Boiling)	Gas Factor (GF)	Reference Table (See Notes)
				Level (mg/L)	Basis				
7664-41-7	Ammonia (anhydrous)*	17.03	1.31	0.14	ERPG-2	0.073	0.71	14	Buoyant
7784-42-1	Arsine	77.95	1.28	0.0019	EHS-LOC (IDLH)	0.23	0.30	30	Dense
10294-34-5	Boron trichloride	117.17	1.15	0.010	EHS-LOC (Tox**)	0.22	0.36	36	Dense
7637-07-2	Boron trifluoride	67.81	1.20	0.028	EHS-LOC (IDLH)	0.25	0.31	28	Dense
7782-50-5	Chlorine	70.91	1.32	0.0087	ERPG-2	0.19	0.31	29	Dense
10049-04-4	Chlorine dioxide	67.45	1.25	0.0028	EHS-LOC equivalent (IDLH)†	0.15	0.30	28	Dense
506-77-4	Cyanogen chloride	61.47	1.22	0.030	EHS-LOC equivalent (Tox)†	0.14	0.41	26	Dense
19287-45-7	Diborane	27.67	1.17	0.0011	ERPG-2	0.13	1.13	17	Buoyant
75-21-8	Ethylene oxide	44.05	1.21	0.090	ERPG-2	0.12	0.55	22	Dense
7782-41-4	Fluorine	38.00	1.36	0.0039	EHS-LOC (IDLH)	0.35	0.32	22	Dense
50-00-0	Formaldehyde (anhydrous)*	30.03	1.31	0.012	ERPG-2	0.10	0.59	19	Dense
74-90-8	Hydrocyanic acid	27.03	1.30	0.011	ERPG-2	0.079	0.72	18	Buoyant
7647-01-0	Hydrogen chloride (anhydrous)*	36.46	1.40	0.030	ERPG-2	0.15	0.41	21	Dense
7664-39-3	Hydrogen fluoride (anhydrous)*	20.01	1.40	0.016	ERPG-2	0.066	0.51	16	Buoyant
7783-07-5	Hydrogen selenide	80.98	1.32	0.00066	EHS-LOC (IDLH)	0.21	0.25	31	Dense
7783-06-4	Hydrogen sulfide	34.08	1.32	0.042	ERPG-2	0.13	0.51	20	Dense
74-87-3	Methyl chloride	50.49	1.26	0.82	ERPG-2	0.14	0.48	24	Dense
74-93-1	Methyl mercaptan	48.11	1.20	0.049	ERPG-2	0.12	0.55	23	Dense
10102-43-9	Nitric oxide	30.01	1.38	0.031	EHS-LOC (TLV#)	0.21	0.38	19	Dense
75-44-5	Phosgene	98.92	1.17	0.00081	ERPG-2	0.20	0.35	33	Dense

Exhibit B-1 (continued)

CAS Number	Chemical Name	Molecular Weight	Ratio of Specific Heats	Toxic Endpoint		Liquid Factor Boiling (LFB)	Density Factor (Boiling)	Gas Factor (GF)	Reference Table (See Notes)
				Level (mg/L)	Basis				
7803-51-2	Phosphine	34.00	1.29	0.0035	ERPG-2	0.15	0.65	20	Dense
7446-09-5	Sulfur dioxide (anhydrous)	64.07	1.26	0.0078	ERPG-2	0.16	0.33	27	Dense
7783-60-0	Sulfur tetrafluoride	108.06	1.30	0.0092	EHS-LOC (Tox**)	0.25	0.25 (at -73°C)	36	Dense

Notes:

"Buoyant" in the Reference Table column refers to the tables for neutrally buoyant gases and vapors; "Dense" refers to the tables for dense gases and vapors. See Appendix D, Section D.4.3, for more information on the choice of reference tables.

* See Exhibit B-3 of this appendix for data on water solutions.

** LOC is based on the IDLH-equivalent level estimated from toxicity data.

† Not an EHS; LOC-equivalent value was estimated from one-tenth of the IDLH.

‡ Not an EHS; LOC-equivalent value was estimated from one-tenth of the IDLH-equivalent level estimated from toxicity data.

\# LOC based on Threshold Limit Value (TLV) - Time-weighted average (TWA) developed by the American Conference of Governmental Industrial Hygienists (ACGIH).

Exhibit B-2
Data for Toxic Liquids

CAS Number	Chemical Name	Molecular Weight	Vapor Pressure at 25° C (mm Hg)	Toxic Endpoint		Liquid Factors		Density Factor (DF)	Liquid Leak Factor (LLF)	Reference Table (See Notes)	
				Level (mg/L)	Basis	Ambient (LFA)	Boiling (LFB)			Worst Case	Alternative Case
107-02-8	Acrolein	56.06	274	0.0011	ERPG-2	0.047	0.12	0.58	40	Dense	Dense
107-13-1	Acrylonitrile	53.06	108	0.076	ERPG-2	0.018	0.11	0.61	39	Dense	Dense
814-68-6	Acrylyl chloride	90.51	110	0.00090	EHS-LOC (Tox[1])	0.026	0.15	0.44	54	Dense	Dense
107-18-6	Allyl alcohol	58.08	26.1	0.036	EHS-LOC (IDLH)	0.0046	0.11	0.58	41	Dense	Buoyant*
107-11-9	Allylamine	57.10	242	0.0032	EHS-LOC (Tox[1])	0.042	0.12	0.64	36	Dense	Dense
7784-34-1	Arsenous trichloride	181.28	10	0.01	EHS-LOC (Tox[1])	0.0037	0.21	0.23	100	Dense	Buoyant*
353-42-4	Boron trifluoride compound with methyl ether (1:1)	113.89	11	0.023	EHS-LOC (Tox[1])	0.0030	0.16	0.49	48	Dense	Buoyant*
7726-95-6	Bromine	159.81	212	0.0065	ERPG-2	0.073	0.23	0.16	150	Dense	Dense
75-15-0	Carbon disulfide	76.14	359	0.16	ERPG-2	0.075	0.15	0.39	60	Dense	Dense
67-66-3	Chloroform	119.38	196	0.49	EHS-LOC (IDLH)	0.055	0.19	0.33	71	Dense	Dense
542-88-1	Chloromethyl ether	114.96	29.4	0.00025	EHS-LOC (Tox[1])	0.0080	0.17	0.37	63	Dense	Dense
107-30-2	Chloromethyl methyl ether	80.51	199	0.0018	EHS-LOC (Tox[1])	0.043	0.15	0.46	51	Dense	Dense
4170-30-3	Crotonaldehyde	70.09	30.8	0.029	ERPG-2	0.0061	0.12	0.57	41	Dense	Buoyant*
123-73-9	Crotonaldehyde, (E)-	70.09	30.8	0.029	ERPG-2	0.0061	0.12	0.57	41	Dense	Buoyant*
108-91-8	Cyclohexylamine	99.18	10.1	0.16	EHS-LOC (Tox[1])	0.0025	0.14	0.56	41	Dense	Buoyant*
75-78-5	Dimethyldichlorosilane	129.06	141	0.026	ERPG-2	0.042	0.20	0.46	51	Dense	Dense
57-14-7	1,1-Dimethylhydrazine	60.10	157	0.012	EHS-LOC (IDLH)	0.028	0.12	0.62	38	Dense	Dense
106-89-8	Epichlorohydrin	92.53	16.5	0.076	ERPG-2	0.0039	0.14	0.41	56	Dense	Buoyant*
107-15-3	Ethylenediamine	60.10	12.2	0.49	EHS-LOC (IDLH)	0.0022	0.13	0.54	43	Dense	Buoyant*
151-56-4	Ethyleneimine	43.07	211	0.018	EHS-LOC (IDLH)	0.030	0.10	0.58	40	Dense	Dense
110-00-9	Furan	68.08	600	0.0012	EHS-LOC (Tox[1])	0.12	0.14	0.52	45	Dense	Dense
302-01-2	Hydrazine	32.05	14.4	0.011	EHS-LOC (IDLH)	0.0017	0.069	0.48	48	Buoyant*	Buoyant*
13463-40-6	Iron, pentacarbonyl-	195.90	40	0.00044	EHS-LOC (Tox[1])	0.016	0.24	0.33	70	Dense	Dense

Exhibit B-2 (continued)

CAS Number	Chemical Name	Molecular Weight	Vapor Pressure at 25° C (mm Hg)	Toxic Endpoint		Liquid Factors		Density Factor (DF)	Liquid Leak Factor (LLF)	Reference Table (See Notes)	
				Level (mg/L)	Basis	Ambient (LFA)	Boiling (LFB)			Worst Case	Alternative Case
78-82-0	Isobutyronitrile	69.11	32.7	0.14	ERPG-2	0.064	0.12	0.63	37	Dense	Buoyant*
108-23-6	Isopropyl chloroformate	122.55	28	0.10	EHS-LOC (Tox†)	0.080	0.17	0.45	52	Dense	Dense
126-98-7	Methacrylonitrile	67.09	71.2	0.0027	EHS-LOC (TLV#)	0.014	0.12	0.61	38	Dense	Dense
79-22-1	Methyl chloroformate	94.50	108	0.0019	EHS-LOC (Tox†)	0.026	0.16	0.40	58	Dense	Dense
60-34-4	Methyl hydrazine	46.07	49.6	0.0094	EHS-LOC (IDLH)	0.0074	0.094	0.56	42	Dense	Buoyant*
624-83-9	Methyl isocyanate	57.05	457	0.0012	ERPG-2	0.079	0.13	0.52	45	Dense	Dense
556-64-9	Methyl thiocyanate	73.12	10	0.085	EHS-LOC (Tox†)	0.0020	0.11	0.45	51	Dense	Buoyant*
75-79-6	Methyltrichlorosilane	149.48	173	0.018	ERPG-2	0.057	0.22	0.38	61	Dense	Dense
13463-39-3	Nickel carbonyl	170.73	400	0.00067	EHS-LOC (Tox†)	0.14	0.26	0.37	63	Dense	Dense
7697-37-2	Nitric acid (100%)**	63.01	63.0	0.026	EHS-LOC (IDLH)	0.012	0.12	0.32	73	Dense	Dense
79-21-0	Peracetic acid	76.05	14.4	0.0045	EHS-LOC (Tox†)	0.0030	0.12	0.42	55	Dense	Buoyant*
594-42-3	Perchloromethylmercaptan	185.87	6	0.0076	EHS-LOC (IDLH)	0.0023	0.20	0.29	81	Dense	Buoyant*
10025-87-3	Phosphorus oxychloride	153.33	35.8	0.0030	EHS-LOC (Tox†)	0.012	0.20	0.29	80	Dense	Dense
7719-12-2	Phosphorus trichloride	137.33	120	0.028	EHS-LOC (IDLH)	0.037	0.20	0.31	75	Dense	Dense
110-89-4	Piperidine	85.15	32.1	0.022	EHS-LOC (Tox†)	0.072	0.13	0.57	41	Dense	Buoyant*
107-12-0	Propionitrile	55.08	47.3	0.0037	EHS-LOC (Tox†)	0.080	0.10	0.63	37	Dense	Buoyant*
109-61-5	Propyl chloroformate	122.56	20.0	0.010	EHS-LOC (Tox†	0.0058	0.17	0.45	52	Dense	Buoyant*
75-55-8	Propyleneimine	57.10	533	0.12	EHS-LOC (IDLH)	0.032	0.12	0.61	39	Dense	Dense
75-56-9	Propylene oxide	58.08	187	0.59	ERPG-2	0.093	0.13	0.59	40	Dense	Dense
7446-11-9	Sulfur trioxide	80.06	263	0.010	ERPG-2	0.057	0.15	0.26	91	Dense	Dense
75-74-1	Tetramethyllead	267.33	22.5	0.0040	EHS-LOC (IDLH)	0.011	0.29	0.24	96	Dense	Dense
509-14-8	Tetranitromethane	196.04	13	0.0040	EHS-LOC (IDLH)	0.051	0.22	0.30	78	Dense	Buoyant*
7550-45-0	Titanium tetrachloride	189.69	12.4	0.020	ERPG-2	0.0048	0.21	0.28	82	Dense	Buoyant*
584-84-9	Toluene 2,4-diisocyanate	174.16	0.013	0.0070	EHS-LOC (IDLH)	0.000005	0.16	0.40	59	Buoyant*	Buoyant*
91-08-7	Toluene 2,6-diisocyanate	174.16	0.05	0.0070	EHS-LOC (IDLH†)	0.000018	0.16	0.40	59	Buoyant*	Buoyant*

Exhibit B-2 (continued)

CAS Number	Chemical Name	Molecular Weight	Vapor Pressure at 25° C (mm Hg)	Toxic Endpoint		Liquid Factors		Density Factor (DF)	Liquid Leak Factor (LLF)	Reference Table (See Notes)	
				Level (mg/L)	Basis	Ambient (LFA)	Boiling (LFB)			Worst Case	Alternative Case
26471-62-5	Toluene diisocyanate (unspecified isomer)	174.16	0.013	0.0070	EHS-LOC equivalent (IDLH‡)	0.000005	0.16	0.40	59	Buoyant*	Buoyant*
75-77-4	Trimethylchlorosilane	108.64	231	0.050	EHS-LOC (Tox†)	0.061	0.18	0.57	41	Dense	Dense
108-05-4	Vinyl acetate monomer	86.09	114	0.26	ERPG-2	0.026	0.15	0.52	45	Dense	Dense

Notes:

"Buoyant" in the Reference Table column refers to the tables for neutrally buoyant gases and vapors; "Dense" refers to the tables for dense gases and vapors. See Appendix D, Section D.4.3, for more information on the choice of reference tables.

* Use dense gas table if substance is at an elevated temperature.

** See Exhibit B-3 of this appendix for data on water solutions.

† LOC is based on IDLH-equivalent level estimated from toxicity data.

‡ LOC for this isomer is based on IDLH for toluene 2,4-diisocyanate.

' Not an EHS; LOC-equivalent value is based on IDLH for toluene 2,4-diisocyanate.

\# LOC based on Threshold Limit Value (TLV) - Time-weighted average (TWA) developed by the American Conference of Governmental Industrial Hygienists (ACGIH).

Exhibit B-3
Data for Water Solutions of Toxic Substances and for Oleum Average Vapor Pressure and Liquid Factors Over 10 Minutes for Wind Speeds of 1.5 and 3.0 Meters per Second (m/s)

CAS Number	Regulated Substance in Solution	Molecular Weight	Toxic Endpoint		Initial Concentration (Wt %)	10-minute Average Vapor Pressure (mm Hg)		Liquid Factor at 25° C (LFA)		Density Factor (DF)	Reference Table (See Notes)	
			Level (mg/L)	Basis		Wind Speed 1.5 m/sec	Wind Speed 3.0 m/s	Wind Speed 1.5 m/sec	Wind Speed 3.0 m/s		Worst Case	Alternative Case
7664-41-7	Ammonia	17.03	0.14	ERPG-2	30	332	248	0.026	0.019	0.55	Buoyant	Buoyant
					24	241	184	0.019	0.014	0.54	Buoyant	Buoyant
					20	290	148	0.015	0.011	0.53	Buoyant	Buoyant
50-00-0	Formaldehyde	30.027	0.012	ERPG-2	37	1.5	1.4	0.0002	0.0002	0.44	Buoyant	Buoyant
7647-01-0	Hydrochloric acid	36.46	0.030	ERPG-2	38	78	55	0.010	0.0070	0.41	Dense	Buoyant
					37	67	48	0.0085	0.0062	0.42	Dense	Buoyant
					36	56	42	0.0072	0.0053	0.42	Dense	Buoyant
					34	38	29	0.0048	0.0037	0.42	Dense	Buoyant
					30	13	12	0.0016	0.0015	0.42	Buoyant	Buoyant
7664-39-3	Hydrofluoric acid	20.01	0.016	ERPG-2	70	124	107	0.011	0.010	0.39	Buoyant	Buoyant
					50	16	15	0.0014	0.0013	0.41	Buoyant	Buoyant
7697-37-2	Nitric acid	63.01	0.026	EHS-LOC (IDLH)	90	25	22	0.0046	0.0040	0.33	Dense	Buoyant
					85	17	16	0.0032	0.0029	0.33	Dense	Buoyant
					80	10.2	10	0.0019	0.0018	0.33	Dense	Buoyant
8014-95-7	Oleum - based on sulfur trioxide (SO_3)	80.06 (SO_3)	0.010	ERPG-2	30 (SO_3)	3.5 (SO_3)	3.4 (SO_3)	0.0008	0.0007	0.25	Buoyant	Buoyant

Notes:

"Buoyant" in the Reference Table column refers to the tables for neutrally buoyant gases and vapors; "Dense" refers to the tables for dense gases and vapors. See Appendix D, Section D.4.3, for more information on the choice of reference tables.

B.2. Mixtures Containing Toxic Liquids

In case of a spill of a liquid mixture containing a regulated toxic substance (with the exception of common water solutions, discussed in Section 3.3 in the text), the area of the pool formed by the entire liquid spill is determined as described in Section 3.2.2 or 3.2.3. For the area determination, if the density of the mixture is unknown, the density of the regulated substance in the mixture may be assumed as the density of the entire mixture.

If the partial vapor pressure of the regulated substance in the mixture is known, that vapor pressure may be used to derive a release rate using the equations in Section 3.2. If the partial vapor pressure of the regulated toxic substance in the mixture is unknown, it may be estimated from the vapor pressure of the pure substance (listed in Exhibit B-2, Appendix B) and the concentration in the mixture, if you assume the mixture is an ideal solution (an ideal solution is one in which there is complete uniformity of cohesive forces). Use the following steps, based on Raoult's Law for ideal solutions:

- Determine the mole fraction of the regulated substance in the mixture.
  - -- The mole fraction of the regulated substance in the mixture is the number of moles of the regulated substance in the mixture divided by the total number of moles of all substances in the mixture.
  - -- If the molar concentration (moles per liter) of each component of the mixture is known, the mole fraction may be determined as follows:

$$X_r = \frac{M_r \times V_t}{(M_r \times V_t) + (M_x \times V_t) + (M_n \times V_t)} \tag{B-1}$$

or

$$X_r = \frac{M_r}{M_r + M_x + M_n} \tag{B-2}$$

where:

X_r	=	Mole fraction of the regulated substance in the mixture (unitless)
M_r	=	Molar concentration of the regulated substance in the mixture (moles per liter)
V_t	=	Total volume of mixture (liters)
M_x	=	Molar concentration of second component of the mixture (moles per liter)
M_n	=	Molar concentration of any other components of the mixture (moles per liter)

  - -- If the weight of each of the components of the mixture is known, the mole fraction of the regulated substance in the mixture may be calculated as follows:

$$X_r = \frac{\left(\frac{W_r}{MW_r}\right)}{\left(\frac{W_r}{MW_r}\right) - \left(\frac{W_x}{MW_x}\right) - \left(\frac{W_n}{MW_n}\right)} \qquad \textbf{(B-3)}$$

where: X_r = Mole fraction of the regulated substance
W_r = Weight of the regulated substance
MW_r = Molecular weight of the regulated substance
W_x = Weight of the second component of the mixture
MW_x = Molecular weight of the second component of the mixture
W_n = Weight of any other component of the mixture
MW_n = Molecular weight of any other component of the mixture
(Weights can be in any consistent units)

- Estimate the partial vapor pressure of the regulated substance in the mixture as follows:

$$VP_m = X_r \; x \; VP_p \qquad \textbf{(B-4)}$$

where: VP_m = Partial vapor pressure of the regulated substance in the mixture (millimeters of mercury (mm Hg))
X_r = Mole fraction of the regulated substance (unitless)
VP_p = Vapor pressure of the regulated substance in pure form at the same temperature as the mixture (mm Hg) (vapor pressure at 25° C is given in Exhibit B-1, Appendix B)

The evaporation rate for the regulated substance in the mixture is determined as for pure substances, with VP_m as the vapor pressure. If the mixture contains more than one regulated toxic substance, carry out the analysis individually for each of the regulated components. The release rate equation is:

$$QR = \frac{0.0035 \; x \; U^{0.78} \; MW^{2/3} \; x \; A \; x \; VP}{T} \qquad \textbf{(B-5)}$$

where: QR = Evaporation rate (pounds per minute)
U = Wind speed (meters per second)
MW = Molecular weight (given in Exhibit B-2, Appendix B)
A = Surface area of pool formed by the entire quantity of the mixture (square feet) (determined as described in 3.2.2)
VP = Vapor pressure (mm Hg) (VP_m from Equation B-4 above)
T = Temperature (Kelvin (K); temperature in ° C plus 273, or 298 for 25° C)

Worst-case consequence distances to the toxic endpoint may be estimated from the release rate using the tables and instructions presented in Section 4.

APPENDIX C

FLAMMABLE SUBSTANCES

C.1 Equation for Estimation of Distance to 1 psi Overpressure for Vapor Cloud Explosions

For a worst-case release of flammable gases and volatile flammable liquids, the release rate is not considered. The total quantity of the flammable substance is assumed to form a vapor cloud. The entire contents of the cloud is assumed to be within the flammability limits, and the cloud is assumed to explode. For the worst-case, analysis, 10 percent of the flammable vapor in the cloud is assumed to participate in the explosion (i.e., the yield factor is 0.10). Consequence distances to an overpressure level of 1 pound per square inch (psi) may be determined using the following equation, which is based on the TNT-equivalency method:

$$D = 17 x \left(0.1 x W_f x \frac{HC_f}{HC_{TNT}}\right)^{1/3} \qquad \textbf{(C-1)}$$

where: D = Distance to overpressure of 1 psi (meters)
W_f = Weight of flammable substance (kilograms or pounds/2.2)
HC_f = Heat of combustion of flammable substance (kilojoules per kilogram) (listed in Appendix C)
HC_{TNT}=Heat of combustion of trinitrotoluene (TNT) (4,680 kilojoules per kilogram)

The factor 17 is a constant for damages associated with 1.0 psi overpressures. The factor 0.1 represents an explosion efficiency of 10 percent. To convert distances from meters to miles, multiply by 0.00062.

C.2 Mixtures of Flammable Substances

For a mixture of flammable substances, you may estimate the heat of combustion of the mixture from the heats of combustion of the components of the mixture using the equation below and then use the equation given in the previous section of this appendix to determine the vapor cloud explosion distance. The heat of combustion of the mixture may be estimated as follows:

$$HC_m = \frac{W_x}{W_m} x HC_x + \frac{W_y}{W_m} x HC_y \qquad \textbf{(C-2)}$$

where: HC_m = Heat of combustion of mixture (kilojoules per kilogram)
W_x = Weight of component "X" in mixture (kilograms or pounds/2.2)
W_m = Total weight of mixture (kilograms or pounds/2.2)
HC_x = Heat of combustion of component "X" (kilojoules per kilogram)
W_y = Weight of component "Y" in mixture (kilograms or pounds/2.2)
HC_y = Heat of combustion of component "Y" (kilojoules per kilogram)

Heats of combustion for regulated flammable substances are listed in Exhibit B-1 in Exhibit C-1 in the next section (Section C.3) of this appendix.

C.3 Data for Flammable Substances

The exhibits in this section of Appendix C provide the data needed to carry out the calculations for regulated flammable substances using the methods presented in the text of this guidance. Exhibit C-1 presents heat of combustion data for all regulated flammable substances. Exhibit C-2 presents additional data for flammable gases, and Exhibit C-3 presents additional data for flammable liquids.

Exhibit C-1
Heats of Combustion for Flammable Substances

CAS No.	Chemical Name	Physical State at 25° C	Heat of Combustion (kjoule/kg)
75-07-0	Acetaldehyde	Gas	25,072
74-86-2	Acetylene [Ethyne]	Gas	48,222
598-73-2	Bromotrifluoroethylene [Ethene, bromotrifluoro-]	Gas	1,967
106-99-0	1,3-Butadiene	Gas	44,548
106-97-8	Butane	Gas	45,719
25167-67-3	Butene	Gas	45,200*
590-18-1	2-Butene-cis	Gas	45,171
624-64-6	2-Butene-trans [2-Butene, (E)]	Gas	45,069
106-98-9	1-Butene	Gas	45,292
107-01-7	2-Butene	Gas	45,100*
463-58-1	Carbon oxysulfide [Carbon oxide sulfide (COS)]	Gas	9,126
7791-21-1	Chlorine monoxide [Chlorine oxide]	Gas	1,011*
590-21-6	1-Chloropropylene [1-Propene, 1-chloro-]	Liquid	23,000*
557-98-2	2-Chloropropylene [1-Propene, 2-chloro-]	Gas	22,999
460-19-5	Cyanogen [Ethanedinitrile]	Gas	21,064
75-19-4	Cyclopropane	Gas	46,560
4109-96-0	Dichlorosilane [Silane, dichloro-]	Gas	8,225
75-37-6	Difluoroethane [Ethane, 1,1-difluoro-]	Gas	11,484
124-40-3	Dimethylamine [Methanamine, N-methyl-]	Gas	35,813
463-82-1	2,2-Dimethylpropane [Propane, 2,2-dimethyl-]	Gas	45,051
74-84-0	Ethane	Gas	47,509
107-00-6	Ethyl acetylene [1-Butyne]	Gas	45,565
75-04-7	Ethylamine [Ethanamine]	Gas	35,210
75-00-3	Ethyl chloride [Ethane, chloro-]	Gas	19,917
74-85-1	Ethylene [Ethene]	Gas	47,145
60-29-7	Ethyl ether [Ethane, 1,1'-oxybis-]	Liquid	33,775

Exhibit C-1 (continued)

CAS No.	Chemical Name	Physical State at 25° C	Heat of Combustion (kjoule/kg)
75-08-1	Ethyl mercaptan [Ethanethiol]	Liquid	27,948
109-95-5	Ethyl nitrite [Nitrous acid, ethyl ester]	Gas	18,000
1333-74-0	Hydrogen	Gas	119,950
75-28-5	Isobutane [Propane, 2-methyl]	Gas	45,576
78-78-4	Isopentane [Butane, 2-methyl-]	Liquid	44,911
78-79-5	Isoprene [1,3-Butadiene, 2-methyl-]	Liquid	43,809
75-31-0	Isopropylamine [2-Propanamine]	Liquid	36,484
75-29-6	Isopropyl chloride [Propane, 2-chloro-]	Liquid	23,720
74-82-8	Methane	Gas	50,029
74-89-5	Methylamine [Methanamine]	Gas	31,396
563-45-1	3-Methyl-1-butene	Gas	44,559
563-46-2	2-Methyl-1-butene	Liquid	44,414
115-10-6	Methyl ether [Methane, oxybis-]	Gas	28,835
107-31-3	Methyl formate [Formic acid, methyl ester]	Liquid	15,335
115-11-7	2-Methylpropene [1-Propene, 2-methyl-]	Gas	44,985
504-60-9	1,3-Pentadiene	Gas	43,510*
109-66-0	Pentane	Liquid	44,697
109-67-1	1-Pentene	Liquid	44,625
646-04-8	2-Pentene, (E)-	Liquid	44,458
627-20-3	2-Pentene, (Z)-	Liquid	44,520
463-49-0	Propadiene [1,2-Propadiene]	Gas	46,332
74-98-6	Propane	Gas	46,333
115-07-1	Propylene [1-Propene]	Gas	45,762
74-99-7	Propyne [1-Propyne]	Gas	46,165
7803-62-5	Silane	Gas	44,307
116-14-3	Tetrafluoroethylene [Ethene, tetrafluoro-]	Gas	1,280
75-76-3	Tetramethylsilane [Silane, tetramethyl-]	Liquid	41,712
10025-78-2	Trichlorosilane [Silane, trichloro-]	Liquid	3,754

Exhibit C-1 (continued)

CAS No.	Chemical Name	Physical State at 25° C	Heat of Combustion (kjoule/kg)
79-38-9	Trifluorochloroethylene [Ethene, chlorotrifluoro-]	Gas	1,837
75-50-3	Trimethylamine [Methanamine, N,N-dimethyl-]	Gas	37,978
689-97-4	Vinyl acetylene [1-Buten-3-yne]	Gas	45,357
75-01-4	Vinyl chloride [Ethene, chloro-]	Gas	18,848
109-92-2	Vinyl ethyl ether [Ethene, ethoxy-]	Liquid	32,909
75-02-5	Vinyl fluoride [Ethene, fluoro-]	Gas	2,194
75-35-4	Vinylidene chloride [Ethene, 1,1-dichloro-]	Liquid	10,354
75-38-7	Vinylidene fluoride [Ethene, 1,1-difluoro-]	Gas	10,807
107-25-5	Vinyl methyl ether [Ethene, methoxy-]	Gas	30,549

* Estimated heat of combustion

Exhibit C-2
Data for Flammable Gases

CAS Number	Chemical Name	Molecular Weight	Ratio of Specific Heats	Flammability Limits (Vol %)		LFL (mg/L)	Gas Factor (GF)	Reference Table (See Notes)	Pool Fire Factor (PFF)	Flash Fraction Factor (FFF)[‡]
				Lower (LFL)	Upper (UFL)					
75-07-0	Acetaldehyde	44.05	1.18	4.0	60.0	72	22	Dense	2.7	0.018
74-86-2	Acetylene	26.04	1.23	2.5	80.0	27	17	Buoyant	4.8	0.23
598-73-2	Bromotrifluoroethylene	160.92	1.11	•	37.0	•	41*	Dense	0.42	0.15
106-99-0	1,3-Butadiene	54.09	1.12	2.0	11.5	44	24	Dense	5.5	0.15
106-97-8	Butane	58.12	1.09	1.5	9.0	36	25	Dense	5.9	0.15
25167-67-3	Butene	56.11	1.10	1.7	9.5	39	24	Dense	5.6	0.14
590-18-1	2-Butene-cis	56.11	1.12	1.6	9.7	37	24	Dense	5.6	0.11
624-64-6	2-Butene-trans	56.11	1.11	1.8	9.7	41	24	Dense	5.6	0.12
106-98-9	1-Butene	56.11	1.11	1.6	9.3	37	24	Dense	5.7	0.17
107-01-7	2-Butene	56.11	1.10	1.7	9.7	39	24	Dense	5.6	0.12
463-58-1	Carbon oxysulfide	60.08	1.25	12.0	29.0	290	26	Dense	1.3	0.29
7791-21-1	Chlorine monoxide	86.91	1.21	23.5	NA	830	31	Dense	0.15	NA
557-98-2	2-Chloropropylene	76.53	1.12	4.5	16.0	140	29	Dense	3.3	0.011
460-19-5	Cyanogen	52.04	1.17	6.0	32.0	130	24	Dense	2.5	0.40
75-19-4	Cyclopropane	42.08	1.18	2.4	10.4	41	22	Dense	5.4	0.21
4109-96-0	Dichlorosilane	101.01	1.16	4.0	96.0	160	33	Dense	1.3	0.084
75-37-6	Difluoroethane	66.05	1.14	3.7	18.0	100	27	Dense	1.6	0.23
124-40-3	Dimethylamine	45.08	1.14	2.8	14.4	52	22	Dense	3.7	0.089
463-82-1	2,2-Dimethylpropane	72.15	1.07	1.4	7.5	41	27	Dense	6.4	0.11
74-84-0	Ethane	30.07	1.19	2.9	13.0	36	18	Dense	5.4	0.75
107-00-6	Ethyl acetylene	54.09	1.11	2.0	32.9	44	24	Dense	5.4	0.091
75-04-7	Ethylamine	45.08	1.13	3.5	14.0	64	22	Dense	3.6	0.040

Exhibit C-2 (continued)

CAS Number	Chemical Name	Molecular Weight	Ratio of Specific Heats	Flammability Limits (Vol %)		LFL (mg/L)	Gas Factor (GF)	Reference Table (See Notes)	Pool Fire Factor (PFF)	Flash Fraction Factor (FFF)‡
				Lower (LFL)	Upper (UFL)					
75-00-3	Ethyl chloride	64.51	1.15	3.8	15.4	100	27	Dense	2.6	0.053
74-85-1	Ethylene	28.05	1.24	2.7	36.0	31	18	Buoyant	5.4	0.63
109-95-5	Ethyl nitrite	75.07	1.30	4.0	50.0	120	30	Dense	2.0	NA
1333-74-0	Hydrogen	2.02	1.41	4.0	75.0	3.3	5.0	**	†	NA
75-28-5	Isobutane	58.12	1.09	1.8	8.4	43	25	Dense	6.0	0.23
74-82-8	Methane	16.04	1.30	5.0	15.0	33	14	Buoyant	5.6	0.87
74-89-5	Methylamine	31.06	1.19	4.9	20.7	62	19	Dense	2.7	0.12
563-45-1	3-Methyl-1-butene	70.13	1.08	1.5	9.1	43	26	Dense	6.0	0.030
115-10-6	Methyl ether	46.07	1.15	3.3	27.3	64	22	Dense	3.4	0.22
115-11-7	2-Methylpropene	56.11	1.10	1.8	8.8	41	24	Dense	5.7	0.18
504-60-9	1,3-Pentadiene	68.12	1.30	2.0	NA	56	28	Dense	NA	NA
463-49-0	Propadiene	40.07	1.16	2.1	2.1	34	21	Dense	5.2	0.20
74-98-6	Propane	44.10	1.13	2.0	9.5	36	22	Dense	5.7	0.38
115-07-1	Propylene	42.08	1.15	2.0	11.0	34	21	Dense	5.5	0.35
74-99-7	Propyne	40.07	1.16	1.7	39.9	28	21	Dense	4.9	0.18
7803-62-5	Silane	32.12	1.24	*	*	*	19*	Dense	5.7	0.41
116-14-3	Tetrafluoroethylene	100.02	1.12	11.0	60.0	450	33	Dense	0.25	0.55
79-38-9	Trifluorochloroethylene	116.47	1.11	8.4	38.7	400	35	Dense	0.34	0.27
75-50-3	Trimethylamine	59.11	1.10	2.0	11.6	48	25	Dense	4.8	0.12
689-97-4	Vinyl acetylene	52.08	1.13	2.2	31.7	47	24	Dense	5.4	0.086
75-01-4	Vinyl chloride	62.50	1.18	3.6	33.0	92	26	Dense	2.4	0.14
75-02-5	Vinyl fluoride	46.04	1.20	2.6	21.7	49	23	Dense	0.28	0.41
75-38-7	Vinylidene fluoride	64.04	1.16	5.5	21.3	140	27	Dense	1.8	0.50
107-25-5	Vinyl methyl ether	58.08	1.12	2.6	39.0	62	25	Dense	3.7	0.093

Exhibit C-2 (continued)

Notes

"Buoyant" in the Reference Table column refers to the tables for neutrally buoyant gases and vapors; "Dense" refers to the tables for dense gases and vapors. See Appendix D, Section D.4.3, for more information on the choice of reference tables.

NA: Data not available

* Reported to be spontaneously combustible; estimation of dispersion distance to LFL not appropriate.

** Much lighter than air; table of distances for neutrally buoyant gases not appropriate.

† Pool fire unlikely.

‡ Calculated at 298 K (25° C) with the following exceptions:

Acetylene factor at 250 K as reported in TNO, *Methods for the Calculation of the Physical Effects of the Escape of Dangerous Material* (1980).
Ethylene factor calculated at critical temperature, 282 K.
Methane factor calculated at critical temperature, 191 K.
Silane factor calculated at critical temperature, 270 K.

Exhibit C-3
Data for Flammable Liquids

CAS Number	Chemical Name	Molecular Weight	Flammability Limit (Vol%)		LFL (mg/L)	Liquid Factors		Density Factor	Liquid Leak Factor (LLF)	Reference Table	Pool Fire Factor (PFF)
			Lower (LFL)	Upper (UFL)		Ambient (LFA)	Boiling (LFB)				
590-21-6	1-Chloropropylene	76.53	4.5	16.0	140	0.17	0.15	0.52	45	Dense	3.2
60-29-7	Ethyl ether	74.12	1.9	48.0	57	0.11	0.15	0.69	34	Dense	4.3
75-08-1	Ethyl mercaptan	62.14	2.8	18.0	71	0.10	0.13	0.58	40	Dense	3.3
78-78-4	Isopentane	72.15	1.4	7.6	41	0.14	0.15	0.79	30	Dense	6.1
78-79-5	Isoprene	68.12	2.0	9.0	56	0.11	0.14	0.72	32	Dense	5.5
75-31-0	Isopropylamine	59.11	2.0	10.4	48	0.10	0.13	0.71	33	Dense	4.1
75-29-6	Isopropyl chloride	78.54	2.8	10.7	90	0.11	0.16	0.57	41	Dense	3.1
563-46-2	2-Methyl-1-butene	70.13	1.4	9.6	40	0.12	0.15	0.75	31	Dense	5.8
107-31-3	Methyl formate	60.05	5.9	20.0	140	0.10	0.13	0.50	46	Dense	1.8
109-66-0	Pentane	72.15	1.3	8.0	38	0.10	0.15	0.78	30	Dense	5.8
109-67-1	1-Pentene	70.13	1.5	8.7	43	0.13	0.15	0.77	31	Dense	5.8
646-04-8	2-Pentene, (E)-	70.13	1.4	10.6	40	0.10	0.15	0.76	31	Dense	5.6
627-20-3	2-Pentene, (Z)-	70.13	1.4	10.6	40	0.10	0.15	0.75	31	Dense	5.6
75-76-3	Tetramethylsilane	88.23	1.5	NA	54	0.17	0.17	0.59	40	Dense	6.3
10025-78-2	Trichlorosilane	135.45	1.2	90.5	66	0.18	0.23	0.37	64	Dense	0.68
109-92-2	Vinyl ethyl ether	72.11	1.7	28.0	50	0.10	0.15	0.65	36	Dense	4.2
75-35-4	Vinylidene chloride	96.94	7.3	NA	290	0.15	0.18	0.44	54	Dense	1.6

NA: Data not available

APPENDIX D

TECHNICAL BACKGROUND

D.1 Worst-Case Release Rate for Gases

D.1.1 Unmitigated Release

The assumption that the total quantity of gas is released in 10 minutes is the same assumption used in EPA's *Technical Guidance for Hazards Analysis* (1987).

D.1.2 Gaseous Release Inside Building

The mitigation factor for gaseous release inside a building is based on a document entitled "Risk Mitigation in Land Use Planning: Indoor Releases of Toxic Gases" by S.R. Porter. This paper presented three release scenarios and discussed the mitigating effects that would occur in a building with a volume of 1,000 cubic meters at three different building air exchange rates. There is a concern that a building may not be able to withstand the pressures of a very large release. However, this paper indicated that release rates of at least 2,000 pounds per minute could be withstood by a building.

Analyzing the data in this paper several ways, the value of 55 percent emerged as representing the mitigation that could occur for a release scenario into a building. Data are provided on the maximum release rate in a building and the maximum release rate from a building. Making this direct comparison at the lower maximum release rate (3.36 kg/s) gave a release rate from the building of 55 percent of the release rate into the building. Using information provided on another maximum release rate (10.9 kg/min) and accounting for the time for the release to accumulate in the building, approximately 55 percent emerged again.

The choice of building ventilation rates affects the results. The paper presented mitigation for three different ventilation rates, 0.5, 3, and 10 air changes per hour. A ventilation rate of 0.5 changes per hour is typical for buildings designed to house toxic gases; therefore, EPA decided that this ventilation rate was appropriate for this analysis. A release factor of 55 percent serves as a conservative value to use in the event of a gaseous release which does not destroy the building into which it is released.

D.2 Worst-Case Release Rate for Liquids

D.2.1 Evaporation Rate Equation

The equation for estimating the evaporation rate of a liquid from a pool is from the *Technical Guidance for Hazards Analysis*, Appendix G. The same assumptions are made for determination of maximum pool area (i.e., the pool is assumed to be 1 centimeter (0.033 feet) deep). The evaporation rate equation has been modified to include a different mass transfer coefficient for water, the reference compound. For this document, a value of 0.67 centimeters per second is used as the mass transfer coefficient, instead of the value of 0.24 cited in the *Technical Guidance for Hazards Analysis*. The value of 0.67 is based on Donald MacKay and Ronald S. Matsugu, "Evaporation Rates of Liquid Hydrocarbon Spills on Land and Water," *Canadian Journal of Chemical Engineering*, August 1973, p. 434. The evaporation equation becomes:

$$QR = \frac{0.284 \times U^{0.78} \times MW^{\frac{2}{3}} \times A \times VP}{82.05 \times T} \qquad \textbf{(D-1)}$$

where: QR = Evaporation rate (pounds per minute)
U = Wind speed (meters per second)
MW = Molecular weight (given in Exhibit B-2, Appendix B)
A = Surface area of pool formed by the entire quantity of the mixture (square feet) (determined as described in 3.2.2)
VP = Vapor pressure (mm Hg) (VP_m from Equation B-4 above)
T = Temperature (Kelvin (K); temperature in ° C plus 273, or 298 for 25° C)

D.2.2 Factors for Evaporation Rate Estimates

Liquid Factors. The liquid factors, Liquid Factor Ambient (LFA) and Liquid Factor Boiling (LFB) used to estimate the evaporation rate from a liquid pool (see Section 3.2 of this guidance document), are derived as described in the *Technical Guidance for Hazards Analysis*, Appendix G, with the following differences:

- The mass transfer coefficient of water is assumed to be 0.67, as discussed above; the value of the factor that includes conversion factors, the mass transfer coefficient for water, and the molecular weight of water to the one-third power, given as 0.106 in the *Technical Guidance* is 0.284 in this guidance.

- Density of all substances was assumed to be the density of water in the *Technical Guidance*; the density was included in the liquid factors. For this guidance document, density is not included in the LFA and LFB values presented in the tables; instead, a separate Density Factor (DF) (discussed below) is provided to be used in the evaporation rate estimation.

With these modifications, the LFA is:

$$LFA = \frac{0.284 \times MW^{\frac{2}{3}} \times VP}{82.05 \times 298} \qquad \textbf{(D-2)}$$

where: MW = Molecular weight
VP = Vapor pressure at ambient temperature in millimeters of mercury
298 K (25° C) = Ambient temperature

LFB is:

$$LFB = \frac{0.284 \times MW^{\frac{2}{3}} \times 760}{82.05 \times BP} \qquad \textbf{(D-3)}$$

where: MW = Molecular weight
760 = Vapor pressure at boiling temperature (millimeters of mercury (mm Hg))
BP = Boiling point (K)

Density Factor. Because some of the regulated liquids have densities very different from that of water, the density of each substance was used to develop a Density Factor (DF) for the determination of maximum pool area for the evaporation rate estimation. The density factor is:

$$DF = \frac{1}{d \times 0.033} \qquad \textbf{(D-4)}$$

where: DF = Density factor ($1/(lbs/ft^2)$)
d = Density of the substance in pounds per cubic foot
0.033 = Depth of pool for maximum area (feet)

D.2.3 Common Water Solutions

Water solutions of regulated toxic substances must be analyzed somewhat differently from pure toxic liquids. Except for solutions of relatively low concentration, the evaporation rate varies with the concentration of the solution. At one specific concentration, the composition of the liquid does not change as evaporation occurs. For concentrated solutions of volatile substances, the evaporation rate from a pool may decrease, very rapidly in some cases, as the toxic substance volatilizes and its concentration in the pool decreases. Using a the ALOHA model with an additional feature (not available in the public version), changes in the release rate could be incorporated and the effects of these changes on the consequence distance analyzed. The distance results obtained using this model for various solutions were compared with the results from various time averages to examine the sensitivity of the results. An averaging time of 10 minutes was found to give reasonable agreement with the step-function model for most substances at various concentrations.

NOAA developed a computerized calculation method to estimate partial vapor pressures and release rates for regulated toxic substance in solution as a function of concentration, based on vapor pressure data from *Perry's Engineers' Handbook* and other sources. Using this method, EPA estimated partial vapor pressures and evaporation rates at one-minute intervals over 10 minutes for solutions of various concentrations. The 10-minute time period was chosen based on the ALOHA results. For each one-minute interval, EPA estimated the concentration of the solution based on the quantity evaporated in the previous interval, and estimated the partial vapor pressure based on the concentration. These estimated vapor pressures were used to calculate an average vapor pressure over the 10-minute period; this average vapor pressure was used to derive Liquid Factor Ambient (LFA) values, as described above for liquids. Use of these factors is intended to give an evaporation rate that accounts for the decrease in evaporation rate expected to take place as the solution evaporates.

Density Factors (DF) were developed for solutions of various concentrations from data in *Perry's Engineers' Handbook* and other sources, as discussed above for liquids.

Because solutions do not have defined boiling points, EPA did not develop Liquid Factor Boiling (LFB) values for solutions. As a simple and conservative approach, the quantity of a regulated substance in a solution at an elevated temperatures is treated as a pure substance. This approach will likely give an overestimate of the consequence distance.

D.2.4 Releases Inside Buildings

If a toxic liquid is released inside a building, its release to the outside air will be mitigated in two ways. First, the evaporation rate of the liquid may be much lower inside a building than outside. This is due to wind speed, which directly affects the evaporation rate. The second mitigating factor is that the building provides resistance to discharge of contaminated air to the outdoors.

In this method, a conservative wind speed, U, of 0.1 m/s was assumed in the building. (See end of text for a justification of this wind speed.) For a release outdoors in a worst-case scenario, U is set to 1.5 m/s, and for an alternative scenario, U is set to 3 m/s. The evaporation rate equation is:

$$QR = U^{0.78} \ x \ (LFA, LFB) \ x \ A \qquad \textbf{(D-5)}$$

where: QR = Release rate (pounds per minute)
U = Wind speed (meters per second)
LFA = Liquid Factor Ambient
LFB = Liquid Factor Boiling
A = Area of pool (square feet).

As can be seen, if U inside a building is only 0.1, then the evaporation rate inside a building will be much lower than a corresponding evaporation rate outside (assuming the temperature is the same). The rate will only be $(0.1/1.5)^{0.78}$, about 12 percent of the rate for a worst case, and $(0.1/3)^{0.78}$, about seven percent of the rate for an alternative case.

The evaporated liquid mixes with and contaminates the air in the building. What EPA is ultimately interested in is the rate at which this contaminated air exits the building. In order to calculate the release of contaminated air outside the building, EPA adapted a method from an UK Health and Safety Executive paper entitled, *Risk Mitigation in Land Use Planning: Indoor Releases of Toxic Gases*, by S.R. Porter. EPA assumed that the time for complete evaporation of the liquid pool was one hour. The rate at which contaminated air was released from the building during liquid evaporation (based on the paper) was assumed to be equal to the evaporation rate plus the building ventilation rate (no pressure buildup in building). The building ventilation rate was set equal to 0.5 air changes per hour, which is a typical ventilation rate for a building used to store toxic liquids and gases. EPA used a typical storage building with a volume of 1000 m^3 and a floor area of 200 m^2 (2152 ft^2), and assumed that the liquid pool would cover the entire building floor, representing a conservative scenario.

To provide a conservative estimate, EPA calculated the evaporation rate for a spill of a volatile liquid, carbon disulfide, under ambient conditions inside the building:

$$QR = 0.1^{0.78} \times 0.075 \times 2152 = 26.8 \text{ lbs/min.}$$

Next, this evaporation rate was converted to m^3/min using the ideal gas law:

$$26.8 \text{ lbs/min} \times 454 \text{ g/lb} \times 1 \text{ mol } CS_2/76.1 \text{ g} \times 0.0224 \text{ m}^3\text{/mol} = 3.58 \text{ m}^3\text{/min.}$$

The ventilation rate of the building is 0.5 changes per hour, which equals 500 m^3 per hour, or 8.33 m^3/min. Therefore, during evaporation, contaminated air is leaving the building at a rate of 8.33 + 3.58, or 11.9 m^3/min.

EPA used an iterative calculation for carbon disulfide leaving a building using the above calculated parameters. During the first minute of evaporation, 26.8 lbs of pure carbon disulfide evaporates, and EPA assumed this evenly disperses through the building so that the concentration of CS_2 in the building air is 0.0268 lbs/m^3 (assuming 1000 m^3 volume in the building). Contaminated air is exiting the building at a rate of 11.9 m^3/min, so EPA deduced that $11.9 \times 0.0268 = 0.319$ lbs of carbon disulfide exit the building in the first minute, leaving 26.5 lbs still evenly dispersed inside. Since this release occurs over one minute, the release rate of the carbon disulfide to the outside is 0.319 lbs/min. During the second minute, another 26.8 lbs of pure carbon disulfide evaporates and disperses, so that the building now contains 26.8 + 26.5 = 53.3 lbs of carbon disulfide, or 0.0533 lbs/m^3. Contaminated air is still exiting the building at a rate of 11.9 m^3/min, so $11.9 \times 0.05328 = 0.634$ lbs of carbon disulfide are released, leaving 52.6 lbs inside. Again, this release occurs over one minute so that the rate of carbon disulfide exiting the building in terms of contaminated air is 0.634 lbs/min. EPA continued to perform this estimation over a period of one hour. The rate of release of carbon disulfide exiting the building in the contaminated air at the sixty minute mark is 13.7 lbs/min. This represents the maximum rate of carbon disulfide leaving the building. After all of the carbon disulfide is evaporated, there is a drop in the concentration of carbon disulfide in the contaminated air leaving the building because the evaporation of carbon disulfide no longer contributes to the overall contamination of the air.

Note that if the same size pool of carbon disulfide formed outside, the release rate for a worst case scenario would be:

$$QR = 1.5^{0.78} \times 0.075 \times 2152 = 221 \text{ lbs/min.}$$

and for an alternative case:

$$QR = 3^{0.78} \times 0.075 \times 2152 = 380 \text{ lbs/min.}$$

The maximum release rate of carbon disulfide in the contaminated building air, assuming a 1,000 m^3 building with a building exchange rate of 0.5 air changes per hour, was only about 6 percent (13.7÷221 lbs/min x 100) of the worst case scenario rate, and only about 3.6 percent (13.7÷380 lbs/min x 100) of the alternative scenario rate. EPA set an overall building mitigation factor equal to 10 percent and five percent, respectively, in order to be conservative. Please note that (at a constant ventilation rate of 0.5 changes per hour) as the size of the building increases, the maximum rate of contaminated air leaving the building will decrease, although only slightly due to the balancing effect of building volume and ventilation rate. Obviously, a higher ventilation rate will yield a higher maximum release rate of contaminated air from the building, but most buildings used to store a toxic chemical should have ventilation rates close to 0.5 changes per hour.

For a release inside a building, EPA assumed a building air velocity of 0.1 m/s. This conservative value was derived by setting the size of the ventilation fan equal to 1.0 m^2. This fan is exchanging air from the building with the outside at a rate of 0.5 changes per hour. For a 1000 m^3 building, this value becomes 500 m^3/hour, or 0.14 m^3/s. Dividing 0.14 m^3/s by the area of the fan yields a velocity of 0.14 m/s, which was rounded down to 0.1 m/s.

D.3 Toxic Endpoints

The toxic endpoints found in Appendix B, Exhibits B-1, B-2, and B-3, were chosen as follows, in order of preference:

(1) Emergency Response Planning Guideline 2 (ERPG-2), developed by the American Industrial Hygiene Association, if available;

(2) Level of Concern (LOC) derived for extremely hazardous substances (EHSs) regulated under section 302 of the Emergency Planning and Community Right-to-Know Act (EPCRA) (see the *Technical Guidance for Hazards Analysis* for more information on LOCs); the LOC for EHSs is based on:

-- One-tenth of the Immediately Dangerous to Life and Health (IDLH) level, developed by the National Institute of Occupational Safety and Health (NIOSH), using IDLH values developed before 1994,

or, if no IDLH value is available,

-- One-tenth of an estimated IDLH derived from toxicity data; the IDLH is estimated as described in Appendix D of the *Technical Guidance for Hazards Analysis*.

ERPG-2 is defined as the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

IDLH is defined in the NIOSH *Pocket Guide to Chemical Hazards* (1994) as a condition that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed adverse health effects or prevent escape from such an environment. The IDLHs are intended to ensure that workers can escape from a given contaminated environment in the event of failure of the respiratory protection equipment.

The estimated IDLH is derived from animal toxicity data, in order of preferred data, as follows:

- From median lethal concentration (LC_{50}) (inhalation): 0.1 x LC_{50}

- From lowest lethal concentration (LC_{LO}) (inhalation): $1 \times LC_{LO}$
- From median lethal dose (LD_{50}) (oral): $0.01 \times LD_{50}$
- From lowest lethal dose (LD_{LO}) (oral): $0.1 \times LD_{LO}$

The toxic endpoints based on LOCs for EHSs presented in the tables in Appendix B are, in some cases, different from the LOCs listed in the *Technical Guidance for Hazards Analysis*, because some of the LOCs were updated based on IDLHs that were published after the development of the LOCs (and before 1994) or on new or revised toxicity data.

D.4 Reference Tables for Distances to Toxic and Flammable Endpoints

D.4.1 Neutrally Buoyant Gases

Toxic Substances. Reference tables for distances to toxic endpoints for neutrally buoyant gases and vapors were derived from the Gaussian model using the longitudinal dispersion coefficients based on work by Beals (*Guide to Local Diffusion of Air Pollutants*. Technical Report 214. Scott Air Force Base, Illinois: U.S. Air Force, Air Weather Service. 1971). The reasons for using the Beals dispersion coefficients are discussed below.

Longitudinal dispersion (dispersion in the along-wind direction) is generated mostly by vertical wind shear. Wind shear results from the tendency of the wind speed to assume a wind profile—the speed is lowest next to the ground and increases with height until it reaches an asymptotic value at approximately a few hundred feet above the surface. To account for shear-driven dispersion, any air dispersion model intended for modeling short-duration releases must include either (a) a formulation that accounts, either implicitly or explicitly, for the height-dependence of wind speed or (b) some type of parameterization that converts shear effect into σ_x, the standard deviation function in the along-wind direction.

Because the standard Gaussian formula does not incorporate σ_x (it includes only σ_y and σ_z, the crosswind and horizontal functions), very few alternate ways to formulate σ_x have been proposed. The simplest method was proposed by Turner (*Workbook of Atmospheric Dispersion Estimates*. Report PB-191 482. Research Triangle Park, North Carolina: Office of Air Programs, U.S. Environmental Protection Agency. 1970), who suggested simply setting σ_x equal to σ_y. Textbooks such as that by Pasquill and Smith (*Atmospheric Diffusion*. 3rd ed. New York: Halstead Press. 1983) describe a well-known analytic model. However, this model is more complex than a Gaussian model because according to it, dispersion depends on wind shear and the vertical variation of the vertical diffusion coefficient. Wilson (Along-wind Diffusion of Source Transients, *Atmospheric Environment* 15:489-495. 1981) proposed another method in which σ_x is determined as a function of wind shear, but in a form that can then be used in a Gaussian model. However, it is now believed that Wilson's formulation gives σ_xs that are too large.

To avoid the problems of the analytic method and Wilson's formulation, we chose to include a formulation for σ_x derived from work by Beals (1971). We had three reasons for doing so. First, in terms of magnitude, Beals' σ_x fell in the midrange of the alternative formulations that we reviewed. Second, Beals' σ_x indirectly accounts for wind shear by using (unpublished) experimental data. Third, both the ALOHA and DEGADIS models incorporate the Beal's methodology.

Averaging time is the time interval over which the instantaneous concentration of the hazardous material in the vapor cloud is averaged to assess the health effects of the exposure. Averaging time should generally be equal to or shorter than either the release duration or cloud duration and if possible, should reflect the exposure time associated with the toxic exposure guideline of interest. In this regulation, the exposure time associated with the toxic endpoints include 30 minutes for the Immediately Dangerous to Life and Health (IDLH) level and 60 minutes for the Emergency Response Planning Guideline (ERPG). For the neutrally buoyant tables, the 10-minute release scenario was modeled using a 10-minute averaging time. The 60-minute release scenario was modeled using a 30-minute averaging time to be consistent with the 30-minute exposure time associated with the IDLH. A 60-minute averaging time may have underpredicted consequence distances.

Cloud dispersion from a release of finite duration (10 and 60-minute releases) is calculated using an equation specified in the NOAA publication *ALOHA™ 5.0 Theoretical Description*, Technical Memorandum NOS ORCA 65, August 1992.

Flammable Substances. The reference tables of distances for neutrally buoyant flammable substances were derived using the same model as for toxic substances, as described above. The endpoint for modeling was the lower flammability limit (LFL). For flammable substances, an averaging time of 0.1 minute (six seconds) was used, because fires are considered to be nearly instantaneous events.

Distances of interest for flammable substances are generally much shorter than for toxic substance, because the LFL concentrations are much larger than the toxic endpoints. For the short distances found in modeling the flammable substances, modeling results were found to be the same for 10-minute and 30-minute releases; therefore, one table of distances for rural conditions and one table for urban conditions, applicable for both 10-minute and 30-minute releases, were developed for flammable substances.

D.4.2 Dense Gases

Toxic Substances. The reference tables for dense gases were developed using the widely accepted SLAB model, developed by Lawrence Livermore National Laboratory. SLAB solves conservation equations of mass, momentum, energy, and species for continuous, finite duration, and instantaneous releases. The reference tables were based on the evaporating pool algorithm and on releases of hydrogen chloride (HCl). A SLAB modeling analysis of releases of dense CAA gases or vapors with different molecular weights revealed that releases of HCl generally provided conservative results under a variety of stability/wind speed combinations, release rates, and toxic endpoints.

Similar to the modeling of neutrally buoyant plumes, the 10-minute release scenario of toxic chemicals was modeled using a 10-minute averaging time. The 60-minute release scenario was modeled using a 30-minute averaging time to be consistent with the 30 minute exposure time associated with the IDLH.

For all dense gas tables, the reference height for the wind speed was 10 meters. Relative humidity was assumed to be 50 percent, and the ambient temperature was 25°C. The source area was the smallest value that still enabled the model to run for all release rates. The surface roughness factor was one meter for urban scenarios and three centimeters for rural scenarios.

Flammable Substances. The reference tables for dispersion of dense flammable gases, the same model was used as for toxic substances. as described above. and the same assumptions were made. For the dispersion of flammable chemicals. averaging time should be very small (i.e., no more than a few seconds) since flammable vapors need only be exposed to an ignition source for a short period of time to initiate the combustion process. Thus, both the 10-minute and 60-minute reference tables for flammable substances use an averaging time of 10 seconds. The 10-minute and 60-minute tables were combined for flammable substances because the modeling results were found to be the same.

D.4.3 Choice of Reference Table for Liquids and Solutions

The methodology presented in this guidance for consequence analysis for liquids and solutions assumes evaporation from a pool. All of the toxic liquids regulated under CAA section 112(r) have molecular weights greater than the molecular weight of air; therefore, their vapor would be heavier than air. However, because the vapor from a pool will mix with air as it evaporates, the initial density of the vapor with respect to air may not in all cases indicate whether the vapor released from a pool should be modeled as a dense gas or a neutrally buoyant gas. If the rate of release from the pool is relatively low, the vapor-air mixture that is generated may be neutrally buoyant even if the vapor is denser than air.

To identify substances with molecular weight greater than air that might behave as neutrally buoyant gases when evaporating from a pool, EPA used the ALOHA model for pool evaporation of a number of substances with a range of molecular weights and vapor pressures. Modeling was carried out for F stability and wind speed 1.0 meter per second and for D stability and wind speed 3.0 meters per second. Pool spread to a depth of one centimeter was assumed. EPA noted the molecular weights and vapor pressures in cases where ALOHA used the model for neutrally buoyant gases. The molecular weight-vapor pressure combinations at which ALOHA used the neutrally buoyant gas model for the two stability and wind speed combinations were used to develop the reference table choices given in Exhibit B-2 (for liquids) and B-3 (for solutions) in Appendix B. The neutrally buoyant tables are to be used at ambient conditions when indicated, for the liquids; at elevated temperatures, evaporation rates will be greater, and the dense gas tables should be used. When use of the neutrally buoyant tables is indicated, these tables should generally give reasonable results for pool evaporation under ambient conditions; however, the reference table choices shown in Exhibit B-2 are not intended to predict the behavior of the substances when evaporating under all conditions. The analysis did not take into account all factors (e.g., pool size) that may affect the degree of mixing of the vapor with air.

D.5 Worst-Case Consequence Analysis for Flammable Substances

The equation used for the vapor cloud explosion analysis for the worst case involving flammable substances is given in Appendix C. This equation is based on the TNT-equivalency method of the UK Health and Safety Executive, as presented in the publication of the Center for Chemical Process Safety of the American Institute of Chemical Engineers (AIChE), *Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions. Flash Fires, and BLEVEs* (1994). The assumption was made for the worst case that the total quantity of the released substance is in the flammable part of the cloud. The AIChE document lists this assumption as one of a number that have been used for vapor cloud explosion blast prediction; it was chosen as a conservative assumption for the worst-case analysis. The yield factor of 10 percent was a conservative worst-case assumption, based on information presented in the AIChE document. According to the AIChE document, reported values for TNT equivalency for vapor cloud explosions range from a fraction of one percent to tens of percent; for most major vapor cloud explosions, the range is one to ten percent.

The endpoint for the vapor cloud explosion analysis, 1 psi, is reported to cause damage such as shattering of glass windows and partial demolition of houses. Skin laceration from flying glass also is reported. This endpoint was chosen for the consequence analysis because of the potential for serious injuries to people from the property damage that might result from an explosion.

The TNT equivalent model was chosen as the basis for the consequence analysis because of its simplicity and wide use. This model does not take into account site-specific factors and many chemical-specific factors that may affect the results of a vapor cloud explosion. Other methods are available for vapor cloud explosion modeling; see the list of references in Appendix A for some publications that include information on other vapor cloud explosion modeling methods.

D.6 Alternative Scenario Analysis for Toxic Gases

The equation for estimating release rate of a gas from a hole in a tank is based on the equations for gas discharge rate presented in the *Handbook of Chemical Hazard Analysis Procedures* by the Federal Emergency Management Agency (FEMA), DOT, and EPA, and equations in EPA's *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*. The equation for an instantaneous discharge under non-choked flow conditions is:

$$m = C_d A_h \sqrt{2 p_0 \rho_0 \left(\frac{\gamma}{\gamma - 1}\right) \left[\left(\frac{p_1}{p_0}\right)^{\frac{2}{\gamma}} - \left(\frac{p_1}{p_0}\right)^{\frac{\gamma+1}{\gamma}}\right]} \qquad \textbf{(D-6)}$$

where: m = Discharge rate, kg/s
C_d = Discharge coefficient
A_h = Opening area, m^2
γ = Ratio of specific heats
p_0 = Tank pressure, Pascals
p_1 = Ambient pressure, Pascals
ρ_0 = Density, kg/m^3

Under choked flow conditions (maximum flow rate), the equation becomes:

$$m = C_d A_h \sqrt{\gamma p_0 \rho_0 \left(\frac{2}{\gamma - 1}\right)^{\frac{\gamma+1}{\gamma-1}}} \qquad \textbf{(D-7)}$$

For development of the equation and gas factors presented in this guidance, density (ρ) was rewritten as a function of pressure and molecular weight, based on the ideal gas law:

$$\rho = \frac{p_0 MW}{RT_t} \qquad \textbf{(D-8)}$$

where: MW = Molecular weight (kilograms per kilomole)
R = Gas constant (8314 Joules per degree-kilomole)
T_t = Tank temperature (K)

The choked flow equation can be rewritten:

$$m = C_{dA_h} p_0 \frac{1}{\sqrt{T_t}} \sqrt{\gamma \left(\frac{2}{\gamma - 1} \right)^{\frac{\gamma + 1}{\gamma - 1}}} \sqrt{\frac{MW}{8314}} A_h \qquad \textbf{(D-9)}$$

To derive the equation presented in the guidance, all the chemical-specific properties, constants, and appropriate conversion factors were combined into the "Gas Factor" (GF). The discharge coefficient was assumed to have a value of 0.8, based on the screening value recommended in EPA's *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*. The GF was derived as follows:

$$GF = 132.2 \times 0.6895 \times 10^{4} \times 6.4516 \times 10^{-4} \times 0.8 \sqrt{\gamma \left(\frac{2}{\gamma + 1} \right)^{\frac{\gamma + 1}{\gamma - 1}}} \sqrt{\frac{MW}{8314}} \qquad \textbf{(D-10)}$$

where: 132.2 = Conversion factor for kg/s to lbs/min
0.6895×10^{4} = Conversion factor for Pascals to psi
6.4516×10^{-4} = Conversion factor for square meters to square inches

GF values were calculated for all gases regulated under CAA section 112(r) and are listed in Appendix B, Exhibit B-1, for toxic gases and Appendix C, Exhibit C-2, for flammable gases.

From the equation for choked flow above and the equation for the GF above, the initial release rate for a gas from a hole in a tank can be written as:

$$Q_r = HA \times P_t \times \frac{1}{\sqrt{T_t}} \times GF \qquad \textbf{(D-11)}$$

where: QR = Release rate (pounds per minute)
HA = Hole area (square inches)
P_t = Tank pressure (psia)
T_t = Tank temperature (K)

D.7 Alternative Scenario Analysis for Toxic Liquids

D.7.1 Releases from Holes in Tanks

The equation for estimating release rate of a liquid from a hole in a tank is based on the equations for liquid release rate presented in the *Handbook of Chemical Hazard Analysis Procedures* by FEMA, DOT, and EPA and EPA's *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*. The equation for the instantaneous release rate:

$$m = A_h C_d \sqrt{\rho_l \left[2 g \rho_l \left(H_L - H_h\right) + 2\left(P_0 - P_a\right)\right]} \qquad \textbf{(D-12)}$$

where: m = Discharge rate (kilograms per second)
A_h = Opening area (square meters)
C_d = Discharge coefficient (unitless)
g = Gravitational constant (9.8 meters per second squared)
ρ_l = Liquid density (kilograms per cubic meter)
P_0 = Storage pressure (Pascals)
P_a = Ambient pressure (Pascals)
H_L = Liquid height above bottom of container (meters)
H_h = Height of opening (meters)

If the liquid is stored at ambient pressure, the equation becomes:

$$m = A_h C_d \rho_l \sqrt{2 g \left(H_L - H_h\right)} \qquad \textbf{(D-13)}$$

To derive the equation presented in the guidance, all the chemical-specific properties, constants, and conversion factors were combined into the "Liquid Leak Factor" (LLF). The discharge coefficient was assumed to have a value of 0.8, based on the screening value recommended in EPA's *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*. The LLF was derived as follows:

$$LLF = 132.2 \times 6.4516 \times 10^{-4} \times 0.1594 \times 0.8 \times \sqrt{2 \times 9.8} \times \rho_l \qquad \textbf{(D-14)}$$

where: LLF = Liquid Leak Factor (pounds per minute-inches$^{2.5}$)
132.2 = Conversion factor for kilograms per second to pounds per minute
6.4516×10^{-4} = Conversion factor for square meters to square inches
0.1594 = Conversion factor for square root of meters to square root of inches
0.8 = Discharge coefficient (0.8),
9.8 = Gravitational constant (meters per second squared)
ρ_l = Liquid density (kilograms per cubic meter)

LLF values were calculated for all liquids regulated under CAA section 112(r) and are listed in Appendix B, Exhibit B-2, for toxic liquids and Appendix C, Exhibit C-3, for flammable liquids.

From the equation for liquid release rate from a hole in a tank at ambient pressure and the equation for the LLF, the initial release rate for a liquid from a tank under atmospheric pressure can be written as:

$$QR_L = HA \times \sqrt{LH} \times LLF \qquad \textbf{(D-15)}$$

where: QR_L = Liquid release rate (pounds per minute)
HA = Hole area (square inches)
LH = Height of liquid above hole (inches)

D.7.2 Releases from Pipes

The equation used to estimate releases of liquids from pipes is the Bernoulli equation. It assumes that the density of the liquid is constant and does not account for losses in velocity due to wall friction. The equation follows:

$$\frac{(P_a - P_b)}{D} - \frac{g(Z_a - Z_b)}{g_c} = \frac{(V_b^2 - V_a^2)}{2g_c} \qquad \textbf{(D-16)}$$

where: P_a = Pressure at pipe inlet (Pascals)
P_b = Pressure at pipe outlet (Pascals)
Z_a = Height above datum plane at pipe inlet (meters)
Z_b = Height above datum plane at pipe release (meters)
g = Gravitational acceleration (9.8 meters per second^2)
g_c = Newton's law proportionality factor (1.0)
V_a = Operational velocity (meters per second)
V_b = Release velocity (meters per second)
D = Density of liquid (kilograms per cubic meter)

Isolating V_b yields:

$$V_b = \sqrt{\frac{2 \times g_c \times (P_a - P_b)}{D} + 2 \times g \times (Z_a - Z_b) + V_a^2} \qquad \textbf{(D-17)}$$

Adjusting V_b in feet per minute yields:

$$V_b = \sqrt{\frac{(77{,}500 \times P_a - 7.85 \times 10^9)}{D} + (77{,}460 \times g \times Z) + V_a^2} \qquad \textbf{(D-18)}$$

where: P_a = Operational pipe pressure (Pascals)
Z = Change in pipe elevation, inlet to outlet (meters)
g = Gravitational acceleration (9.8 meters per second^2)
V_a = Operational velocity (feet per minute)
V_b = Release velocity (feet per minute)
D = Density of liquid (kilograms per cubic meter)

D.8 Vapor Cloud Fires

Factors for leaks from tanks for flammable substances were derived as described for toxic substances (see above).

The endpoint for estimating impact distances for vapor cloud fires of flammable substances, the lower flammability limit (LFL), was chosen as a reasonable, but not very conservative, estimation of the possible extent of a vapor cloud fire.

D.9 Pool Fires

Factors for estimating the distances to a heat radiation level that could cause second degree burns from a 40-second exposure was developed based on equations presented in the AIChE document, *Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, Flash Fires, and BLEVEs* and in the Netherlands TNO document, *Methods for the Determination of Possible Damage to People and Objects Resulting from Releases of Hazardous Materials* (1992). The AIChE and TNO documents present a point-source model that assumes that a selected fraction of the heat of combustion is emitted as radiation in all directions. The radiation per unit area received by a target at some distance from the point source is given by:

$$q = \frac{f m H_c \tau_a}{4 \pi x^2} \qquad \textbf{(D-19)}$$

where: q = Radiation per unit area received by the receptor (Watts per square meter)
m = Rate of combustion (kilograms per second)
τ_a = Atmospheric transmissivity
H_c = Heat of combustion (Joules per kilogram)
f = Fraction of heat of combustion radiated
x = Distance from point source to receptor (meters)

The fraction of combustion energy dissipated as thermal radiation (f in the equation above) is reported to range from 0.1 to 0.4. To develop factors for estimating distances for pool fires, this fraction was assumed to be 0.4 for all the regulated flammable substances. The heat radiation level (q) was assumed to be 5,000 Watts per square meter. This level is reported to cause second degree burns from a 40-second exposure. It was assumed that exposed people would be able to escape from the heat in 40 seconds. The atmospheric transmissivity (τ_a) was assumed equal to one.

For a pool fire of a flammable substance with a boiling point above the ambient temperature, the combustion rate can be estimated by the following empirical equation:

$$m = \frac{0.0010\ H_c A}{H_v - C_p\ (T_b - T_a)} \tag{D-20}$$

where: m = Rate of combustion (kilograms per second)
H_c = Heat of combustion (Joules per kilogram)
H_v = Heat of vaporization (Joules per kilogram)
C_p = Liquid heat capacity (Joules per kilogram-degree K)
A = Pool area (square meters)
T_b = Boiling temperature (K)
T_a = Ambient temperature (K)
0.0010 = Constant

Combining the two equations given above, and assuming a heat radiation level of 5,000 Watts per square meter, gives the following equation for liquid pools of substances with boiling points above ambient temperature:

$$x = H_c \sqrt{0.4\ \frac{\left(\dfrac{0.0010\ A}{H_v - C_p(T_b - T_a)}\right)}{4\pi q}} \tag{D-21}$$

or

$$x = H_c \sqrt{\frac{0.0001\ A}{5{,}000\pi\,(H_v - C_p(T_b - T_a))}} \tag{D-22}$$

where: x = Distance from point source to receptor (meters)
q = Radiation per unit area received by the receptor = 5,000 Watts per square meter
H_c = Heat of combustion (Joules per kilogram)
f = Fraction of heat of combustion radiated = 0.4
H_v = Heat of vaporization (Joules per kilogram)
C_p = Liquid heat capacity (Joules per kilogram-degree K)
A = Pool area (square meters)
T_b = Boiling temperature (K)
T_a = Ambient temperature (K)
0.0010 = Constant

For a pool fire of a flammable substance with a boiling point below the ambient temperature (i.e., liquefied gases) the combustion rate can be estimated by the following equation, based on the TNO document:

$$m = \frac{0.0010\ H_c\, A}{H_v} \tag{D-23}$$

where: m = Rate of combustion (kilograms per second)
H_v = Heat of vaporization (Joules per kilogram)
H_c = Heat of combustion (Joules per kilogram)
A = Pool area (square meters)
0.0010 = Constant

Then the equation for distance at which the radiation received equals 5,000 Watts per square meter becomes:

$$x = H_c \sqrt{\frac{0.0001\, A}{5{,}000\pi\ H_v}} \tag{D-24}$$

where: x = Distance from point source to receptor (meters)
Radiation per unit area received by the receptor = 5,000 Watts per square meter
H_c = Heat of combustion (Joules per kilogram)
H_v = Heat of vaporization (Joules per kilogram)
A = Pool area (square meters)
0.0001 = Derived constant (see equations D-20 and D-21)

A "Pool Fire Factor" (PFF) was calculated for each regulated flammable liquid and gas to allow estimation of the distance to the heat radiation level that would lead to second degree burns. For the derivation of this factor, ambient temperature was assumed to be 298 K (25° C). Other factors are discussed above. The PFF for liquids with boiling points above ambient temperature was derived as follows:

$$PFF = H_c \sqrt{\frac{0.0001}{5{,}000\pi (H_v + C_p(T_b - 298))}}\ \sqrt{0.0929} \tag{D-25}$$

where: 5,000 = Radiation per unit area received by the receptor (Watts per square meter)
H_c = Heat of combustion (Joules per kilogram)
H_v = Heat of vaporization (Joules per kilogram)
C_p = Liquid heat capacity (Joules per kilogram-degree K)
T_b = Boiling temperature (K)
298 = Assumed ambient temperature (K)

0.0001 = Derived constant (see above)
0.0929 = Conversion factor for square meters to square feet

For liquids with boiling points below ambient temperature, the PFF is derived as follows:

$$PFF = H_c \sqrt{\frac{0.0001}{5{,}000\ \pi\ H_v}}\ \sqrt{0.0929} \qquad \textbf{(D-26)}$$

where: 5,000 = Radiation per unit area received by the receptor (Watts per square meter)
H_c = Heat of combustion (Joules per kilogram)
H_v = Heat of vaporization (Joules per kilogram)
0.0001 = Derived constant (see above)
0.0929 = Conversion factor for square meters to square feet

Distances where exposed people could potentially suffer second degree burns can be estimated as the PFF multiplied by the square root of the pool area (in square feet), as discussed in the text.

D.10 BLEVEs

Reference Table 22, the table of distances for BLEVEs, was developed based on equations presented in the AIChE document, *Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, Flash Fires, and BLEVEs*. The Hymes point-source model for a fireball, as cited in the AIChE document, uses the following equation for the radiation received by a receptor:

$$q = \frac{2.2\ \tau_a\ R\ H_c\ m_f^{\,0.67}}{4\pi L^2} \qquad \textbf{(D-27)}$$

where: q = Radiation received by the receptor (W/m^2)
m_f = Mass of fuel in the fireball (kg)
τ_a = Atmospheric transmissivity
H_c = Heat of combustion (J/kg)
R = Radiative fraction of heat of combustion
L = Distance from fireball center to receptor (meters)
π = 3.14

Hymes (as cited by AIChE) suggests the following values for R:

R = 0.3 for vessels bursting below relief valve pressure
R = 0.4 for vessels bursting at or above relief valve pressure

For development of the table in Exhibit 16, the following conservative assumptions were made:

$R = 0.4$
$\tau_a = 1$

The effects of radiant heat on an exposed person depend on both the intensity of the radiation and the duration of the exposure. For development of the table of distances for BLEVEs, it was assumed that the time of exposure would equal the duration of the fireball. The AIChE document gives the following equations for duration of a fireball:

$$t_c = 0.45\, m_f^{\frac{1}{3}} \text{ for } m_f < 30{,}000 \text{ kg} \quad \textbf{(D-28)}$$

and

$$t_c = 2.6\, m_f^{\frac{1}{6}} \text{ for } m_f > 30{,}000 \text{ kg} \quad \textbf{(D-29)}$$

where: m_f = Mass of fuel (kg)
t_c = Combustion duration (seconds)

According to several sources (e.g., Eisenberg, et al., *Vulnerability Model, A Simulation System for Assessing Damage Resulting from Marine Spills*; Mudan, *Thermal Radiation Hazards from Hydrocarbon Pool Fires* (citing K. Buettner)), the effects of thermal radiation are generally proportional to radiation intensity to the four-thirds power times time of exposure. Thus, a thermal "dose" can be estimated using the following equation:

$$Dose = t\, q^{\frac{4}{3}} \quad \textbf{(D-30)}$$

where: t = Duration of exposure (seconds)
q = Radiation intensity (Watts/m^2)

The thermal "dose" that could cause second-degree burns was estimated assuming 40 seconds as the duration of exposure and 5,000 Watts/m^2 as the radiation intensity. The corresponding dose is 3,420,000 $(\text{Watts/m}^2)^{4/3}$-s.

For estimating the distance from a fireball at which a receptor might receive enough thermal radiation to cause second degree burns, the dose estimated above was substituted into the equation for radiation received from a fireball:

$$q = \left[\frac{3,420,000}{t}\right]^{\frac{3}{4}} \tag{D-31}$$

$$\left[\frac{3,420,000}{t}\right]^{\frac{3}{4}} = \frac{2.2\ \tau_a\ R\ H_c\ m_f^{\ 0.67}}{4\pi L^2} \tag{D-32}$$

$$L = \sqrt{\frac{2.2\ \tau_a\ R\ H_c\ m_f^{\ 0.67}}{4\pi\left[\frac{3,420,000}{t}\right]^{\frac{3}{4}}}} \tag{D-33}$$

where: L = Distance from fireball center to receptor (meters)
q = Radiation received by the receptor (W/m^2)
m_f = Mass of fuel in the fireball (kg)
τ_a = Atmospheric transmissivity (assumed to be 1)
H_c = Heat of combustion (J/kg)
R = Radiative fraction of heat of combustion (assumed to be 0.4)
t = Duration of the fireball (seconds) (estimated from the equations above); assumed to be duration of exposure

D.11 Alternative Scenario Analysis for Vapor Cloud Explosions

For consideration of vapor cloud explosion as a potential alternative scenario, the guidance provides a method to estimate the quantity in the cloud from the fraction flashed into vapor plus the quantity that might be carried along as aerosol. The recommendation to use twice the quantity flashed into vapor as the quantity flashed plus aerosol for determination of consequence distance is based on the method recommended by the UK Health and Safety Executive (HSE), as cited in the AIChE document, *Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, Flash Fires, and BLEVEs*. In addition, according to T.A. Kletz, in "Unconfined Vapor Cloud Explosions" (Eleventh Loss Prevention Symposium, sponsored by AIChE, 1977), unconfined vapor cloud explosions almost always result from the release of flashing liquids.

The equation for the flash fraction, for possible use in for the alternative scenario analysis, is based on the Netherlands TNO document, *Methods for the Calculation of the Physical Effects of the Escape of Dangerous Material* (1980), Chapter 4, "Spray Release." The following equation is provided:

$$X_{vap,a} = \left(X_{vap,b} \frac{T_b}{T_l} \right) - \left(\frac{T_b C_l}{h_v} \ln \frac{T_l}{T_b} \right) \quad \textbf{(D-34)}$$

where: $X_{vap,a}$ = Weight fraction of vapor after expansion
$X_{vap,b}$ = Weight fraction of vapor before expansion (assumed to be 0 for calculation of the flash fraction)
T_b = Boiling temperature of gas compressed to liquid (K)
T_l = Temperature of stored gas compressed to liquid (K)
C_l = Specific heat of gas compressed to liquid (Joules/kilogram-K)
h_v = Heat of evaporation of gas compressed to liquid (Joules/kilogram)

To develop a Flash Fraction Factor (FFF) for use in consequence analysis, compressed gases were assumed to be stored at 25°C (298 K) (except in cases where the gas could not be liquefied at that temperature). The equation for FFF is:

$$FFF = \left(\frac{T_b C_l}{h_v} \ln \frac{298}{T_b} \right) \quad \textbf{(D-35)}$$

where: T_b = Boiling temperature of gas compressed to liquid (K)
C_l = Specific heat of gas compressed to liquid (Joules/kilogram-K)
h_v = Heat of evaporation of gas compressed to liquid (Joules/kilogram)
298 = Temperature of stored gas compressed to liquid (K)

The recommendation to use a yield factor of 0.03 for the alternative scenario analysis for vapor cloud explosions also is based on the UK HSE method cited by AIChE.

APPENDIX E

RISK MANAGEMENT PROGRAM RULE

1. Part 68 is amended by redesignating Subpart C as Subpart F as follows:

Subpart F Regulated Substances for Accidental Release Prevention

2. The table of contents of Part 68 is revised to read as follows:

Part 68 — ACCIDENTAL RELEASE PREVENTION PROVISIONS

3. The authority citation is revised to read as follows:

Authority: 42 U.S.C. 7412(r), 7601(a)(1), 7661-7661f.

4. Section 68.3 is amended to add the following definitions:

68.3 Definitions

Act means the Clean Air Act as amended (42 U.S.C. 7401 *et seq.*)

Administrative controls mean written procedural mechanisms used for hazard control.

AIChE/CCPS means the American Institute of Chemical Engineers/Center for Chemical Process Safety.

API means the American Petroleum Institute.

ASME means the American Society of Mechanical Engineers.

Catastrophic release means a major uncontrolled emission, fire, or explosion, involving one or more regulated substances that presents imminent and substantial endangerment to public health and the environment.

Classified information means "classified information" as defined in the Classified Information Procedures Act, 18 U.S.C. App. 3, section 1(a) as "any information or material that has been determined by the United States Government pursuant to an executive order, statute, or regulation, to require protection against unauthorized disclosure for reasons of national security."

Covered process means a process that has a regulated substance present in more than a threshold quantity as determined under § 68.115 of this part.

Designated agency means the state, local, or Federal agency designated by the state under the provisions of § 68.215(d) of this part.

Environmental receptor means natural areas such as national or state parks, forests, or monuments; officially designated wildlife sanctuaries, preserves, refuges, or areas; and Federal wilderness areas, that could be exposed at any time to toxic concentrations, radiant heat, or overpressure greater than or equal to the endpoints provided in § 68.22(a) of this part, as a result of an accidental release and that can be identified on local U. S. Geological Survey maps.

Hot work means work involving electric or gas welding, cutting, brazing, or similar flame or spark-producing operations.

Implementing agency means the state or local agency that obtains delegation for an accidental release prevention program under subpart E, 40 CFR part 63. The implementing agency may, but is not required to, be the state or local air permitting agency. If no state or local agency is granted delegation, EPA will be the implementing agency for that state.

Injury means any effect on a human that results either from direct exposure to toxic concentrations; radiant heat; or overpressures from accidental releases or from the direct consequences of a vapor cloud explosion (such as flying glass, debris, and other projectiles) from an accidental release and that requires medical treatment or hospitalization.

Major change means introduction of a new process, process equipment, or regulated substance, an alteration of process chemistry that results in any change to safe operating limits, or other alteration that introduces a new hazard.

Mechanical integrity means the process of ensuring that process equipment is fabricated from the proper materials of construction and is properly installed, maintained, and replaced to prevent failures and accidental releases.

Medical treatment means treatment, other than first aid, administered by a physician or registered professional personnel under standing orders from a physician.

Mitigation or mitigation system means specific activities, technologies, or equipment designed or deployed to capture or control substances upon loss of containment to minimize exposure of the public or the environment. Passive mitigation means equipment, devices, or technologies that function without human, mechanical, or other energy input. Active mitigation means equipment, devices, or technologies that need human, mechanical, or other energy input to function.

NFPA means the National Fire Protection Association.

Offsite means areas beyond the property boundary of the stationary source, and areas within the property boundary to which the public has routine and unrestricted access during or outside business hours.

OSHA means the U.S. Occupational Safety and Health Administration.

Owner or operator means any person who owns, leases, operates, controls, or supervises a stationary source.

Population means the public.

Public means any person except employees or contractors at the stationary source.

Public receptor means offsite residences, institutions (e.g., schools, hospitals), industrial, commercial, and office buildings, parks, or recreational areas inhabited or occupied by the public at any time without restriction by the stationary source where members of the public could be exposed to toxic concentrations, radiant heat, or overpressure, as a result of an accidental release.

Replacement in kind means a replacement that satisfies the design specifications.

RMP means the risk management plan required under subpart G of this part.

SIC means Standard Industrial Classification.

Typical meteorological conditions means the temperature, wind speed, cloud cover, and atmospheric stability class, prevailing at the site based on data gathered at or near the site or from a local meteorological station.

Worst-case release means the release of the largest quantity of a regulated substance from a vessel or process line failure that results in the greatest distance to an endpoint defined in § 68.22(a) of this part.

5. Section 68.10 is added to read as follows:

68.10 Applicability.

(a) An owner or operator of a stationary source that has more than a threshold quantity of a regulated substance in a process, as determined under § 68.115 of this part, shall comply with the requirements of this part no later than the latest of the following dates:

(1) [insert date 3 years after the date of publication in the FEDERAL REGISTER];

(2) Three years after the date on which a regulated substance is first listed under § 68.130 of this part; or

(3) The date on which a regulated substance is first present above a threshold quantity in a process.

(b) *Program 1 eligibility requirements.* A covered process is eligible for Program 1 requirements as provided in § 68.12(b) of this part if it meets all of the following requirements:

(1) For the five years prior to the submission of an RMP, the process has not had an accidental release of a regulated substance where exposure to the substance, its reaction products, overpressure generated by an explosion involving the substance, or radiant heat generated by a fire involving the substance led to any of the following offsite:

(i) Death;

(ii) Injury; or

(iii) Response or restoration activities for an exposure of an environmental receptor;

(2) The distance to a toxic or flammable endpoint for a worst-case release assessment conducted under Subpart B and § 68.25 of this part is less than the distance to any public receptor, as defined in § 68.30 of this part; and

(3) Emergency response procedures have been coordinated between the stationary source and local emergency planning and response organizations.

(c) *Program 2 eligibility requirements.* A covered process is subject to Program 2 requirements if it does not meet the eligibility requirements of either paragraph (b) or paragraph (d) of this section.

(d) *Program 3 eligibility requirements.* A covered process is subject to Program 3 if the process does not meet the requirements of paragraph (b) of this section, and if either of the following conditions is met:

(1) The process is in SIC code 2611, 2812, 2819, 2821, 2865, 2869, 2873, 2879, or 2911; or

(2) The process is subject to the OSHA process safety management standard, 29 CFR 1910.119.

(e) If at any time a covered process no longer meets the eligibility criteria of its Program level, the owner or operator shall comply with the requirements of the new Program level that applies to the process and update the RMP as provided in § 68.190 of this part.

6. Section 68.12 is added to read as follows:

68.12 General requirements.

(a) *General requirements.* The owner or operator of a stationary source subject to this part shall submit a single RMP, as provided in §§ 68.150 to 68.185 of this part. The RMP shall include a registration that reflects all covered processes.

(b) *Program 1 requirements.* In addition to meeting the requirements of paragraph (a) of this section, the owner or operator of a stationary source with a process eligible for Program 1, as provided in § 68.10(b) of this part, shall:

(1) Analyze the worst-case release scenario for the process(es), as provided in § 68.25 of this part; document that the nearest public receptor is beyond the distance to a toxic or flammable endpoint defined in § 68.22(a) of this part; and submit in the RMP the worst-case release scenario as provided in § 68.165 of this part;

(2) Complete the five-year accident history for the process as provided in § 68.42 of this part and submit it in the RMP as provided in § 68.168 of this part;

(3) Ensure that response actions have been coordinated with local emergency planning and response agencies; and

(4) Certify in the RMP the following: "Based on the criteria in 40 CFR 68.10, the distance to the specified endpoint for the worst-case accidental release scenario for the following process(es) is less than the distance to the nearest public receptor: [list process(es)]. Within the past five years, the process(es) has (have) had no accidental release that caused offsite impacts provided in the risk management program rule (40 CFR 68.10(b)(1)). No additional measures are necessary to prevent offsite impacts from accidental releases. In the event of fire, explosion, or a release of a regulated substance from the process(es), entry within the distance to the specified endpoints may pose a danger to public emergency responders. Therefore, public emergency responders should not enter this area except as arranged with the emergency contact indicated in the RMP. The undersigned certifies that, to the best of my knowledge, information, and belief, formed after reasonable inquiry, the information submitted is true, accurate, and complete. [Signature, title, date signed]."

(c) *Program 2 requirements.* In addition to meeting the requirements of paragraph (a) of this section, the owner or operator of a stationary source with a process subject to Program 2, as provided in § 68.10(c) of this part, shall:

(1) Develop and implement a management system as provided in § 68.15 of this part;

(2) Conduct a hazard assessment as provided in §§ 68.20 through 68.42 of this part;

(3) Implement the Program 2 prevention steps provided in §§ 68.48 through 68.60 of this part or implement the Program 3 prevention steps provided in §§ 68.65 through 68.87 of this part;

(4) Develop and implement an emergency response program as provided in §§ 68.90 to 68.95 of this part; and

(5) Submit as part of the RMP the data on prevention program elements for Program 2 processes as provided in § 68.170 of this part.

(d) *Program 3 requirements.* In addition to meeting the requirements of paragraph (a) of this section, the owner or operator of a stationary source with a process subject to Program 3, as provided in § 68.10(d) of this part shall:

(1) Develop and implement a management system as provided in § 68.15 of this part;

(2) Conduct a hazard assessment as provided in §§ 68.20 through 68.42 of this part;

(3) Implement the prevention requirements of §§ 68.65 through 68.87 of this part;

(4) Develop and implement an emergency response program as provided in §§ 68.90 to 68.95 of this part; and

(5) Submit as part of the RMP the data on prevention program elements for Program 3 processes as provided in § 68.175 of this part.

7. Section 68.15 is added to read as follows:

68.15 Management.

(a) The owner or operator of a stationary source with processes subject to Program 2 or Program 3 shall develop a management system to oversee the implementation of the risk management program elements.

(b) The owner or operator shall assign a qualified person or position that has the overall responsibility for the development, implementation, and integration of the risk management program elements.

(c) When responsibility for implementing individual requirements of this part is assigned to persons other than the person identified under paragraph (b) of this section, the names or positions of these people shall be documented and the lines of authority defined through an organization chart or similar document.

8. Subpart B is added to read as follows:

Subpart B Hazard Assessment

68.20 Applicability. The owner or operator of a stationary source subject to this part shall prepare a worst-case release scenario analysis as provided in § 68.25 of this part and complete the five-year accident history as provided in § 68.42 of this part. The owner or operator of a Program 2 and 3 process must comply with all sections in this subpart for these processes.

68.22 Offsite consequence analysis parameters.

(a) Endpoints. For analyses of offsite consequences, the following endpoints shall be used:

(1) Toxics. The toxic endpoints provided in Appendix A of this part.

(2) Flammables. The endpoints for flammables vary according to the scenarios studied:

(i) Explosion. An overpressure of 1 psi.

(ii) Radiant heat/exposure time. A radiant heat of 5 kw/m^2 for 40 seconds.

(iii) Lower flammability limit. A lower flammability limit as provided in NFPA documents or other generally recognized sources.

(b) Wind speed/atmospheric stability class. For the worst-case release analysis, the owner or operator shall use a wind speed of 1.5 meters per second and F atmospheric stab lity class. If the owner or operator can demonstrate that local meteorological data applicable to the stationary source show a higher minimum wind speed or less stable atmosphere at all times during the previous three years, these minimums may be used. For analysis of alternative scenarios, the owner or operator may use the typical meteorological conditions for the stationary source.

(c) Ambient temperature/humidity. For worst-case release analysis of a regulated toxic substance, the owner or operator shall use the highest daily maximum temperature in the previous three years and average humidity for the site, based on temperature/humidity data gathered at the stationary source or at a local meteorological station; an owner or operator using the *RMP Offsite Consequence Analysis Guidance* may use 25°C and 50 percent humidity as values for these variables. For analysis of alternative scenarios, the owner or operator may use typical temperature/humidity data gathered at the stationary source or at a local meteorological station.

(d) Height of release. The worst-case release of a regulated toxic substance shall be analyzed assuming a ground level (0 feet) release. For an alternative scenario analysis of a regulated toxic substance, release height may be determined by the release scenario.

(e) Surface roughness. The owner or operator shall use either urban or rural topography, as appropriate. Urban means that there are many obstacles in the immediate area; obstacles include buildings or trees. Rural means there are no buildings in the immediate area and the terrain is generally flat and unobstructed.

(f) Dense or neutrally buoyant gases. The owner or operator shall ensure that tables or models used for dispersion analysis of regulated toxic substances appropriately account for gas density.

(g) Temperature of released substance. For worst case, liquids other than gases liquified by refrigeration only shall be considered to be released at the highest daily maximum temperature, based on data for the previous three years appropriate for the stationary source, or at process temperature, whichever is higher. For alternative scenarios, substances may be considered to be released at a process or ambient temperature that is appropriate for the scenario.

68.25 Worst-case release scenario analysis.

(a) The owner or operator shall analyze and report in the RMP:

(1) For Program 1 processes, one worst-case release scenario for each Program 1 process;

(2) For Program 2 and 3 processes:

(i) One worst-case release scenario that is estimated to create the greatest distance in any direction to an endpoint provided in Appendix A of this part resulting from an accidental release of regulated toxic substances from covered processes under worst-case conditions defined in § 68.22 of this part;

(ii) One worst-case release scenario that is estimated to create the greatest distance in any direction to an endpoint defined in § 68.22(a) of this part resulting from an accidental release of regulated flammable substances from covered processes under worst-case conditions defined in § 68.22 of this part; and

(iii) Additional worst-case release scenarios for a hazard class if a worst-case release from another covered process at the stationary source potentially affects public receptors different from those potentially affected by the worst-case release scenario developed under paragraphs (a)(2)(i) or (a)(2)(ii) of this section.

(b) Determination of worst-case release quantity. The worst-case release quantity shall be the greater of the following:

(1) For substances in a vessel, the greatest amount held in a single vessel, taking into account administrative controls that limit the maximum quantity; or

(2) For substances in pipes, the greatest amount in a pipe, taking into account administrative controls that limit the maximum quantity.

(c) Worst-case release scenario — toxic gases.

(1) For regulated toxic substances that are normally gases at ambient temperature and handled as a gas or as a liquid under pressure, the owner or operator shall assume that the quantity in the vessel or pipe, as determined under paragraph (b) of this section, is released as a gas over 10 minutes. The release rate shall be assumed to be the total quantity divided by 10 unless passive mitigation systems are in place.

(2) For gases handled as refrigerated liquids at ambient pressure:

(i) If the released substance is not contained by passive mitigation systems or if the contained pool would have a depth of 1 cm or less, the owner or operator shall assume that the substance is released as a gas in 10 minutes;

(ii) If the released substance is contained by passive mitigation systems in a pool with a depth greater than 1 cm, the owner or operator may assume that the quantity in the vessel or pipe, as determined under paragraph (b) of this section, is spilled instantaneously to form a liquid pool. The volatilization rate (release rate) shall be calculated at the boiling point of the substance and at the conditions specified in paragraph (d) of this section.

(d) Worst-case release scenario — toxic liquids.

(1) For regulated toxic substances that are normally liquids at ambient temperature, the owner or operator shall assume that the quantity in the vessel or pipe, as determined under paragraph (b) of this section, is spilled instantaneously to form a liquid pool.

(i) The surface area of the pool shall be determined by assuming that the liquid spreads to 1 centimeter deep unless passive mitigation systems are in place that serve to contain the spill and limit the surface area. Where passive mitigation is in place, the surface area of the contained liquid shall be used to calculate the volatilization rate.

(ii) If the release would occur onto a surface that is not paved or smooth, the owner or operator may take into account the actual surface characteristics.

(2) The volatilization rate shall account for the highest daily maximum temperature occurring in the past three years, the temperature of the substance in the vessel, and the concentration of the substance if the liquid spilled is a mixture or solution.

(3) The rate of release to air shall be determined from the volatilization rate of the liquid pool. The owner or operator may use the methodology in the *RMP Offsite Consequence Analysis Guidance* or any other publicly available techniques that account for the modeling conditions and are recognized by industry as applicable as part of current practices. Proprietary models that account for the modeling conditions may be used provided the owner or operator allows the implementing agency access to the model and describes model features and differences from publicly available models to local emergency planners upon request.

(e) Worst-case release scenario - flammables. The owner or operator shall assume that the quantity of the substance, as determined under paragraph (b) of this section, vaporizes resulting in a vapor cloud explosion. A yield factor of 10 percent of the available energy released in the explosion shall be used to determine the distance to the explosion endpoint if the model used is based on TNT-equivalent methods.

(f) Parameters to be applied. The owner or operator shall use the parameters defined in § 68.22 of this part to determine distance to the endpoints. The owner or operator may use the methodology provided in the *RMP Offsite Consequence Analysis Guidance* or any commercially or publicly available air dispersion modeling techniques, provided the techniques account for the modeling conditions and are recognized by industry as applicable as part of current practices. Proprietary models that account for the modeling conditions may be used provided the owner or operator allows the implementing agency access to the model and describes model features and differences from publicly available models to local emergency planners upon request.

(g) Consideration of passive mitigation. Passive mitigation systems may be considered for the analysis of worst case provided that the mitigation system is capable of withstanding the release event triggering the scenario and would still function as intended.

(h) Factors in selecting a worst-case scenario. Notwithstanding the provisions of paragraph (b) of this section, the owner or operator shall select as the worst case for flammable regulated substances or the worst case for regulated toxic substances, a scenario based on the following factors if such a scenario would result in a greater distance to an endpoint defined in § 68.22(a) of this part beyond the stationary source boundary than the scenario provided under paragraph (b) of this section:

(1) Smaller quantities handled at higher process temperature or pressure; and

(2) Proximity to the boundary of the stationary source.

68.28 Alternative release scenario analysis.

(a) The number of scenarios. The owner or operator shall identify and analyze at least one alternative release scenario for each regulated toxic substance held in a covered process(es) and at least one alternative release scenario to represent all flammable substances held in covered processes.

(b) Scenarios to consider. (1) For each scenario required under paragraph (a) of this section, the owner or operator shall select a scenario:

(i) That is more likely to occur than the worst-case release scenario under § 68.25 of this part; and

(ii) That will reach an endpoint offsite, unless no such scenario exists.

(2) Release scenarios considered should include, but are not limited to, the following, where applicable:

(i) Transfer hose releases due to splits or sudden hose uncoupling;

(ii) Process piping releases from failures at flanges, joints, welds, valves and valve seals, and drains or bleeds;

(iii) Process vessel or pump releases due to cracks, seal failure, or drain, bleed, or plug failure;

(iv) Vessel overfilling and spill, or overpressurization and venting through relief valves or rupture disks; and

(v) Shipping container mishandling and breakage or puncturing leading to a spill.

(c) Parameters to be applied. The owner or operator shall use the appropriate parameters defined in § 68.22 of this part to determine distance to the endpoints. The owner or operator may use either the methodology provided in the *RMP Offsite Consequence Analysis Guidance* or any commercially or publicly available air dispersion modeling techniques, provided the techniques account for the specified modeling conditions and are recognized by industry as applicable as part of current practices. Proprietary models that account for the modeling conditions may be used provided the owner or operator allows the implementing agency access to the model and describes model features and differences from publicly available models to local emergency planners upon request.

(d) Consideration of mitigation. Active and passive mitigation systems may be considered provided they are capable of withstanding the event that triggered the release and would still be functional.

(e) Factors in selecting scenarios. The owner or operator shall consider the following in selecting alternative release scenarios:

(1) The five-year accident history provided in § 68.42 of this part; and

(2) Failure scenarios identified under §§ 68.50 or 68.67 of this part.

68.30 Defining offsite impacts — population.

(a) The owner or operator shall estimate in the RMP the population within a circle with its center at the point of the release and a radius determined by the distance to the endpoint defined in § 68.22(a) of this part.

(b) Population to be defined. Population shall include residential population. The presence of institutions (schools, hospitals, prisons), parks and recreational areas, and major commercial, office, and industrial buildings shall be noted in the RMP.

(c) Data sources acceptable. The owner or operator may use the most recent Census data, or other updated information, to estimate the population potentially affected.

(d) Level of accuracy. Population shall be estimated to two significant digits.

68.33 Defining offsite impacts — environment.

(a) The owner or operator shall list in the RMP environmental receptors within a circle with its center at the point of the release and a radius determined by the distance to the endpoint defined in § 68.22(a) of this part.

(b) Data sources acceptable. The owner or operator may rely on information provided on local U.S. Geological Survey maps or on any data source containing U.S.G.S. data to identify environmental receptors.

68.36 Review and update.

(a) The owner or operator shall review and update the offsite consequence analyses at least once every five years.

(b) If changes in processes, quantities stored or handled, or any other aspect of the stationary source might reasonably be expected to increase or decrease the distance to the endpoint by a factor of two or more, the owner or operator shall complete a revised analysis within six months of the change and submit a revised risk management plan as provided in § 68.190 of this part.

68.39 Documentation. The owner or operator shall maintain the following records on the offsite consequence analyses:

(a) For worst-case scenarios, a description of the vessel or pipeline and substance selected as worst case, assumptions and parameters used, and the rationale for selection; assumptions shall include use of any administrative controls and any passive mitigation that were assumed to limit the quantity that could be released. Documentation shall include the anticipated effect of the controls and mitigation on the release quantity and rate.

(b) For alternative release scenarios, a description of the scenarios identified, assumptions and parameters used, and the rationale for the selection of specific scenarios; assumptions shall include use of any administrative controls and any mitigation that were assumed to limit the quantity that could be released. Documentation shall include the effect of the controls and mitigation on the release quantity and rate.

(c) Documentation of estimated quantity released, release rate, and duration of release.

(d) Methodology used to determine distance to endpoints.

(e) Data used to estimate population and environmental receptors potentially affected.

68.42 Five-year accident history.

(a) The owner or operator shall include in the five-year accident history all accidental releases from covered processes that resulted in deaths, injuries, or significant property damage on site, or known offsite deaths, injuries, evacuations, sheltering in place, property damage, or environmental damage.

(b) Data required. For each accidental release included, the owner or operator shall report the following information:

(1) Date, time, and approximate duration of the release;

(2) Chemical(s) released;

(3) Estimated quantity released in pounds;
(4) The type of release event and its source;
(5) Weather conditions, if known;
(6) On-site impacts;
(7) Known offsite impacts;
(8) Initiating event and contributing factors if known;
(9) Whether offsite responders were notified if known; and
(10) Operational or process changes that resulted from investigation of the release.
(c) Level of accuracy. Numerical estimates may be provided to two significant digits.

9. Subpart C is added to read as follows:

Subpart C Program 2 Prevention Program

68.48 Safety information.

(a) The owner or operator shall compile and maintain the following up-to-date safety information related to the regulated substances, processes, and equipment:

(1) Material Safety Data Sheets that meet the requirements of 29 CFR 1910.1200(g);

(2) Maximum intended inventory of equipment in which the regulated substances are stored or processed;

(3) Safe upper and lower temperatures, pressures, flows, and compositions;

(4) Equipment specifications; and

(5) Codes and standards used to design, build, and operate the process.

(b) The owner or operator shall ensure that the process is designed in compliance with recognized and generally accepted good engineering practices. Compliance with Federal or state regulations that address industry-specific safe design or with industry-specific design codes and standards may be used to demonstrate compliance with this paragraph.

(c) The owner or operator shall update the safety information if a major change occurs that makes the information inaccurate.

68.50 Hazard review

(a) The owner or operator shall conduct a review of the hazards associated with the regulated substances, process, and procedures. The review shall identify the following:

(1) The hazards associated with the process and regulated substances;

(2) Opportunities for equipment malfunctions or human errors that could cause an accidental release;

(3) The safeguards used or needed to control the hazards or prevent equipment malfunction or human error; and

(4) Any steps used or needed to detect or monitor releases.

(b) The owner or operator may use checklists developed by persons or organizations knowledgeable about the process and equipment as a guide to conducting the review. For processes designed to meet industry standards or Federal or state design rules, the hazard review shall, by inspecting all equipment, determine whether the process is designed, fabricated, and operated in accordance with the applicable standards or rules.

(c) The owner or operator shall document the results of the review and ensure that problems identified are resolved in a timely manner.

(d) The review shall be updated at least once every five years. The owner or operator shall also conduct reviews whenever a major change in the process occurs; all issues identified in the review shall be resolved before startup of the changed process.

68.52 Operating procedures.

(a) The owner or operator shall prepare written operating procedures that provide clear instructions or steps for safely conducting activities associated with each covered process consistent with the safety information for that process. Operating procedures or instructions provided by equipment manufacturers or developed by persons or organizations knowledgeable about the process and equipment may be used as a basis for a stationary source's operating procedures.

(b) The procedures shall address the following:

(1) Initial startup;

(2) Normal operations;

(3) Temporary operations;

(4) Emergency shutdown and operations;

(5) Normal shutdown;

(6) Startup following a normal or emergency shutdown or a major change that requires a hazard review;

(7) Consequences of deviations and steps required to correct or avoid deviations; and

(8) Equipment inspections.

(c) The owner or operator shall ensure that the operating procedures are updated, if necessary, whenever a major change occurs and prior to startup of the changed process.

68.54 Training.

(a) The owner or operator shall ensure that each employee presently operating a process, and each employee newly assigned to a covered process have been trained or tested competent in the operating procedures provided in § 68.52 of this part that pertain to their duties. For those employees already operating a process on [insert date 3 years after the date of publication in the FEDERAL REGISTER], the owner or operator may certify in writing that the employee has the required knowledge, skills, and abilities to safely carry out the duties and responsibilities as provided in the operating procedures.

(b) Refresher training. Refresher training shall be provided at least every three years, and more often if necessary, to each employee operating a process to ensure that the employee understands and adheres to the current operating procedures of the process. The owner or operator, in consultation with the employees operating the process, shall determine the appropriate frequency of refresher training.

(c) The owner or operator may use training conducted under Federal or state regulations or under industry-specific standards or codes or training conducted by covered process equipment vendors to demonstrate compliance with this section to the extent that the training meets the requirements of this section.

(d) The owner or operator shall ensure that operators are trained in any updated or new procedures prior to startup of a process after a major change.

68.56 Maintenance.

(a) The owner or operator shall prepare and implement procedures to maintain the on-going mechanical integrity of the process equipment. The owner or operator may use procedures or instructions provided by covered process equipment vendors or procedures in Federal or state regulations or industry codes as the basis for stationary source maintenance procedures.

(b) The owner or operator shall train or cause to be trained each employee involved in maintaining the on-going mechanical integrity of the process. To ensure that the employee can perform the job tasks in a safe manner, each such employee shall be trained in the hazards of the process, in how to avoid or correct unsafe conditions, and in the procedures applicable to the employee's job tasks.

(c) Any maintenance contractor shall ensure that each contract maintenance employee is trained to perform the maintenance procedures developed under paragraph (a) of this section.

(d) The owner or operator shall perform or cause to be performed inspections and tests on process equipment. Inspection and testing procedures shall follow recognized and generally accepted good engineering practices. The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations, industry standards or codes, good engineering practices, and prior operating experience.

68.58 Compliance audits.

(a) The owner or operator shall certify that they have evaluated compliance with the provisions of this subpart at least every three years to verify that the procedures and practices developed under the rule are adequate and are being followed.

(b) The compliance audit shall be conducted by at least one person knowledgeable in the process.

(c) The owner or operator shall develop a report of the audit findings.

(d) The owner or operator shall promptly determine and document an appropriate response to each of the findings of the compliance audit and document that deficiencies have been corrected.

(e) The owner or operator shall retain the two (2) most recent compliance audit reports. This requirement does not apply to any compliance audit report that is more than five years old.

68.60 Incident investigation.

(a) The owner or operator shall investigate each incident which resulted in, or could reasonably have resulted in a catastrophic release.

(b) An incident investigation shall be initiated as promptly as possible, but not later than 48 hours following the incident.

(c) A summary shall be prepared at the conclusion of the investigation which includes at a minimum:

(1) Date of incident;

(2) Date investigation began;

(3) A description of the incident;

(4) The factors that contributed to the incident; and,

(5) Any recommendations resulting from the investigation.

(d) The owner or operator shall promptly address and resolve the investigation findings and recommendations. Resolutions and corrective actions shall be documented.

(e) The findings shall be reviewed with all affected personnel whose job tasks are affected by the findings.

(f) Investigation summaries shall be retained for five years.

10. Subpart D is added to read as follows:

Subpart D Program 3 Prevention Program

68.65 Process safety information.

(a) In accordance with the schedule set forth in § 68.67 of this part, the owner or operator shall complete a compilation of written process safety information before conducting any process hazard analysis required by the rule. The compilation of written process safety information is to enable the owner or operator and the employees involved in operating the process to identify and understand the hazards posed by those processes involving regulated substances. This process safety information shall include information pertaining to the hazards of the regulated substances used or produced by the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process.

(b) Information pertaining to the hazards of the regulated substances in the process. This information shall consist of at least the following:

(1) Toxicity information;

(2) Permissible exposure limits;

(3) Physical data;

(4) Reactivity data;

(5) Corrosivity data;

(6) Thermal and chemical stability data; and

(7) Hazardous effects of inadvertent mixing of different materials that could foreseeably occur.

Note: Material Safety Data Sheets meeting the requirements of 29 CFR 1910.1200(g) may be used to comply with this requirement to the extent they contain the information required by this subparagraph.

(c) Information pertaining to the technology of the process.

(1) Information concerning the technology of the process shall include at least the following:

(i) A block flow diagram or simplified process flow diagram;

(ii) Process chemistry;

(iii) Maximum intended inventory;

(iv) Safe upper and lower limits for such items as temperatures, pressures, flows or compositions; and,

(v) An evaluation of the consequences of deviations.

(2) Where the original technical information no longer exists, such information may be developed in conjunction with the process hazard analysis in sufficient detail to support the analysis.

(d) Information pertaining to the equipment in the process.

(1) Information pertaining to the equipment in the process shall include:

(i) Materials of construction;

(ii) Piping and instrument diagrams (P&ID's);

(iii) Electrical classification;

(iv) Relief system design and design basis;

(v) Ventilation system design;

(vi) Design codes and standards employed;

(vii) Material and energy balances for processes built after [insert date 3 years after the date of publication in the FEDERAL REGISTER]; and

(viii) Safety systems (e.g. interlocks, detection or suppression systems).

(2) The owner or operator shall document that equipment complies with recognized and generally accepted good engineering practices.

(3) For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, the owner or operator shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

68.67 Process hazard analysis.

(a) The owner or operator shall perform an initial process hazard analysis (hazard evaluation) on processes covered by this part. The process hazard analysis shall be appropriate to the complexity of the process and shall identify, evaluate, and control the hazards involved in the process. The owner or operator shall determine and document the priority order for conducting process hazard analyses based on a rationale which includes such considerations as extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process. The process hazard analysis shall be conducted as soon as possible, but not later than [insert date 3 years after the date of publication in the FEDERAL REGISTER]. Process hazards analyses completed to comply with 29 CFR 1910.119(e) are acceptable as initial process hazards analyses. These process hazard analyses shall be updated and revalidated, based on their completion date.

(b) The owner or operator shall use one or more of the following methodologies that are appropriate to determine and evaluate the hazards of the process being analyzed.

(1) What-If;

(2) Checklist;

(3) What-If/Checklist;

(4) Hazard and Operability Study (HAZOP);

(5) Failure Mode and Effects Analysis (FMEA);

(6) Fault Tree Analysis; or

(7) An appropriate equivalent methodology.

(c) The process hazard analysis shall address:

(1) The hazards of the process;

(2) The identification of any previous incident which had a likely potential for catastrophic consequences.

(3) Engineering and administrative controls applicable to the hazards and their interrelationships such as appropriate application of detection methodologies to provide early warning of releases. (Acceptable detection methods might include process monitoring and control instrumentation with alarms, and detection hardware such as hydrocarbon sensors.);

(4) Consequences of failure of engineering and administrative controls;

(5) Stationary source siting;

(6) Human factors; and

(7) A qualitative evaluation of a range of the possible safety and health effects of failure of controls.

(d) The process hazard analysis shall be performed by a team with expertise in engineering and process operations, and the team shall include at least one employee who has experience and knowledge specific to the process being evaluated. Also, one member of the team must be knowledgeable in the specific process hazard analysis methodology being used.

(e) The owner or operator shall establish a system to promptly address the team's findings and recommendations; assure that the recommendations are resolved in a timely manner and that the resolution is documented; document what actions are to be taken; complete actions as soon as possible; develop a written schedule of when these actions are to be completed; communicate the actions to operating, maintenance and other employees whose work assignments are in the process and who may be affected by the recommendations or actions.

(f) At least every five (5) years after the completion of the initial process hazard analysis, the process hazard analysis shall be updated and revalidated by a team meeting the requirements in paragraph (d) of this section, to assure that the process hazard analysis is consistent with the current process. Updated and revalidated process hazard analyses completed to comply with 29 CFR 1910.119(e) are acceptable to meet the requirements of this paragraph.

(g) The owner or operator shall retain process hazards analyses and updates or revalidations for each process covered by this section, as well as the documented resolution of recommendations described in paragraph (e) of this section for the life of the process.

68.69 Operating procedures.

(a) The owner or operator shall develop and implement written operating procedures that provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information and shall address at least the following elements.

(1) Steps for each operating phase:

(i) Initial startup;

(ii) Normal operations;

(iii) Temporary operations;

(iv) Emergency shutdown including the conditions under which emergency shutdown is required, and the assignment of shutdown responsibility to qualified operators to ensure that emergency shutdown is executed in a safe and timely manner.

(v) Emergency operations;

(vi) Normal shutdown; and,

(vii) Startup following a turnaround, or after an emergency shutdown.

(2) Operating limits:

(i) Consequences of deviation; and

(ii) Steps required to correct or avoid deviation.

(3) Safety and health considerations:

(i) Properties of, and hazards presented by, the chemicals used in the process;

(ii) Precautions necessary to prevent exposure, including engineering controls, administrative controls, and personal protective equipment;

(iii) Control measures to be taken if physical contact or airborne exposure occurs;

(iv) Quality control for raw materials and control of hazardous chemical inventory levels; and,

(v) Any special or unique hazards.

(4) Safety systems and their functions.

(b) Operating procedures shall be readily accessible to employees who work in or maintain a process.

(c) The operating procedures shall be reviewed as often as necessary to assure that they reflect current operating practice, including changes that result from changes in process chemicals, technology, and equipment, and changes to stationary sources. The owner or operator shall certify annually that these operating procedures are current and accurate.

(d) The owner or operator shall develop and implement safe work practices to provide for the control of hazards during operations such as lockout/tagout; confined space entry; opening process equipment or piping; and control over entrance into a stationary source by maintenance, contractor, laboratory, or other support personnel. These safe work practices shall apply to employees and contractor employees.

68.71 Training.

(a) Initial training. (1) Each employee presently involved in operating a process, and each employee before being involved in operating a newly assigned process, shall be trained in an overview of the process and in the operating procedures as specified in § 68.69 of this part. The training shall include emphasis on the specific safety and health hazards, emergency operations including shutdown, and safe work practices applicable to the employee's job tasks.

(2) In lieu of initial training for those employees already involved in operating a process on [insert date 3 years after the date of publication in the FEDERAL REGISTER] an owner or operator may certify in writing that the employee has the required knowledge, skills, and abilities to safely carry out the duties and responsibilities as specified in the operating procedures.

(b) Refresher training. Refresher training shall be provided at least every three years, and more often if necessary, to each employee involved in operating a process to assure that the employee understands and adheres to the current operating procedures of the process. The owner or operator, in consultation with the employees involved in operating the process, shall determine the appropriate frequency of refresher training.

(c) Training documentation. The owner or operator shall ascertain that each employee involved in operating a process has received and understood the training required by this paragraph. The owner or operator shall prepare a record which contains the identity of the employee, the date of training, and the means used to verify that the employee understood the training.

68.73 Mechanical integrity.

(a) Application. Paragraphs (b) through (f) of this section apply to the following process equipment:

(1) Pressure vessels and storage tanks;

(2) Piping systems (including piping components such as valves);

(3) Relief and vent systems and devices;

(4) Emergency shutdown systems;

(5) Controls (including monitoring devices and sensors, alarms, and interlocks) and,

(6) Pumps.

(b) Written procedures. The owner or operator shall establish and implement written procedures to maintain the on-going integrity of process equipment.

(c) Training for process maintenance activities. The owner or operator shall train each employee involved in maintaining the on-going integrity of process equipment in an overview of that process and its hazards and in the procedures applicable to the employee's job tasks to assure that the employee can perform the job tasks in a safe manner.

(d) Inspection and testing. (1) Inspections and tests shall be performed on process equipment.

(2) Inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

(3) The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations and good engineering practices, and more frequently if determined to be necessary by prior operating experience.

(4) The owner or operator shall document each inspection and test that has been performed on process equipment. The documentation shall identify the date of the inspection or test, the name of the person who performed the inspection or test, the serial number or other identifier of the equipment on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.

(e) Equipment deficiencies. The owner or operator shall correct deficiencies in equipment that are outside acceptable limits (defined by the process safety information in § 68.65 of this part) before further use or in a safe and timely manner when necessary means are taken to assure safe operation.

(f) Quality assurance. (1) In the construction of new plants and equipment, the owner or operator shall assure that equipment as it is fabricated is suitable for the process application for which they will be used.

(2) Appropriate checks and inspections shall be performed to assure that equipment is installed properly and consistent with design specifications and the manufacturer's instructions.

(3) The owner or operator shall assure that maintenance materials, spare parts and equipment are suitable for the process application for which they will be used.

68.75 Management of change.

(a) The owner or operator shall establish and implement written procedures to manage changes (except for "replacements in kind") to process chemicals, technology, equipment, and procedures; and, changes to stationary sources that affect a covered process.

(b) The procedures shall assure that the following considerations are addressed prior to any change:

(1) The technical basis for the proposed change;

(2) Impact of change on safety and health;

(3) Modifications to operating procedures;

(4) Necessary time period for the change; and,

(5) Authorization requirements for the proposed change.

(c) Employees involved in operating a process and maintenance and contract employees whose job tasks will be affected by a change in the process shall be informed of, and trained in, the change prior to start-up of the process or affected part of the process.

(d) If a change covered by this paragraph results in a change in the process safety information required by § 68.65 of this part, such information shall be updated accordingly.

(e) If a change covered by this paragraph results in a change in the operating procedures or practices required by § 68.69 of this part, such procedures or practices shall be updated accordingly.

68.77 Pre-startup review.

(a) The owner or operator shall perform a pre-startup safety review for new stationary sources and for modified stationary sources when the modification is significant enough to require a change in the process safety information.

(b) The pre-startup safety review shall confirm that prior to the introduction of regulated substances to a process:

(1) Construction and equipment is in accordance with design specifications;

(2) Safety, operating, maintenance, and emergency procedures are in place and are adequate;

(3) For new stationary sources, a process hazard analysis has been performed and recommendations have been resolved or implemented before startup; and modified stationary sources meet the requirements contained in management of change, § 68.75 of this part.

(4) Training of each employee involved in operating a process has been completed.

68.79 Compliance audits.

(a) The owner or operator shall certify that they have evaluated compliance with the provisions of this section at least every three years to verify that the procedures and practices developed under the standard are adequate and are being followed.

(b) The compliance audit shall be conducted by at least one person knowledgeable in the process.

(c) A report of the findings of the audit shall be developed.

(d) The owner or operator shall promptly determine and document an appropriate response to each of the findings of the compliance audit, and document that deficiencies have been corrected.

(e) The owner or operator shall retain the two (2) most recent compliance audit reports.

68.81 Incident investigation.

(a) The owner or operator shall investigate each incident which resulted in, or could reasonably have resulted in a catastrophic release of a regulated substance.

(b) An incident investigation shall be initiated as promptly as possible, but not later than 48 hours following the incident.

(c) An incident investigation team shall be established and consist of at least one person knowledgeable in the process involved, including a contract employee if the incident involved work of the contractor, and other persons with appropriate knowledge and experience to thoroughly investigate and analyze the incident.

(d) A report shall be prepared at the conclusion of the investigation which includes at a minimum:

(1) Date of incident;

(2) Date investigation began;

(3) A description of the incident;

(4) The factors that contributed to the incident; and,

(5) Any recommendations resulting from the investigation.

(e) The owner or operator shall establish a system to promptly address and resolve the incident report findings and recommendations. Resolutions and corrective actions shall be documented.

(f) The report shall be reviewed with all affected personnel whose job tasks are relevant to the incident findings including contract employees where applicable.

(g) Incident investigation reports shall be retained for five years.

68.83 Employee participation.

(a) The owner or operator shall develop a written plan of action regarding the implementation of the employee participation required by this section.

(b) The owner or operator shall consult with employees and their representatives on the conduct and development of process hazards analyses and on the development of the other elements of process safety management in this rule.

(c) The owner or operator shall provide to employees and their representatives access to process hazard analyses and to all other information required to be developed under this rule.

68.85 Hot work permit.

(a) The owner or operator shall issue a hot work permit for hot work operations conducted on or near a covered process.

(b) The permit shall document that the fire prevention and protection requirements in 29 CFR 1910.252(a) have been implemented prior to beginning the hot work operations; it shall indicate the date(s) authorized for hot work; and identify the object on which hot work is to be performed. The permit shall be kept on file until completion of the hot work operations.

68.87 Contractors.

(a) Application. This section applies to contractors performing maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to a covered process. It does not apply to contractors providing incidental services which do not influence process safety, such as janitorial work, food and drink services, laundry, delivery or other supply services.

(b) Owner or operator responsibilities. (1) The owner or operator, when selecting a contractor, shall obtain and evaluate information regarding the contract owner or operator's safety performance and programs.

(2) The owner or operator shall inform contract owner or operator of the known potential fire, explosion, or toxic release hazards related to the contractor's work and the process.

(3) The owner or operator shall explain to the contract owner or operator the applicable provisions of subpart E of this part.

(4) The owner or operator shall develop and implement safe work practices consistent with § 68.69(d) of this part, to control the entrance, presence, and exit of the contract owner or operator and contract employees in covered process areas.

(5) The owner or operator shall periodically evaluate the performance of the contract owner or operator in fulfilling their obligations as specified in paragraph (c) of this section.

(c) Contract owner or operator responsibilities. (1) The contract owner or operator shall assure that each contract employee is trained in the work practices necessary to safely perform his/her job.

(2) The contract owner or operator shall assure that each contract employee is instructed in the known potential fire, explosion, or toxic release hazards related to his/her job and the process, and the applicable provisions of the emergency action plan.

(3) The contract owner or operator shall document that each contract employee has received and understood the training required by this section. The contract owner or operator shall prepare a record which contains the identity of the contract employee, the date of training, and the means used to verify that the employee understood the training.

(4) The contract owner or operator shall assure that each contract employee follows the safety rules of the stationary source including the safe work practices required by § 68.69(d) of this part.

(5) The contract owner or operator shall advise the owner or operator of any unique hazards presented by the contract owner or operator's work, or of any hazards found by the contract owner or operator's work.

11. Subpart E is added to read as follows:

Subpart E Emergency Response

68.90 Applicability.

(a) Except as provided in paragraph (b) of this section, the owner or operator of a stationary source with Program 2 and Program 3 processes shall comply with the requirements of § 68.95 of this part.

(b) The owner or operator of stationary source whose employees will not respond to accidental releases of regulated substances need not comply with § 68.95 of this part provided that they meet the following:

(1) For stationary sources with any regulated toxic substance held in a process above the threshold quantity, the stationary source is included in the community emergency response plan developed under 42 U.S.C. 11003;

(2) For stationary sources with only regulated flammable substances held in a process above the threshold quantity, the owner or operator has coordinated response actions with the local fire department; and

(3) Appropriate mechanisms are in place to notify emergency responders when there is a need for a response.

68.95 Emergency response program

(a) The owner or operator shall develop and implement an emergency response program for the purpose of protecting public health and the environment. Such program shall include the following elements:

(1) An emergency response plan, which shall be maintained at the stationary source and contain at least the following elements:

(i) Procedures for informing the public and local emergency response agencies about accidental releases;

(ii) Documentation of proper first-aid and emergency medical treatment necessary to treat accidental human exposures; and

(iii) Procedures and measures for emergency response after an accidental release of a regulated substance;

(2) Procedures for the use of emergency response equipment and for its inspection, testing, and maintenance;

(3) Training for all employees in relevant procedures; and

(4) Procedures to review and update, as appropriate, the emergency response plan to reflect changes at the stationary source and ensure that employees are informed of changes.

(b) A written plan that complies with other Federal contingency plan regulations or is consistent with the approach in the National Response Team's *Integrated Contingency Plan Guidance* ("One Plan") and that, among other matters, includes the elements provided in paragraph (a) of this section, shall satisfy the requirements of this section if the owner or operator also complies with paragraph (c) of this section.

(c) The emergency response plan developed under paragraph (a)(1) of this section shall be coordinated with the community emergency response plan developed under 42 U.S.C. 11003. Upon request of the local emergency planning committee or emergency response officials, the owner or operator shall promptly provide to the local emergency response officials information necessary for developing and implementing the community emergency response plan.

12. Subpart G is added to read as follows:

Subpart G Risk management plan

68.150 Submission.

68.155 Executive summary.

68.150 Submission.

(a) The owner or operator shall submit a single RMP that includes the information required by §§ 68.155 through 68.185 of this part for all covered processes. The RMP shall be submitted in a method and format to a central point as specified by EPA prior to [insert date 3 years after the date of publication in the FEDERAL REGISTER].

(b) The owner or operator shall submit the first RMP no later than the latest of the following dates:

(1) [insert date 3 years after the date of publication in the FEDERAL REGISTER];

(2) Three years after the date on which a regulated substance is first listed under § 68.130 of this part; or

(3) The date on which a regulated substance is first present above a threshold quantity in a process.

(c) Subsequent submissions of RMPs shall be in accordance with § 68.190 of this part.

(d) Notwithstanding the provisions of §§ 68.155 to 68.190 of this part, the RMP shall exclude classified information. Subject to appropriate procedures to protect such information from public disclosure, classified data or information excluded from the RMP may be made available in a classified annex to the RMP for review by Federal and state representatives who have received the appropriate security clearances.

68.155 Executive summary.

The owner or operator shall provide in the RMP an executive summary that includes a brief description of the following elements:

(a) The accidental release prevention and emergency response policies at the stationary source;

(b) The stationary source and regulated substances handled;

(c) The worst-case release scenario(s) and the alternative release scenario(s), including administrative controls and mitigation measures to limit the distances for each reported scenario;

(d) The general accidental release prevention program and chemical-specific prevention steps;

(e) The five-year accident history;

(f) The emergency response program; and

(g) Planned changes to improve safety.

68.160 Registration.

(a) The owner or operator shall complete a single registration form and include it in the RMP. The form shall cover all regulated substances handled in covered processes.

(b) The registration shall include the following data:

(1) Stationary source name, street, city, county, state, zip code, latitude, and longitude;

(2) The stationary source Dun and Bradstreet number;

(3) Name and Dun and Bradstreet number of the corporate parent company;

(4) The name, telephone number, and mailing address of the owner or operator;

(5) The name and title of the person or position with overall responsibility for RMP elements and implementation;

(6) The name, title, telephone number, and 24-hour telephone number of the emergency contact;

(7) For each covered process, the name and CAS number of each regulated substance held above the threshold quantity in the process, the maximum quantity of each regulated substance or mixture in the process (in pounds) to two significant digits, the SIC code, and the Program level of the process;

(8) The stationary source EPA identifier;

(9) The number of full-time employees at the stationary source;

(10) Whether the stationary source is subject to 29 CFR 1910.119;

(11) Whether the stationary source is subject to 40 CFR part 355;

(12) Whether the stationary source has a CAA Title V operating permit; and

(13) The date of the last safety inspection of the stationary source by a Federal, state, or local government agency and the identity of the inspecting entity.

68.165 Offsite consequence analysis.

(a) The owner or operator shall submit in the RMP information:

(1) One worst-case release scenario for each Program 1 process; and

(2) For Program 2 and 3 processes, one worst-case release scenario to represent all regulated toxic substances held above the threshold quantity and one worst-case release scenario to represent all regulated flammable substances held above the threshold quantity. If additional worst-case scenarios for toxics or flammables are required by § 68.25(a)(2)(iii) of this part, the owner or operator shall submit the same information on the additional scenario(s). The owner or operator of Program 2 and 3 processes shall also submit information on one alternative release scenario for each regulated toxic substance held above the threshold quantity and one alternative release scenario to represent all regulated flammable substances held above the threshold quantity.

(b) The owner or operator shall submit the following data:

(1) Chemical name;

(2) Physical state (toxics only);

(3) Basis of results (give model name if used);

(4) Scenario (explosion, fire, toxic gas release, or liquid spill and vaporization);

(5) Quantity released in pounds;

(6) Release rate;

(7) Release duration;

(8) Wind speed and atmospheric stability class (toxics only);

(9) Topography (toxics only);

(10) Distance to endpoint;

(11) Public and environmental receptors within the distance;

(12) Passive mitigation considered; and

(13) Active mitigation considered (alternative releases only);

68.168 Five-year accident history. The owner or operator shall submit in the RMP the information provided in § 68.42(b) of this part on each accident covered by § 68.42(a) of this part.

68.170 Prevention program/Program 2.

(a) For each Program 2 process, the owner or operator shall provide in the RMP the information indicated in paragraphs (b) through (k) of this section. If the same information applies to more than one covered process, the owner or operator may provide the information only once, but shall indicate to which processes the information applies.

(b) The SIC code for the process.

(c) The name(s) of the chemical(s) covered.

(d) The date of the most recent review or revision of the safety information and a list of Federal or state regulations or industry-specific design codes and standards used to demonstrate compliance with the safety information requirement.

(e) The date of completion of the most recent hazard review or update.

(1) The expected date of completion of any changes resulting from the hazard review;

(2) Major hazards identified;

(3) Process controls in use;

(4) Mitigation systems in use;

(5) Monitoring and detection systems in use; and

(6) Changes since the last hazard review.

(f) The date of the most recent review or revision of operating procedures.

(g) The date of the most recent review or revision of training programs;

(1) The type of training provided — classroom, classroom plus on the job, on the job; and

(2) The type of competency testing used.

(h) The date of the most recent review or revision of maintenance procedures and the date of the most recent equipment inspection or test and the equipment inspected or tested.

(i) The date of the most recent compliance audit and the expected date of completion of any changes resulting from the compliance audit.

(j) The date of the most recent incident investigation and the expected date of completion of any changes resulting from the investigation.

(k) The date of the most recent change that triggered a review or revision of safety information, the hazard review, operating or maintenance procedures, or training.

68.175 Prevention program/Program 3.

(a) For each Program 3 process, the owner or operator shall provide the information indicated in paragraphs (b) through (p) of this section. If the same information applies to more than one covered process, the owner or operator may provide the information only once, but shall indicate to which processes the information applies.

(b) The SIC code for the process.

(c) The name(s) of the substance(s) covered.

(d) The date on which the safety information was last reviewed or revised.

(e) The date of completion of the most recent PHA or update and the technique used.

(1) The expected date of completion of any changes resulting from the PHA;

(2) Major hazards identified;

(3) Process controls in use;

(4) Mitigation systems in use;

(5) Monitoring and detection systems in use; and

(6) Changes since the last PHA.

(f) The date of the most recent review or revision of operating procedures.

(g) The date of the most recent review or revision of training programs;

(1) The type of training provided — classroom, classroom plus on the job, on the job; and

(2) The type of competency testing used.

(h) The date of the most recent review or revision of maintenance procedures and the date of the most recent equipment inspection or test and the equipment inspected or tested.

(i) The date of the most recent change that triggered management of change procedures and the date of the most recent review or revision of management of change procedures.

(j) The date of the most recent pre-startup review.

(k) The date of the most recent compliance audit and the expected date of completion of any changes resulting from the compliance audit;

(l) The date of the most recent incident investigation and the expected date of completion of any changes resulting from the investigation;

(m) The date of the most recent review or revision of employee participation plans;

(n) The date of the most recent review or revision of hot work permit procedures;

(o) The date of the most recent review or revision of contractor safety procedures; and

(p) The date of the most recent evaluation of contractor safety performance.

68.180 Emergency response program.

(a) The owner or operator shall provide in the RMP the following information:

(1) Do you have a written emergency response plan?

(2) Does the plan include specific actions to be taken in response to an accidental releases of a regulated substance?

(3) Does the plan include procedures for informing the public and local agencies responsible for responding to accidental releases?

(4) Does the plan include information on emergency health care?

(5) The date of the most recent review or update of the emergency response plan;

(6) The date of the most recent emergency response training for employees.

(b) The owner or operator shall provide the name and telephone number of the local agency with which the plan is coordinated.

(c) The owner or operator shall list other Federal or state emergency plan requirements to which the stationary source is subject.

68.185 Certification.

(a) For Program 1 processes, the owner or operator shall submit in the RMP the certification statement provided in § 68.12(b)(4) of this part.

(b) For all other covered processes, the owner or operator shall submit in the RMP a single certification that, to the best of the signer's knowledge, information, and belief formed after reasonable inquiry, the information submitted is true, accurate, and complete.

68.190 Updates.

(a) The owner or operator shall review and update the RMP as specified in paragraph (b) of this section and submit it in a method and format to a central point specified by EPA prior to [insert date 3 years after the date of publication in the FEDERAL REGISTER].

(b) The owner or operator of a stationary source shall revise and update the RMP submitted under § 68.150 as follows:

(1) Within five years of its initial submission or most recent update required by paragraphs (b)(2)-(b)(7) of this section, whichever is later.

(2) No later than three years after a newly regulated substance is first listed by EPA;

(3) No later than the date on which a new regulated substance is first present in an already covered process above a threshold quantity;

(4) No later than the date on which a regulated substance is first present above a threshold quantity in a new process;

(5) Within six months of a change that requires a revised PHA or hazard review;

(6) Within six months of a change that requires a revised offsite consequence analysis as provided in § 68.36 of this part; and

(7) Within six months of a change that alters the Program level that applied to any covered process.

(c) If a stationary source is no longer subject to this part, the owner or operator shall submit a revised registration to EPA within six months indicating that the stationary source is no longer covered.

13. Subpart H is added to read as follows:

Subpart H Other Requirements

68.200 Recordkeeping.

The owner or operator shall maintain records supporting the implementation of this part for five years unless otherwise provided in Subpart D of this part.

68.210 Availability of information to the public.

(a) The RMP required under subpart G of this part shall be available to the public under 42 U.S.C. 7414(c).

(b) The disclosure of classified information by the Department of Defense or other Federal agencies or contractors of such agencies shall be controlled by applicable laws, regulations, or executive orders concerning the release of classified information.

68.215 Permit content and air permitting authority or designated agency requirements.

(a) These requirements apply to any stationary source subject to part 68 and parts 70 or 71 of this Chapter. The 40 CFR part 70 or part 71 permit for the stationary source shall contain:

(1) A statement listing this part as an applicable requirement;

(2) Conditions that require the source owner or operator to submit:

(i) A compliance schedule for meeting the requirements of this part by the date provided in § 68.10(a) of this part or;

(ii) As part of the compliance certification submitted under 40 CFR 70.6(c)(5), a certification statement that the source is in compliance with all requirements of this part, including the registration and submission of the RMP.

(b) The owner or operator shall submit any additional relevant information requested by the air permitting authority or designated agency.

(c) For 40 CFR part 70 or part 71 permits issued prior to the deadline for registering and submitting the RMP and which do not contain permit conditions described in paragraph (a) of this section, the owner or operator or air permitting authority shall initiate permit revision or reopening according to the procedures of 40 CFR 70.7 or 71.7 to incorporate the terms and conditions consistent with paragraph (a) of this section.

(d) The state may delegate the authority to implement and enforce the requirements of paragraph (e) of this section to a state or local agency or agencies other than the air permitting authority. An up-to-date copy of any delegation instrument shall be maintained by the air permitting authority. The state may enter a written agreement with the Administrator under which EPA will implement and enforce the requirements of paragraph (e) of this section.

(e) The air permitting authority or the agency designated by delegation or agreement under paragraph (d) of this section shall, at a minimum:

(1) Verify that the source owner or operator has registered and submitted an RMP or a revised plan when required by this part;

(2) Verify that the source owner or operator has submitted a source certification or in its absence has submitted a compliance schedule consistent with paragraph (a)(2) of this section;

(3) For some or all of the sources subject to this section, use one or more mechanisms such as, but not limited to, a completeness check, source audits, record reviews, or facility inspections to ensure that permitted sources are in compliance with the requirements of this part: and

(4) Initiate enforcement action based on paragraphs (e)(1) and (e)(2) of this section as appropriate.

68.220 Audits.

(a) In addition to inspections for the purpose of regulatory development and enforcement of the Act, the implementing agency shall periodically audit RMPs submitted under subpart G of this part to review the adequacy of such RMPs and require revisions of RMPs when necessary to ensure compliance with subpart G of this part.

(b) The implementing agency shall select stationary sources for audits based on any of the following criteria:

(1) Accident history of the stationary source;

(2) Accident history of other stationary sources in the same industry;

(3) Quantity of regulated substances present at the stationary source;

(4) Location of the stationary source and its proximity to the public and environmental receptors;

(5) The presence of specific regulated substances:

(6) The hazards identified in the RMP; and

(7) A plan providing for neutral, random oversight.

(c) Exemption from audits. A stationary source with a Star or Merit ranking under OSHA's voluntary protection program shall be exempt from audits under paragraph (b)(2) and (b)(7) of this section.

(d) The implementing agency shall have access to the stationary source, supporting documentation, and any area where an accidental release could occur.

(e) Based on the audit, the implementing agency may issue the owner or operator of a stationary source a written preliminary determination of necessary revisions to the stationary source's RMP to ensure that the RMP meets the criteria of subpart G of this part. The preliminary determination shall include an explanation for the basis for the revisions, reflecting industry standards and guidelines (such as AIChE/CCPS guidelines and ASME and API standards) to the extent that such standards and guidelines are applicable, and shall include a timetable for their implementation.

(f) Written response to a preliminary determination.

(1) The owner or operator shall respond in writing to a preliminary determination made in accordance with paragraph (e) of this section. The response shall state the owner or operator will implement the revisions contained in the preliminary determination in accordance with the timetable included in the preliminary determination or shall state that the owner or operator rejects the revisions in

whole or in part. For each rejected revision, the owner or operator shall explain the basis for rejecting such revision. Such explanation may include substitute revisions.

(2) The written response under paragraph (f)(1) of this section shall be received by the implementing agency within 90 days of the issue of the preliminary determination or a shorter period of time as the implementing agency specifies in the preliminary determination as necessary to protect public health and the environment. Prior to the written response being due and upon written request from the owner or operator, the implementing agency may provide in writing additional time for the response to be received.

(g) After providing the owner or operator an opportunity to respond under paragraph (f) of this section, the implementing agency may issue the owner or operator a written final determination of necessary revisions to the stationary source's RMP. The final determination may adopt or modify the revisions contained in the preliminary determination under paragraph (e) of this section or may adopt or modify the substitute revisions provided in the response under paragraph (f) of this section. A final determination that adopts a revision rejected by the owner or operator shall include an explanation of the basis for the revision. A final determination that fails to adopt a substitute revision provided under paragraph (f) of this section shall include an explanation of the basis for finding such substitute revision unreasonable.

(h) Thirty days after completion of the actions detailed in the implementation schedule set in the final determination under paragraph (g) of this section, the owner or operator shall be in violation of subpart G of this part and this section unless the owner or operator revises the RMP prepared under subpart G of this part as required by the final determination, and submits the revised RMP as required under § 68.150 of this part.

(i) The public shall have access to the preliminary determinations, responses, and final determinations under this section in a manner consistent with § 68.210 of this part.

(j) Nothing in this section shall preclude, limit, or interfere in any way with the authority of EPA or the state to exercise its enforcement, investigatory, and information gathering authorities concerning this part under the Act.

14. Part 68 Appendix A is added to read as follows:

APPENDIX A
TABLE OF TOXIC ENDPOINTS
(as defined in § 68.22 of this part)

CAS No.	Chemical Name	Toxic Endpoint (mg/L)
107-02-8	Acrolein [2-Propenal]	0.0011
107-13-1	Acrylonitrile [2-Propenenitrile]	0.076
814-68-6	Acrylyl chloride [2-Propenoyl chloride]	0.00090
107-18-6	Allyl alcohol [2-Propen-1-ol]	0.036
107-11-9	Allylamine [2-Propen-1-amine]	0.0032
7664-41-7	Ammonia (anhydrous)	0.14
7664-41-7	Ammonia (conc 20% or greater)	0.14
7784-34-1	Arsenous trichloride	0.010
7784-42-1	Arsine	0.0019
10294-34-5	Boron trichloride [Borane, trichloro-]	0.010
7637-07-2	Boron trifluoride [Borane, trifluoro-]	0.028
353-42-4	Boron trifluoride compound with methyl ether (1:1) [Boron, trifluoro[oxybis[methane]]-, T-4	0.023
7726-95-6	Bromine	0.0065
75-15-0	Carbon disulfide	0.16
7782-50-5	Chlorine	0.0087
10049-04-4	Chlorine dioxide [Chlorine oxide (ClO_2)]	0.0028
67-66-3	Chloroform [Methane, trichloro-]	0.49
542-88-1	Chloromethyl ether [Methane, oxybis[chloro-]	0.00025
107-30-2	Chloromethyl methyl ether [Methane, chloromethoxy-]	0.0018
4170-30-3	Crotonaldehyde [2-Butenal]	0.029
123-73-9	Crotonaldehyde, (E)- [2-Butenal, (E)-]	0.029
506-77-4	Cyanogen chloride	0.030
108-91-8	Cyclohexylamine [Cyclohexanamine]	0.16
19287-45-7	Diborane	0.0011
75-78-5	Dimethyldichlorosilane [Silane, dichlorodimethyl-]	0.026
57-14-7	1,1-Dimethylhydrazine [Hydrazine, 1,1-dimethyl-]	0.012

CAS No.	Chemical Name	Toxic Endpoint (mg/L)
106-89-8	Epichlorohydrin [Oxirane, (chloromethyl)-]	0.076
107-15-3	Ethylenediamine [1,2-Ethanediamine]	0.49
151-56-4	Ethyleneimine [Aziridine]	0.018
75-21-8	Ethylene oxide [Oxirane]	0.090
7782-41-4	Fluorine	0.0039
50-00-0	Formaldehyde (solution)	0.012
110-00-9	Furan	0.0012
302-01-2	Hydrazine	0.011
7647-01-0	Hydrochloric acid (conc 30% or greater)	0.030
74-90-8	Hydrocyanic acid	0.011
7647-01-0	Hydrogen chloride (anhydrous) [Hydrochloric acid]	0.030
7664-39-3	Hydrogen fluoride/Hydrofluoric acid (conc 50% or greater) [Hydrofluoric acid]	0.016
7783-07-5	Hydrogen selenide	0.00066
7783-06-4	Hydrogen sulfide	0.042
13463-40-6	Iron, pentacarbonyl- [Iron carbonyl (Fe(CO)5), (TB-5-11)-]	0.00044
78-82-0	Isobutyronitrile [Propanenitrile, 2-methyl-]	0.14
108-23-6	Isopropyl chloroformate [Carbonochloridic acid, 1-methylethyl ester]	0.10
126-98-7	Methacrylonitrile [2-Propenenitrile, 2-methyl-]	0.0027
74-87-3	Methyl chloride [Methane, chloro-]	0.82
79-22-1	Methyl chloroformate [Carbonochloridic acid, methylester]	0.0019
60-34-4	Methyl hydrazine [Hydrazine, methyl-]	0.0094
624-83-9	Methyl isocyanate [Methane, isocyanato-]	0.0012
74-93-1	Methyl mercaptan [Methanethiol]	0.049
556-64-9	Methyl thiocyanate [Thiocyanic acid, methyl ester]	0.085
75-79-6	Methyltrichlorosilane [Silane, trichloromethyl-]	0.018
13463-39-3	Nickel carbonyl	0.00067
7697-37-2	Nitric acid (conc 80% or greater)	0.026
10102-43-9	Nitric oxide [Nitrogen oxide (NO)]	0.031
8014-95-7	Oleum (Fuming Sulfuric acid) [Sulfuric acid, mixture with sulfur trioxide]	0.010
79-21-0	Peracetic acid [Ethaneperoxoic acid]	0.0045

CAS No.	Chemical Name	Toxic Endpoint (mg/L)
594-42-3	Perchloromethylmercaptan [Methanesulfenyl chloride, trichloro-]	0.0076
75-44-5	Phosgene [Carbonic dichloride]	0.00081
7803-51-2	Phosphine	0.0035
10025-87-3	Phosphorus oxychloride [Phosphoryl chloride]	0.0030
7719-12-2	Phosphorus trichloride [Phosphorous trichloride]	0.028
110-89-4	Piperidine	0.022
107-12-0	Propionitrile [Propanenitrile]	0.0037
109-61-5	Propyl chloroformate [Carbonochloridic acid, propylester]	0.010
75-55-8	Propyleneimine [Aziridine, 2-methyl-]	0.12
75-56-9	Propylene oxide [Oxirane, methyl-]	0.59
7446-09-5	Sulfur dioxide (anhydrous)	0.0078
7783-60-0	Sulfur tetrafluoride [Sulfur fluoride (SF4), (T-4)-]	0.0092
7446-11-9	Sulfur trioxide	0.010
75-74-1	Tetramethyllead [Plumbane, tetramethyl-]	0.0040
509-14-8	Tetranitromethane [Methane, tetranitro-]	0.0040
7550-45-0	Titanium tetrachloride [Titanium chloride (TiCl4) (T-4)-]	0.020
584-84-9	Toluene 2,4-diisocyanate [Benzene, 2,4-diisocyanato-1-methyl-]	0.0070
91-08-7	Toluene 2,6-diisocyanate [Benzene, 1,3-diisocyanato-2-methyl-]	0.0070
26471-62-5	Toluene diisocyanate (unspecified isomer) [Benzene, 1,3-diisocyanatomethyl-]	0.0070
75-77-4	Trimethylchlorosilane [Silane, chlorotrimethyl-]	0.050
108-05-4	Vinyl acetate monomer [Acetic acid ethenyl ester]	0.26

Appendix F

Hazardous Material Incident Response Regulations

29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
29 CFR 1910.38	Employee Emergency and Fire Protection Plans
40 CFR 110	Discharge of Oil
40 CFR 116	Hazardous Substances, Designation of
40 CFR 117	Hazardous Substances, Reportable Quantities
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 302	Designation, Reportable Quantities, and Notification
PL 92-500	Federal Water Pollution Control Act, as amended
NFPA 471	Recommended Practice for Responding to Hazardous Material Incidents
NFPA 472	Professional Competence of Responders to Hazardous Material Incidents
EO 12088	Federal Compliance with Pollution Standards
DODD 5030.41	Oil and Hazardous Substances Pollution Prevention and Contingency Program
DODD 6050.8	Storage and Disposal of Non-DOD Owned Hazardous or Toxic Materials on DOD Installations
AR 200-1	Environmental Protection and Enhancement
AR 385-40	Accident Reporting and Records
AR 420-90	Fire Protection
AR 500-60	Disaster Relief