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Emergency

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Guide

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HAZARDS SURVEYS AND HAZARDS ASSESSMENTS

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1. INTRODUCTION

The purpose of this volume is to assist Department of Energy (DOE) Operations/Field Offices and operating contractors in complying with the DOE O 151.1 requirement that Hazards Surveys and facility-specific Hazards Assessments be prepared, maintained, and used for emergency planning purposes. The Order requires that emergency management efforts begin with the identification of hazards and that the scope and extent of emergency planning and preparedness at a DOE facility/site be commensurate with the hazards. The first step in the implementation of this graded approach to emergency management is the identification and qualitative assessment of the facility/site-specific hazards and the associated emergency conditions which may require response. If the qualitative process identifies hazards associated with the presence of hazardous materials in quantities that pose a serious potential threat to worker or public health and safety, then quantitative analyses are performed to estimate the severity of impact. The results provide the information necessary to determine the scope and extent of the facility/site emergency management program.

The Order refers to the qualitative portion of the hazards identification process described above as a “Hazards Survey”. The Hazards Survey briefly describes the potential impacts of emergency events or conditions and summarizes the planning and preparedness requirements that apply. Each DOE facility/site is to be covered by a Hazards Survey which identifies the scope of the Base Program and documents all applicable requirements.

If the Hazards Survey identifies hazardous materials at the facility/site in excess of predetermined thresholds (see Section 3.3), a facility/site-specific “Hazards Assessment” is required. A Hazards Assessment includes the identification and characterization of hazardous materials specific to a facility/site, analyses of potential accidents or events, and evaluation of potential consequences. The Hazards Assessment also includes a determination of the size of the geographic area surrounding the site, known as the Emergency Planning Zone (EPZ), within which special planning and preparedness activities are required to reduce the potential health and safety impacts from an event involving hazardous materials. The Hazards Assessment provides the technical basis for the Hazardous Materials Program.

This guidance is directed at operations and emergency management staff responsible for DOE facilities, both at the Operations/Field Offices and operating contractor organizations. It is expected that emergency management staff will obtain support from a variety of scientific and technical disciplines within their respective organizations to conduct and document the analyses described herein.

Hazards Survey and Hazards Assessment activities may reveal opportunities to decrease the likelihood or magnitude of, or to improve recognition and management of, possible emergency conditions by modifying facility features or procedures. The responsible staff should be aware of this potentially valuable byproduct and encouraged to identify likely improvements, such as reduced hazardous material inventories, enhanced administrative controls, or additional alarm features to facility management.

This volume provides guidance and information in several forms. Sections 2 through 6 describe suggested approaches to conducting facility Hazards Surveys and Hazards Assessments and applying the results to emergency management programs. Appendices A and B provide guidance on defining facility boundaries and consequence thresholds, respectively. Appendices C and D illustrate the application of the suggested Hazards Survey and Hazards Assessment methods to a hypothetical facility and site.

Base Program. Each DOE facility/site/activity is required by the Order to have an Operational Emergency Base Program that provides the framework for response to serious events or conditions that involve health and safety, the environment, and safeguards and security. The Base Program is intended to incorporate all emergency response requirements for a facility/site by integrating various requirements promulgated by external agencies and other DOE orders. The Hazards Survey identifies all emergency response requirements for the DOE facility/site thus establishing the scope of the Operational Emergency Base Program. The Hazards Survey is required to combine as many facilities as possible that are subject to the same hazard, to the extent that a single Hazards Survey for a site would meet the requirement. If the Hazards Survey does not identify the presence of hazardous materials in excess of the thresholds discussed in Section 3.3 of this Chapter, then neither a Hazards Assessment, nor an Operational Emergency Hazardous Materials Program, is required. In this case, the Base Program defines the requirements of the comprehensive Emergency Management Program at the facility/site. The sections of this Chapter applicable to a Base Program are: Sections 2, 5 and Appendix C.

2. HAZARDS SURVEYS

2.1 General

This Chapter outlines the process for conducting and documenting Hazards Surveys. The Hazards Survey is intended to identify emergency management program needs which are different from those addressed by the Hazards Assessment. Therefore, each facility/site should be included in a Hazards Survey, regardless of the need for a Hazards Assessment.

It is expected that much of the material necessary to generate a Hazards Survey will already have been developed in the course of meeting other DOE and Federal agency requirements relating to facility safety, occupational safety, environmental and effluent controls, and hazardous materials management. However, the intent of the Order is not likely to be met by simply defining existing documents or analyses as the Hazards Survey Document. Information, such as facility descriptions or materials inventories, may be incorporated by reference; hazardous material inventory information need only be documented to the extent necessary to determine whether further assessment and planning are required. However, the Hazards Survey Document should be a distinct document and should contain, or incorporate by reference, the information specified herein.

To promote efficiency, the Order requires that each Hazards Survey incorporate as many facilities as possible that are subject to the same type of hazards. To facilitate incorporation of multiple facilities, it is recommended that information be compiled and presented in tabular or matrix format. An example of a tabular presentation is provided in Appendix C.

The recommended steps in the Hazards Survey are:

(1) Identify and briefly describe each facility;

(2) Identify the generic emergency conditions that apply to each facility;

(3) Qualitatively describe the potential health, safety, or environmental impacts of the applicable emergencies; and

(4) Identify the applicable planning and preparedness requirements.

2.2 Identify and Describe the Facility

Each facility or activity covered by the Hazards Survey should be identified and a brief description of its operations provided. Highly specific and detailed information is not necessary and may be included by reference. However, at a minimum, sufficient information to provide a general understanding of the facility(ies) covered should be included. Areas to be addressed include:

- A general characterization of the facility and its operations (e.g., office building, laboratory, warehouse);

- The normal occupancy, including the number of people in other than ground floor work locations;

- Whether classified material is used or stored in the facility;

- Any special designations, such as nuclear facility; radiological facility; hazardous waste site; Treatment, Storage, or Disposal (TSD) facility; etc.; and

- Whether hazardous materials (other than standard office products and cleaning supplies) are used or stored in the facility.

If hazardous materials are identified, a preliminary screening to determine the need for a quantitative Hazards Assessment should be performed. The methodology for identification and screening of hazardous materials is discussed in Section 3.3 of this Chapter. During the survey, this methodology does not need to be applied or documented as rigorously as it would during the Hazards Assessment process. Any material identified by the methodology as hazardous and used, stored, or transported in quantities greater then the screening thresholds is sufficient to establish the need for a Hazards Assessment. The Hazards Survey should identify each facility or activity and the hazardous material which exceeds the screening thresholds.

DOE offsite transportation activities, identified during the Hazards Survey process as involving hazardous materials in excess of the screening thresholds stated in Section 3.3, are also subject to the requirement for a Hazards Assessment.

2.3 Identify Generic Emergency Conditions

Identify and document the emergency conditions that may occur at each facility for which some level of planning and preparedness may be required. Hazardous materials below the screening thresholds or not specifically addressed as part of the hazardous materials program should be considered when identifying generic emergency conditions. As a minimum, the following generic emergency conditions should be considered:

- Structure fires;

- Natural phenomena impacts (wind, flood, earthquake, wildfire);
- Environmental releases (of oil or other pollutants that degrade the environment);
- Hazardous material releases;
- Malevolent acts (hostage-taking, sabotage, armed assault);
- Facility damage with possible compromise of classified material;
- Workplace accidents/mass casualty events (explosion, release of toxic fumes, high energy system failure);
- Hazards external to the facility/site (e.g., hazardous materials in near-by facilities, transportation accidents, accidents involving utilities, etc.); and
- Accidental criticality.

Some emergency conditions will apply to nearly every facility (e.g., fires) while others will only apply to facilities that exceed a threshold inventory (e.g., oil) or are located near other hazards. Site-specific potential hazards, such as flooding from a nearby dam failure, should be included in the list of potential emergencies to identify the facilities that are potentially threatened. Federal Emergency Management Agency (FEMA), National Weather Service (NWS) , and insurance industry documents are all potential sources of information. The Local Emergency Planning Committee (LEPC) is a potential source of information in hazards faced by the area.

Hazards originating outside the DOE facility and site that could impact the health and safety of onsite personnel or other DOE interests should be identified and examined. As a minimum, the Local Emergency Planning Committee should be consulted to identify nearby facilities having hazardous material inventories that could impact the DOE site.

Railroads, highways, and other transportation arteries that pass through or near a DOE facility or site should be considered as possible locations of hazardous material transportation accidents. If the transportation artery is a known corridor for a particular hazardous substance, identify the substance, quantities, approximate shipment frequencies, and Protective Action Zone distance specified in the Department of Transportation (DOT) emergency response guidebook. Because the chemicals covered by the DOT Emergency Response Guidebook are limited, distances similar to Protective Action Zones may need to be calculated for excluded hazardous substances. Once this information is collected, determine whether specific arrangements should be made for protection of onsite personnel. As a minimum, identify the transportation arteries as potential sources of a hazard to onsite personnel.

2.4 Qualitatively Describe Potential Impacts

Qualitatively describe the potential impacts of the emergency conditions identified in the previous step. These descriptions should relate the potential impacts to the different types of operational emergencies identified in Chapter V of the Order. Consideration should be given to "cascade effects," where the emergency condition can result in plausible disruption of response capabilities. For example, an earthquake could result in fires from downed power lines while rupturing fire mains.

Following are examples of potential impacts of several emergency conditions.

Facility Type	Emergency Condition	Qualitative Description of Impact
Office building	Structure fire	Workers killed/injured by smoke inhalation and burns; compromise of classified material.
Waste incinerator	Earthquake	Workers killed/injured/trapped by building collapse; release of hazardous materials; contamination of facility and surroundings; spill of fuel oil into streams/wetlands.
Offsite DOE Transportation Activity	Collision	Actual or potential release of hazardous materials; exposures exceeding Protective Action Criteria.

2.5 Identify Applicable Planning and Preparedness Requirements

Various State, Federal, and local regulations include requirements that pertain to planning and preparedness for emergencies. The Order recognizes these requirements and directs that they be incorporated into site emergency management programs.

From the results of Sections 2.2-2.4, facilities can be placed in one of two groups according to the following types of emergencies.

- **Facilities Requiring a Quantitative Hazards Assessment**. Facilities with hazardous materials in excess of the screening quantities specified in Chapter IV of the Order, require a quantitative Hazards Assessment. If the Hazards Assessment indicates the potential for emergencies that would warrant classification as an Alert or higher, the planning, preparedness, and response requirements for both the Operational Emergency Base Program (Chapter III) and Hazardous Material Program (Chapter IV) apply to these facilities.

- **All other facilities.** Facilities not having significant quantities of hazardous materials do not require a quantitative Hazards Assessment. Such facilities are subject to the Base Program planning, preparedness, and response requirements of Chapter III of the Order.

Emergency planners should correlate Hazards Survey results with the relevant planning/preparedness requirements from other Federal, State, or local requirements that apply to a particular facility, providing a summary of the required scope of emergency planning and preparedness at the site. The summary should address each of the Base Program planning and preparedness requirements listed in Chapter III of the Order and identify how they are met.

When completed, the Hazards Survey should document and serve as a guide to assessing site compliance with a variety of DOE and non-DOE requirements that are integral parts of the comprehensive Emergency Management System.

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3. HAZARDS ASSESSMENTS

3.1 General

This chapter outlines a process for conducting and documenting facility Hazards Assessments. As a practical matter, the basic steps of the process should be accomplished and documented in the order presented. However, within any given step of the process, there is substantial leeway within which the unique features of the facility, operations, and site can be accommodated.

The recommended steps in the Hazards Assessment are:

(1) Define and describe the facility and operations;

(2) Identify and screen the hazards;

(3) Characterize the hazards remaining after screening;

(4) Analyze emergency events and conditions; and

(5) Estimate the consequences.

For fixed facilities, as detailed in Chapter 4 of this Volume and elsewhere in the Emergency Management Guide, the results of the Hazards Assessment should then be used to determine the EPZs for each facility and site, as well as the emergency class, protective actions, and the observable indications [Emergency Action Levels (EALs)] corresponding to each event or condition. For DOE offsite transportation activities, the results of the Hazards Assessment should be used to determine observable indicators corresponding to an Operational Emergency not requiring classification, protective action needs, and exclusion zone recommendations to be provided to local authorities. Evaluation of the consequences may assist the user in determining required elements of the Emergency Response Organization (ERO).

To the maximum extent possible, the Hazards Assessment should make use of facility description and accident scenarios from Safety Analysis Reports (SARs), consequence assessment methods used during emergency response, and existing hazardous materials inventories maintained for other purposes.

Hazards Assessments should be prepared and documented in a manner that permits critical review of the analyses and results and, if necessary, reconstruction by independent analysts. Detailed descriptions of the methods, assumptions, and models need not be included in the Hazards Assessment Document if they are documented elsewhere and referenced.

Security or safeguards concerns should not restrict the scope or depth of the Hazards Assessment. All relevant information is to be utilized and, if necessary, the resulting Hazards Assessment Document classified and handled accordingly. It may be necessary to have both classified and unclassified versions of the Hazards Assessment Document, or to segregate all the classified aspects of the analysis in a classified appendix with limited distribution.

3.2 Define and Describe Facility and Operations

A clear, accurate, and unambiguous written and schematic description of the facility and its operations should be provided. This description should provide sufficient detail to support the identification and characterization of all hazards and their potential consequences. For many facilities, the descriptions of the facility and its operations from current SARs or environmental reports should serve this purpose and may be briefly summarized and incorporated by reference.

In most cases, the boundaries of the facility and operations in question will have been previously defined (e.g., a security boundary or fence.) Facility "definitions" used for SAR purposes should be applicable. However, these boundaries should be re-examined with the objectives of this Hazards Assessment in mind.

For Hazards Assessment purposes, several structures or component units with a common or related purpose may constitute a single "facility." For example, a waste tank farm may be defined as one facility because it is composed of a number of units of approximately the same nature and purpose under common management and operational control. On the other hand, a complex of dissimilar buildings, operations, and equipment may be considered a single facility if they are physically adjacent, under common management, and contribute to a common programmatic mission. For example, a research reactor with its associated cooling tower, fuel handling and waste storage buildings, laboratory, and hot machine shop might be considered one facility for purposes of the Hazards Assessment. If a single building or structure contains several tenant activities or units, such as process lines, hot cells, or hazardous material storage, the entire structure may be considered as one facility, even though the tenant activities have little to do with one another. The Hazards Assessment Document should identify what constitutes the subject facility. Additional guidance on facility definition is presented in Appendix A.

The written facility description should include general site information related to the site mission, operations, and physical characteristics, including an assessment of the site exposure to external and natural phenomena hazards. It should include the location of the facility relative to other facilities on the same site, the site boundaries, the nearest public access locations, and transportation networks, such as highways, railroads, and rivers.

To simplify the Hazards Assessment, some facilities may be analyzed as independent segments. Segments are considered independent if hardware failures and human errors in one segment do not propagate into another segment. Independence of segments also requires that initiating events in one segment are not capable of causing release of material in another (e.g., no common-cause or chain-reaction accidents).

For transportation activities, the "facility description" should include the type of materials transported, the containers and vehicles used, the routes, speeds, number of shipments per year, and other controls (e.g., escorts or overpacks) relevant to the likelihood or severity of an accident.

3.3 Identify and Screen Hazardous Chemical or Radioactive Material

The objective of this step is to identify hazards that are significant enough to warrant consideration in a facility's operational emergency hazardous material program. Note that "hazard", as used in this chapter, refers to hazardous chemical or radioactive material.

3.3.1 Identification of Hazards

- For most facilities, the basic source of non-radioactive hazardous material inventory information will be the records and data bases that support compliance with the reporting requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Effluent release permits for byproduct off-gases from processes should also be reviewed. The inventory records may not specify the types of containers, the number of different containers, or reaction product chemicals that may be released in an emergency. These factors must be established from other operating documents or walk-throughs of the facilities.

- SARs, Technical Safety Requirements, and subordinate facility operating procedures and limits will be the source of inventory information on most radioactive and some non-radioactive hazardous materials. Material Control and Accountability records should be a primary source of information on current holdings and authorized limits for Special Nuclear Material. Test plans, process safety assessments, or other controlling documentation for hazards of a transient or intermittent nature should contain relevant hazardous material inventory information.

- For facilities having a documented Vulnerability Analysis as required by DOE O 470.1, the identified targets that are also hazardous materials (e.g., radioactive materials at risk from theft, diversion, or sabotage) should be included in the list of facility hazards. The “target” list will normally be classified.

3.3.2 Screening Thresholds

Screening quantities or thresholds should be used to eliminate the need to analyze insignificant hazards.

- The lowest quantity listed as a Threshold Quantity in 29 CFR 1910.119 or 40 CFR 68.130 or the Threshold Planning Quantity listed in 40 CFR 355 may be used as screening thresholds for those chemicals listed. For chemicals not listed, the Reportable Quantities (RQs) for hazardous substances listed in 40 CFR 302.4 may be used. Facilities may choose to set their screening thresholds lower, and they should be alert to the possibility that small quantities of some materials may produce significant consequences outside the facility. Toxic chemicals not listed may be either included on the hazard list for full characterization, or the facility may develop and document screening quantities based on the physical and toxicological properties of the materials and conservative (i.e., tending to yield the largest impact) consequence modeling.

- For radioactive materials, the quantities listed in 10 CFR 30.72, Schedule C, requiring consideration of the need for emergency planning for licensed byproduct material facilities may be used as screening thresholds for the radionuclides listed. Facilities may choose to set their screening thresholds lower than these values. Generic thresholds for radionuclides not listed may be used or the facility may develop and document screening quantities based on the properties of the material and conservative consequence modeling.

- Those materials for which the maximum facility segment inventory is less than the screening quantity may be eliminated from further consideration in the Hazards Assessment. It should be noted whether the maximum facility inventory is a physical limit, such as a tank capacity, or an administrative limit. If neither type of limit exists, an expected or historical maximum quantity should be used.

3.3.3 Other Materials

Common hazardous materials, such as vehicle fuel and commonly used small quantities of solvents or gases, which are used in a wide variety of facilities and operating environments, can be hazardous to a limited extent by themselves or in combination with other materials. For such materials, the hazard is generally limited to the immediately involved worker and it is not the intent of this guidance that the Hazards Assessment belabor these common, well-understood, and limited hazards. Screening quantities should be developed for these materials or the materials should be listed with a brief statement of the rationale for excluding them from further analysis. Suggested bases for eliminating materials from consideration in the Hazards Assessment are as follows.

- The material is commonly used by the general public. This includes any substance to the extent it is used for personal, family, or household purposes or is present in the same form and concentration as a product packaged for distribution and use by the general public (e.g., bleach, motor oil, gasoline).

- The material is a monolithic solid under normal conditions and does not present an airborne exposure concern (e.g., lead bricks).

- The material is not hazardous to humans as a result of inhalation, ingestion, or dermal exposure.

- The material has a vapor pressure of $\leq$0.5 mmHg @ 25ºC and an Emergency Response Planning Guideline (ERPG) ERPG-2 or equivalent value of $\geq$1 ppm.

- The material is used in a laboratory setting and in laboratory scale (end user) quantities.

The possible effect of such materials as initiators or promoters of releases of other more hazardous materials should be considered.

Upon completion of the screening process described in this chapter, it is expected that some facilities will have no identified hazards requiring further characterization and analysis. The results of the screening process and the basis for the conclusion should be documented to demonstrate compliance with the Order requirements.

3.4 Characterize Hazards

After the facility hazards have been identified and screened, further characterization of hazards that exceed screening thresholds is necessary. Information that describes and quantifies the hazards should be assembled and documented to support the development of scenarios and analysis of possible releases. This chapter pertains only to hazards that have been determined to exceed the screening thresholds.

Both radioactive and non-radioactive hazardous materials should be included in a tabulation with the following information on each.

- The maximum quantity of the material in appropriate units (pounds, kilograms, curies, becquerels) and its storage or process locations.

- A description of the conditions under which the material is stored or used, including process systems or containers that hold the material and barriers that may impact its release or dispersion, such as shipping containers, buildings, berms, sumps, or catch basins. Where applicable, security and access controls for the storage and use locations should be identified.

- The properties of the material that are needed for determination of source term and consequence analysis, such as the physical form and chemical characteristics of the material (e.g., solid, liquid, gaseous, particle size, flammability, chemical reactivity, density), radiological characteristics, and the temperature and pressure conditions under which it is stored, processed, used, or transported.

- A description of engineered controls, safeguards, or safety systems designed to prevent or mitigate a hazardous material release. These may include both automatic and manually activated mitigative systems (e.g., fire sprinklers, filters, scrubbers, isolation dampers), as well as passive mitigative features and engineered geometry or configuration controls for fissionable materials.

- A description of administrative controls that would prevent or mitigate the initiation of a hazardous material release, such as limits on the total quantity of a material in a single place or container, or restrictions on where certain materials can be used or stored.

For facilities where criticality accidents are considered credible, the "inventory" of interest is the total yield of gaseous and volatile fission products from the postulated criticality event(s). Analyses of these postulated criticality events will generally be available in the facility SAR.

Where the material consists of a reactor core or irradiated fuel containing mixed fission products, the relevant factors that define the radiotoxicity of the mixture (e.g., enrichment, burnup, age) should be analyzed and the case that produces the largest impact selected. The actual isotopic composition of the mixture used for consequence calculations can then be included as an appendix and referenced.

For those facilities having a documented vulnerability analysis, the identified targets may include both hazardous materials and essential parts of the system of barriers, controls, and protection features that keep them in a safe condition. The target list is potentially a source of information regarding both the quantity of certain hazards and the conditions under which they are stored, handled, and used.

Other materials and hazard sources, such as flammable or explosive materials and energy sources, should also be included in the characterization. Their potential for initiating releases of radioactive or chemically toxic materials, contributing to dispersal of those materials, or degrading the effectiveness of safety systems should be considered.

Available information concerning the reactive properties of the hazardous materials should be assessed and the possibility of interactions between substances considered.

3.5 Analyze Emergency Events and Conditions

The objective of this process is to determine the combinations of events and conditions that could cause releases of each hazardous material characterized in Section 3.4 above and the magnitudes of those possible releases. The term "release" is used here to mean, primarily, an airborne release, as this pathway typically represents the most time-urgent situation and requires a rapid, coordinated, emergency response on the part of the facility, collocated facilities, and surrounding jurisdictions to protect workers, the public, and the environment. Releases to aquatic and ground pathways, although a matter of serious concern in terms of potential environmental and long-term public health consequences, in most instances do not have the same time urgency as the airborne release. When a release to an aquatic or ground pathway could have a near-term effect on the workers or the public (e.g., through a community water supply), then it should be considered in the Hazards Assessment.

The Hazards Assessment should postulate and analyze events covering the full range of possible initiators and severity levels.

- Initiating events and mechanisms considered in the Hazards Assessment should include traditionally defined "accidents" as well as those arising from external causes and malevolent acts. "Accident" initiators should include causes such as corrosion, manufacturing defects, malfunctioning equipment or control systems, and procedural or human error. External causes that should be considered include impacts of natural phenomena, accidents at nearby facilities, and vehicle or aircraft crashes.

- High-probability, low-consequence events need to be addressed in facility emergency plans because of their potential impacts on workers in the affected facility and those nearby. Both malevolent acts and "severe" events should be included in the Hazards Assessment because they represent the upper end of the consequence spectrum, for which prompt recognition and response may be essential to mitigation of both the event and its health and safety consequences. These events are seldom addressed or analyzed in SARs.

Analysis of barrier challenges and failures should be used to determine both the events and conditions that could release each hazardous material and the magnitudes of those possible releases. For facilities with a DOE 5480.23-compliant SAR, a barrier analysis may have been performed in accordance with Attachment 1 to that Order. These analyses can be summarized and referenced in the Hazards Assessment. For facilities without DOE 5480.23-compliant SARs, the barrier challenge/failure analysis described below can be used to develop scenarios.

3.5.1 Identify Primary Barriers

The primary barrier is generally the one closest to the material. In the case of gaseous or liquid materials, the tank, cylinder, process piping, or other container is usually the primary barrier. For materials that are prevented from being released by their own structure or physical form, consider that form or structure as the barrier.

3.5.2 Identify Failure Modes of Primary Barriers

Evaluate possible initiating events and scenarios that could lead to the release of hazardous materials. For each set of barrier failures that could lead to the release of hazardous material, identify possible initiating events, accident mechanisms, and/or equipment failures that could initiate a release (e.g., spontaneous failure of a barrier, failure of administrative controls, impact of external events, and/or malevolent acts). Incorporate any contributing events or conditions that could influence the progression of the scenario or alter the magnitude or nature of the consequences. For example, failure of fire suppression systems to activate following initiation of a fire would change the event progression. Likewise, different levels of combustible loading in a given area might increase or decrease the magnitude of the fire. Either or both events might affect the degree of damage to the facility or quantity of hazardous material released.

For events that take a finite amount of time between the initiator and the barrier failure (e.g., a loss of purge flow to a tank resulting in a buildup to a flammable mixture), calculate that time. The time is used to determine the likely progression of the event. For example, if rapid buildup of flammable gas in a waste tank vapor space is possible, it is reasonable to postulate that a reaction occurs at the concentration that produces the largest energy release, which is usually well above the lower explosive or flammable limit. However, a slow buildup in concentration makes it more likely that the gas will be ignited sometime after the lower explosive/flammable limit has been exceeded but before the optimum (stoichiometric) condition is achieved, thus producing a lower energy release. These situations should be noted and the factors leading to selection of a lower energy release scenario should be fully justified.

While performing this analysis, the analyst should compile a list of the indications of barrier failure or challenge (e.g., instrument readings, operator observations, alarms) for future use in developing EALs. Summarize the indications of barrier failure/challenge in tabular form and note where indications are lacking. Guidance on the development of EALs is provided Volume III, Chapter 3, of the Emergency Management Guide.

3.5.3 Estimate Magnitude of Release From Primary Barrier

For each cause of failure, develop a quantitative estimate of the Material at Risk (MAR), the amount of material available to be acted on by a given physical stress, and the Damage Ratio (DR), which is the fraction of the MAR impacted by the actual conditions under evaluation. Consider the physical properties of the material, such as volatility, viscosity, melting point, and vapor pressure, as well as the temperature and pressure conditions under which it is stored and the postulated mode of barrier failure. The maximum inventory is typically used to represent the MAR. However, use of a smaller MAR estimate may be justified, based on physical separation of units of inventory or administrative controls. Separate estimates of the maximum and typical inventories can also be developed.

If multiple containers of the same hazardous material exist in the facility, consider the possibility that the same event may cause a release from more than one container (e.g., seismic event or a forklift ramming two or more drums of material), and that the failure of one container could lead to failure of others. This evaluation step estimates the maximum amount of a material released from the primary barrier as a function of time for each event or failure mode, considering the physical, chemical, and thermodynamic properties of that material.

3.5.4 Assess Effects of Secondary Barriers and Mitigative Features

The Leak Path Factor (LPF) quantifies the combined effects of any secondary barriers and mitigating features. In the case of material aerosolized or vaporized inside a glovebox within a building, the LPF represents the fraction of the total aerosol or vapor that is ultimately released to the environment through exhaust filters, door seals, and other leakage paths.

To determine the LPF, characterize the effectiveness of barriers and mitigating features. For example, exhaust filters may have a rated or tested efficiency of 99.95 percent for the first stage and 99 percent efficiency for subsequent stages. The building walls may be assumed to be intact in some scenarios with all the release through the filters. Other scenarios may postulate damage to the walls with release out the openings.

3.5.5 Estimate Source Term

- **Radiological Source Terms.** DOE-HDBK-3010-94 provides Airborne Release Fractions (ARFs), Respirable Fractions (RFs), and Airborne Release Rates (ARRs) applicable to many types of releases. The bounding ARF-RFs, and ARRs listed in the DOE-HDBK-3010 are normally most appropriate for use in Hazards Assessments. Accident-specific ARF-RFs and ARRs derived in other safety documents can also be used in the Hazards Assessment. If no applicable ARF-RF or ARR can be found, those cited in DOE-STD-1027 may be used.

  DOE-HDBK-3010-94 defines the RF as “the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system.” The RF is commonly assumed to include particles “10 µm Aerodynamic Equivalent Diameter (AED) and less.” However, applying the source term equation to materials (such as radioactive noble gases) that do not produce their effect by the inhalation pathway requires that a somewhat more general definition of the RF be used. For such materials, DOE-HDBK-3010-94 recommends that the ARF value of 1.0 for condensable and noncondensable gases. All materials in the gaseous state can be transported and inhaled; therefore, an RF value of 1.0 is assumed for analysis purposes.

  Realistic values should be used in developing the DR and LPF for the particular event. DOE-HDBK-3010-94 provides information on DRs for various phenomena.

  The final source term (ST) is calculated as follows.

  $$\mathbf{ST=(MAR)(DR)(ARF)(RF)(LPF)}$$

  or

ST=(MAR)(DR)(ARR)(t)(RF)(LPF)

where:	ST	=	Source Term (Ci or Bq)
	MAR	=	Material at Risk (Ci or Bq)
	DR	=	Damage Ratio (fraction)
	ARF	=	Airborne Release Fraction
	RF	=	Respirable Fraction
	LPF	=	Leak Path Factor (fraction)
	ARR	=	Airborne Release Rate (fraction/hour)
	t	=	Release Duration (hours)

- **Chemical Source Terms.** The conceptual approach embodied in the source term equations presented above for radioactive materials can also be applied to chemicals. However, no compendium of values for ARF, ARR, and RF currently exists; these parameters will need to be derived from the material properties using basic physical and chemical principles. Alternatively, given the MAR and release scenario, any of several computer codes can be used to determine chemical source terms and model their transport and dispersion. Many of the available models are described in *Atmospheric Dispersion Modeling Resources*. Chemical source terms for reaction product formation (e.g., two chemicals spilling and mixing) are normally determined by manual calculation using conservative assumptions.

3.5.6 Malevolent Acts

Malevolent acts (theft, sabotage, terrorism) including the use of explosives or flammable material are possible release initiators within the scope of emergency planning. It is not intended that all inventories be evaluated with malevolent event initiators. Both moderate and extreme scenarios should be developed and analyzed to establish EALs for events resulting from malevolent acts. “Moderate” scenarios are those that could be initiated by a single individual using materials or tools readily available in the facility, or small quantities of flammables. “Extreme” scenarios, such as those used in vulnerability assessments and/or radiological and toxicological sabotage assessments, should provide the analyst with an upper bound on the severity of potential consequences.

In most cases, malevolent act scenarios will produce releases and consequences similar to those that could be caused by accidental or other external initiators. Therefore, identifying a malevolent act as a potential initiator does not necessarily mean that a separate detailed analysis of that scenario is needed. For example, an explosion and fire that releases a hazardous material from a storage location might be postulated to result from an aircraft or vehicle crash. However, if approximately the same level of damage and source term might also be caused by an act of sabotage in the same location, the malevolent act can simply be considered a second initiator for the same basic fire/explosion condition.

3.5.7 Common Industrial Building Fires

Building fires may produce toxic by-products from the burning of furniture, paint, etc. Fires in office buildings or industrial facilities that do not contain large inventories of hazardous materials of hazardous materials may be categorized as an Operational Emergency if they result in significant structural damage with suspected personnel injuries or death. However, they will not normally be classified. (See Volume III, Chapter 3.) To determine if the Hazards Assessment needs to analyze the release of toxic materials from fires, the results of the Fire Hazards Analysis (FHA), conducted to meet the requirements of DOE O 420.1, should be reviewed. If the FHA results indicate that protective actions will be needed in the downwind area, the toxic material release should be included in the Hazards Assessment.

3.6 Estimate Consequences

Potential consequences of the hazardous material release scenarios developed in the preceding section should be estimated to determine the areas potentially affected, the need for personnel protective actions, and the time available to take those actions.

Methods and calculational models used in estimating consequences should be documented in such a manner that the analyses and their results can be critically reviewed, understood, and if necessary, reconstructed by independent analysts. Detailed descriptions of the methods, assumptions, and models (e.g., dispersion models, dose codes, or other complex calculational methodologies) need not be included in the Hazards Assessment Document if they are documented elsewhere and appropriately referenced.

The consequences of hazardous material releases should be estimated using models and calculational methods that are most appropriate to the material released and to the physical characteristics of the site and its atmospheric dispersion conditions, and if applicable, hydrologic dispersion conditions. Generally, the consequence assessment models used for emergency planning and response purposes and for SAR Evaluation Guide comparisons at the facility should be used to conduct this Hazards Assessment. The selection of dispersion and consequence models should be justified in the Hazards Assessment Document for each facility. Specifically, the applicability of the model to the release mode, the site geographic features, and atmospheric conditions typically experienced at the site should be described. The results of any experimental verification or validation of the models should be cited as well as any known limitations or sources of inaccuracy. The models' capabilities with regard to factors such as buoyancy, dense gas effects, building wake, surface roughness, gravitational settling, and dry deposition should be described.

A listing of available codes is provided in *Atmospheric Dispersion Modeling Resources*. The following modeling recommendations are provided as guidance to consequence analysts.

- Use of a straight line Gaussian model as the atmospheric dispersion portion of the code is acceptable in most cases for emergency planning.

- Radiological computer codes should be verified to ensure that Dose Conversion Factors (DCFs) and exposure times used are consistent with the desired results [e.g., total effective dose equivalent (TEDE) or committed effective dose equivalent (CEDE)].

- Chemical hazards computer codes should be reviewed to ensure that the output values are consistent with the criteria against which they will be compared (peak instantaneous or time-weighted average concentration). See Appendix B for additional guidance on computing time-weighted average concentrations.

- If a significant waterborne pathway exists (i.e., potential for a spill into a waterway with a downstream public water supply intake), site specific calculation of downstream concentrations over a range of spill volumes should be performed.

For certain hazardous materials release scenarios, the results of analyses from SARs or other accident studies may be utilized in the Hazards Assessment. Results of existing analysis may be incorporated by reference or, under some circumstances, the consequences of newly postulated scenarios may be derived from the results of existing analyses (e.g., by ratio).

Consequences of each radiological and chemical release should be summarized in the form of a graph or table that gives the dose (TEDE) or concentration (the highest 15-minute average concentration) versus distance out to a distance beyond that at which protective action criteria [protective action guides (PAGs) and ERPGs] are exceeded. (NOTE: The terms “protective action criteria,” “TEDE,” “PAG,” and “ERPG” are defined and discussed in Appendix B.) These summarized results can then be used to estimate consequences at the following receptor locations relevant to each facility.

3.6.1 Facility boundary

The facility boundary is the demarcation between the facility, together with its immediate vicinity, and the remainder of the site. The facility boundary definition figures prominently in the distinction between events that have only a local impact (i.e., on the facility occupants and associated workers at or near the scene of the event) and events that impact areas of the site outside the immediate vicinity of the affected facility. Considerations in defining the facility boundary are discussed in Appendix A.

3.6.2 Other onsite receptors

Other onsite receptor locations of interest should be identified for each facility, including:

- Adjacent facilities with significant occupancy;
- Protected area boundaries;
- Any locations accessible to the general public or occupied by private sector facilities, such as roads, visitor centers, parking lots, and commercial facilities and operating areas on the site; and
- Emergency response facilities, such as Emergency Operations Centers, evacuation staging areas, medical aid stations, or fire stations.

For the purpose of determining which release scenarios warrant declaration of an Alert, the analyses should estimate the doses and concentrations within the facility boundary (between about 30 m from the point of release out to the nearest facility boundary).

3.6.3 Site boundary

The site boundary receptor is the nearest location to the facility where DOE does not have full ownership and control over access to the property. An event that may produce consequences exceeding a protective action criterion (i.e., the applicable PAG for ionizing radiation or the ERPG-2 value, or equivalent limit, for hazardous chemicals) at or beyond the site boundary is to be classified as General Emergency because of the need to fully involve offsite authorities in the protective response. In some cases, it may be reasonable to treat onsite locations that are accessible to the general public, such as roads, visitor centers, parking lots, or non-DOE (commercial) facilities, as site boundary receptors. Additional considerations in defining site boundary receptors are discussed in Appendix A.

3.6.4 Other offsite locations of interest to emergency planners

These include schools, hospitals, nursing homes, prisons, industrial complexes, evacuation routes, major transportation facilities, emergency operations centers, and concentrations of population. Offsite receptors relevant to the ingestion exposure pathway should include dairy farms, orchards, truck farms, and public water supply intakes.

At least two sets of dispersion conditions should be considered in computing the consequence versus distance data for each set of source terms determined by the methods recommended in Section 3.5. The results should then be used in evaluating the consequences at each receptor location of interest.

- The first case should correspond approximately to the 95 percent worst-case wind speed and stability for the particular site, if this has been determined. If such a determination has not been made for the site, a wind speed of 1 m per second with stability class F is acceptable for this "conservative" case for an assumed ground level release. Consequences calculated using these conditions should be used to develop EALs and determine the size of the EPZ.

- The second case should approximate a typical set of conditions for the site, such as the average wind speed and most prevalent Stability class averaged over the compass sectors. If such information is not available, D stability and 4.5 m per second wind speed are acceptable assumptions. Consequences calculated using these conditions are for general reference and response planning purposes only. Used in conjunction with the "conservative" case results, the "typical" results provide perspective on the risk associated with each scenario. These results may be useful in offsite planning discussions with local authorities and as a resource for emergency response personnel.

- Direction-dependent atmospheric dispersion conditions should not be used to develop EALs or determine the EPZ size. Either site-specific (e.g., 95 percent worst-case) or generic (e.g., 1 m/s and F Stability) conservative conditions should be used to calculate consequences for all receptors.

- EALs based on consequence estimates should not be wind-direction dependent. EPZ shapes should not be based upon prevailing wind direction and related dispersion conditions.

In addition to calculating consequences at specific receptors (e.g., facility boundary, nearest site boundary), the maximum distance at which consequences exceed the applicable protective action criterion or threshold for early (acute) lethality should be determined. The consequences at facility boundary and site boundary will be used to determine the emergency class corresponding to each analyzed event. The distances at which protective action criteria and thresholds for early lethality might be exceeded under the most severe credible accident conditions are considerations in defining the EPZ for the facility. These consequence thresholds are defined and discussed in Appendix B.

The Hazards Assessment should determine the elapsed time from the initiation of the event or condition until each consequence threshold is exceeded at the receptor points and distances of interest. For each release scenario, dispersion condition, downwind distance, and hazardous material, this elapsed time is the time available to recognize the event and carry out the necessary protective action (onsite) or to make the necessary protective action recommendation (offsite). The available time will largely determine what protective actions are feasible for a particular type of release.

The results of the consequence calculations should be summarized in tabular form to aid in the correlation of potential impacts with appropriate event classification criteria (i.e., EALs) and protective response actions. This same information can be used to develop simplified consequence assessment methods for use by response personnel in the event of an actual emergency. Guidance on consequence assessment, protective actions, and development of EALs is provided in Volumes II and III.

4. EMERGENCY PLANNING ZONES

4.1 Background

The Order requires integration of emergency management programs for both radiological and non-radiological hazardous materials and endorses the EPZ concept as a planning tool. DOE facilities are subject to the Environmental Protection Agency (EPA) requirements regarding emergency management activities for non-radiological hazards, and it is DOE policy that emergency management for DOE nuclear facilities be consistent, to the extent practicable, with the requirements of the Nuclear Regulatory Commission (NRC). Basic planning and response principles, as well as the NRC and EPA requirements and their bases, are considered as background for the guidance provided herein.

The NRC and FEMA have established the EPZ requirements for power reactors. The analysis that led to establishment of the standard plume exposure and ingestion pathway planning zones for large, domestic power reactors is documented in NUREG-0396/ EPA 520/1-78-016. The report concluded that a 10-mile plume exposure (airborne) pathway EPZ was adequate because projected doses from the traditionally defined design basis accidents would not exceed the higher PAG levels then in effect (5-rem whole body, 25-rem thyroid dose) outside the zone for any reactor site analyzed, and even the lower PAG values (1-rem whole body, 5-rem thyroid) would not be exceeded for most sites. Furthermore, doses from most beyond-design-basis accidents would not exceed PAG exposure levels outside the zone, and "immediate life-threatening doses" would not occur outside the zone for even the most severe beyond-design-basis accident. Finally, it was determined that detailed planning within 10 miles would provide a substantial base for expansion of response efforts in the event that this proved necessary. The 50 mile ingestion pathway planning zone was largely based on a judgment that the likelihood of exceeding ingestion pathway PAG levels at that distance was comparable to the likelihood of exceeding plume exposure pathway PAG levels at 10 miles.

The EPA has published guidance that leads to determination for non-radiological hazards of a vulnerable zone, described by the EPA as the area that may be subject to concentrations of an airborne, extremely hazardous substance (EHS) at levels that could cause irreversible acute health effects or death to human populations within the area following an accidental release. The EPA guidance defines the vulnerable zone in terms of the distance at which a "level of concern" would be exceeded as a result of a release of the hazardous material under severe (conservative) dispersion conditions. "Level of concern" is defined as the concentration of an EHS in air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time. "Levels of concern" are identified in the EPA guidance for the EHSs listed in 40 CFR 355 Appendix A. The vulnerable zone is intended to be used by community emergency planners in evaluating the risk of and planning for response to hazardous material releases. Because of differences in both the impact (concentration) criteria and the methods used, the vulnerable zone does not directly correspond to the EPZ developed in accordance with this guidance.

Designation of an EPZ and the related planning and preparedness activity are not intended to ensure complete protection of all persons who might be affected by the largest conceivable hazardous material release under the most severe meteorological conditions. The EPA's *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* states, "It is not appropriate to use the maximum distance where a PAG might be exceeded as the basis for establishing the boundary of the EPZ for a facility." Even if detailed planning specific to the affected geographic area has not been done, general hazardous material planning and preparedness by local, State, and Federal agencies provides a substantial basis for effective *ad hoc* tactical response during a hazardous material emergency.

A larger EPZ does not necessarily provide for better protection of the population than a smaller one. The following points must be understood and carefully considered by those responsible for establishing the geographic extent of any facility EPZ.

- For a given wind speed, the elapsed time between initiation of a hazardous material release and the onset of consequences at a receptor location is directly proportional to the distance between the source and receptor. Hence, the greater the distance from the source, the more time will be available to carry out protective actions.

- If distance (and available time) are great enough, *ad hoc* protective actions will be approximately as effective in reducing health impacts as those actions that have been planned and prepared for in detail. As the effectiveness of a preplanned protective action approaches that of an *ad hoc* action, the efficiency of planning/preparedness efforts (expressed in terms of reduced health impacts per unit investment in planning/preparedness) approaches zero.

- Because resources available for protective action planning and preparedness are always limited, use of those resources should be concentrated in the geographic areas where the greatest reduction in health impact per unit expenditure can be achieved.

The EPZ is an area within which the facility/site should support the local, state, and/or tribal authorities in planning and preparedness activities to protect people living and working there. Among these activities are identification of response organizations; establishment of effective communications to notify the public and the responsible authorities within the EPZ; development of public information and education materials; training and provision of equipment for offsite emergency workers; identification of predetermined response actions; and development and testing of response procedures.

4.2 General

The EPZ for each facility should be based on objective analyses of the hazards associated with that facility, not on arbitrary factors such as historical precedent or distance to the site boundary. The results of the consequence analysis described in Section 3.6 as well as other factors should be used as detailed in this guidance to define the facility EPZs.

As a matter of practical necessity, the EPZs for a DOE facility or operation should be developed in cooperation with the responsible state, local, and tribal authorities and other tenant site facilities. The responsible facility management should propose EPZ boundaries based on this guidance, the Hazards Assessment results, and other geographical and jurisdictional factors.

EPZs may be based on risk criteria agreed upon by State and local authorities. Risk-based methods of prioritizing emergency planning and preparedness efforts provide assurance that resources are dedicated to the proper areas and issues. However, such methods require a major investment in a comprehensive Probabilistic Risk Assessment (PRA) for the facility. Facilities for which a PRA has already been prepared or is in progress may choose to use the results to establish their EPZs in cooperation with state and local authorities.

The following issues should be considered when developing and proposing an EPZ.

- Each state, tribal, and local government has a statutory responsibility to protect its citizens. All states, as well as most counties, cities, and towns, have emergency plans and some means to respond to hazardous material emergency conditions within their jurisdictions. Even if detailed planning specific to the affected geographic area has not been done, there exists a level of general planning and preparedness for dealing with hazardous material emergency conditions, such as transportation accidents, that serves as the basis for *ad hoc* tactical response.

- An EPZ associated with a particular DOE facility or operation should be thought of as an area within which government and facility managers determine that special planning and preparedness efforts are warranted, <u>as a means of apportioning preparedness resources to the areas where they are most needed.</u>

- Defining an EPZ for a given type of protective response action, such as evacuation, sheltering, or food pathway intervention, does not mean that implementation of that particular response action will be required in all cases. If an emergency occurs, responsible authorities will assess the actual conditions existing at that time and determine whether protective response action is warranted.

- In the most severe conditions, protective response actions may be needed in areas outside the EPZ. Therefore, the EPZ should be sufficiently large that the planning and preparedness for actions within the defined EPZ provide authorities with a reasonable basis for extending their preplanned response activities to areas outside the EPZ if warranted by the actual conditions.

4.3 Developing Proposed EPZs

If the facility Hazards Assessment indicates no emergency higher than the Alert class, an EPZ need not be defined for the facility.

For those facilities that do not choose the risk-based approach, the EPZ should, as a minimum, include the area where people would be at risk of death or severe injury from the severe releases under severe meteorological conditions. It may also include part of the area where protective actions would be warranted for the same release and meteorological conditions.

Steps for developing a technically defensible plume exposure pathway EPZ are as follows.

1. From the results of consequence calculations done in accordance with Section 3.6, determine the distance at which a threshold for early lethality would be exceeded for the most severe analyzed release (excluding those which result from "extreme" malevolent acts discussed in Section 3.5) under severe meteorological conditions. This distance is the smallest EPZ radius that should be considered.

2. Determine the distance at which a protective action criterion would be exceeded for the most severe analyzed release (excluding those that are "beyond design basis" natural phenomena events or which result from "extreme" malevolent acts discussed in Section 3.5) under severe meteorological conditions. This distance, or 16 km, whichever is smaller, is the largest EPZ radius that should be considered.

3. Within the limits of the largest and smallest EPZ radii, consider other factors and adjust size and shape in accordance with the following principles.

- The full spectrum of emergencies that contribute to facility/site offsite risk should be considered. Even if a comprehensive PRA has not been done, local knowledge of the probability or risk contribution of the most severe analyzed event relative to the other events that comprise the balance of the site/facility risk may be used in a semi-quantitative way to determine whether the EPZ size should be closer to the maximum or minimum values determined in the steps described above.

  - If the most severe analyzed release would result from a single failure event or is believed to have a relatively high probability of occurrence, an EPZ radius closer to the maximum than the minimum value should be selected.

  - If the probability of the most severe analyzed release is judged to be extremely low or if it contributes a minor fraction of the total offsite risk from site emergencies, an EPZ radius closer to the minimum than the maximum value is indicated.

- The hazards judged to contribute most heavily to the offsite risk should be considered, as follows.

  - If the hazard is radiological, an EPZ radius closer to the minimum than the maximum value should be selected because of the wide margin (a factor of greater than 100) between the thresholds for protective action and early lethality.

  - If the hazard is non-radiological, an EPZ radius closer to the maximum than the minimum value should be selected because of the narrower margin (typically a factor of 3 to 10) between the concentration thresholds for protective action and lethality (as defined in Appendix B), and the potential for severe irreversible effects resulting from exposure to concentrations between the protective action and lethality thresholds.

- Definition of an EPZ is meaningful only if significant planning and preparedness measures are implemented within it. This commitment and responsibility to expend resources planning and preparing for the protection of people must be factored into EPZ size. Among the planning and preparedness activities that the facility/site should expect to support on behalf of the population within the EPZ are the following.

- Identification of responsible onsite and offsite emergency response organizations and the mechanisms for activating their services.
- Establishment of effective communication networks to promptly notify the public within the EPZ and the responsible authorities.
- Development and delivery of public information and education materials to ensure timely and correct response to warnings.
- Implementation of training programs and provision of equipment for offsite emergency workers.
- Identification of predetermined response actions.
- Development and testing of response procedures.

- The cost of implementing an EPZ is usually directly related to the geographic size of the EPZ. If creating a larger EPZ means that scarce resources are allocated to the protection of people who are at minimal risk, a larger EPZ may actually be less effective at mitigating overall risk to the population than a smaller one.

- If distance from the source and the time available to respond are great enough, protective actions carried out on an *ad hoc* basis will be approximately as effective in reducing risk as those actions that have been planned and prepared in detail. Also, planning and preparedness for the EPZ will provide a basis for more effective response activities outside the EPZ if conditions should warrant.

- The EPZ should conform to the physical and jurisdictional realities of the site and surrounding area.

- The EPZ size should give confidence that planning and preparedness will be sufficiently flexible and detailed to deal with a wide range of types and magnitudes of emergency conditions. Four significant considerations that cannot be readily stated as quantitative guidance are presented below in the form of questions to be used as "tests of reasonableness" for the proposed EPZ size.

- Is the EPZ large enough to provide a credible basis for extending response activities outside the EPZ if conditions warrant?

- Is the EPZ large enough to support an effective response at and near the scene of the emergency (i.e., to preclude interference from uninvolved people and activity, facilitate onsite protective actions, optimize on-scene command, control, and mitigation efforts)?

- Is the EPZ likely to meet the expectations and needs of offsite agencies?

- What enhancement of the facility and site preparedness stature would be achieved by increasing the size of the EPZ? What resources, costs, and liabilities might a larger EPZ engender? Would a larger EPZ result in a large increase in preparedness without correspondingly large increases in cost or other detriment?

Document the consideration of each of the tests and any adjustments to the EPZ size that were made. The resulting value and its bases provide the beginning point for discussions with state, local, and tribal authorities.

Where several facilities are located in close proximity to one another and the nature of the hazards is the same at each, the largest impact from an event at any of the facilities may be used to define the EPZ for the entire area. Though it is possible that under certain conditions (e.g., major earthquake) releases from several facilities might occur at the same time with consequences that are additive, the EPZ size should not be based on concurrent events at separate facilities.

Where a number of individual facilities and activities are located in close proximity to one another, a composite EPZ for the group of facilities or the entire site should be defined to simplify communications and offsite interactions.

Onsite transportation accidents involving hazardous materials should be handled as follows.

- Transportation of hazardous materials within the site may be analyzed either in a Hazards Assessment for the fixed facility(ies) with which the materials are associated or in a special Hazards Assessment covering all transportation activity on the site.

- Emergency plans and procedures should include criteria by which to categorize and classify a range of onsite transportation accidents.

- The EPZ for a site should not be extended beyond the site boundary solely on the basis of potential consequences of a transportation accident if the transportation activity is comparable (in terms of materials, quantities, and mode of shipment) to that normally conducted on public routes.

- Further guidance on the classification of onsite transportation events is provided in Volume III, Chapter 3.

The planning process should recognize and provide for the need to carry out protective actions in limited portions of the EPZ for specific events or conditions. Dividing the EPZ into sectors by direction and radial distance and using natural or jurisdictional boundaries to define protective action zones are suggested ways to provide a finer planning and response structure.

5. MAINTAINING THE HAZARDS SURVEY AND HAZARDS ASSESSMENT

Hazards Surveys and Hazards Assessments should be maintained so that they accurately reflect changes in the facility design, operations, safety features, inventories of hazardous materials, and features of the surrounding area. In the absence of other overriding requirements on the mechanics of this maintenance process, the following guidelines should be applied.

- Hazards Surveys and Hazards Assessments should be periodically reviewed and, as necessary, updated. Hazards Assessments are to be reviewed at least annually and updated prior to significant changes to the site/facility or hazardous material inventories. Hazards Surveys are to be updated whenever operations warrant a change, but not less than every 3 years.

- Maintenance should be monitored through existing administrative processes and commitment tracking systems.

- The review schedule should be specified in the Emergency Readiness Assurance Plan (ERAP). Reviews should be coordinated and planned to take maximum advantage of other required periodic safety reviews, such as the annual Superfund Amendments and Reauthorization Act hazardous material inventory, nuclear facility safety reviews required by DOE 5480.23 and reviews required by National Pollutant Discharge Elimination System (NPDES) or other permit processes. Reviews should be done whenever significant modifications to facility, process, or materials inventory occur. Consistent with the DOE 5480.23 definition, "significant modification" is used here to mean any change to the facility or its operations that involves an unreviewed safety question, as defined in DOE 5480.21.

- Transitory hazards, such as short-duration storage of large quantities of hazardous materials or the short-term assembly and testing of nuclear explosive devices, may be covered in several ways. If a hazard assessment exists for the facility, the Hazards Assessment and associated emergency planning documents can be updated. For ease of maintenance and to avoid duplication of effort, the test plans or other controlling safety documents for such transitory hazards may be configured to serve as temporary addenda to the site and/or facility emergency plans. Another option is to issue a special abbreviated assessment that contains a description of the activity or operation and its expected duration, discussion and results of the hazards screening and characterization, scenario descriptions, consequence assessments, and EALs.

- Major changes in offsite or onsite population or in transportation features of the site and environs, such as new highways, should also cause the Hazards Assessment to be reviewed.

- The results of each review should be documented and reported to the management responsible for facility operations and emergency preparedness. If a review identifies no significant changes in facility, process, or potential emergency consequences, a finding to that effect should be documented.

- If the review identifies significant changes, they should be documented and reported. The report should address (1) the possible effects on the adequacy of facility and site emergency plans, (2) any temporary compensatory measures that are being considered or implemented, and (3) a schedule for updating the analysis, reporting the results, and proposing any needed changes to the site's emergency planning or response program.

6. USING HAZARD SURVEY AND HAZARDS ASSESSMENT RESULTS

6.1 Hazards Survey and Hazard Assessment

It is expected that DOE facilities already meet most Base Program planning requirements through building fire preplans, building evacuation plans, building warden systems, employee emergency notification systems, onsite medical and security plans, and mutual aid agreements with offsite organizations. For most facilities, the major program development effort resulting from the revised Order and this guidance should be the establishment of emergency categorization criteria and organization changes to ensure that the prompt notification requirement for operational emergencies is met. Volume III, Chapter 3, of the Emergency Management Guide provides guidance on categorization of operational emergencies that do not require classification. Existing site-specific Occurrence Reporting and EAL procedures provide a framework within which the new categorization requirement can be implemented.

Using the results of the Hazards Survey, the "Notification" element of the site emergency management program should be reviewed and responsibility assigned for completing the 30-minute notifications of operational emergencies not requiring classification. Some sites assign the responsibility for all notifications to a single "Notification Center," whereas others split the responsibilities for occurrence and emergency reporting. If the responsibility is split, reporting of operational emergencies not requiring classification should be assigned to the organizational entity currently responsible for reporting emergencies that are classified as Alert and higher.

The Hazards Survey process will involve the review of facility programs already in place to meet Federal, State, and local requirements related to worker health and safety, environmental protection, and hazardous materials reporting. It is not suggested that emergency management departments assume increased responsibility and authority for ensuring compliance with the Resource Conservation & Recovery Act (RCRA), CERCLA, NPDES, and Occupational Safety and Health Administration (OSHA) requirements. However, the Hazards Survey and its periodic updates should, as a minimum, serve as an internal quality assurance check on compliance with those regulations. Site/facility management may find it useful to incorporate the Hazards Survey process into its program of internal oversight and compliance monitoring for hazardous materials, environmental protection, and worker safety regulations.

6.2 Hazards Assessment

In general, existing Hazards Assessments that were done in accordance with the previous guidance will meet the intent of the DOE O 151.1 requirements. Most sites/facilities will need only to continue periodic reviews and updates as specified in the Order. Sites/ facilities will need to revise any EALs that may have been developed to classify offsite events (i.e., transportation accidents) involving DOE hazardous materials and nuclear weapons. Under DOE O 151.1, such offsite events are categorized as operational emergencies but are not to be classified as Alert, Site Area Emergency, or General Emergency.

Once completed, the Hazards Assessment products should be used to develop other program elements. Examples of the use of Hazards Assessment output are provided below.

- **EALs.** The Hazards Assessment provides the quantitative relationships between events and their consequences as well as the event descriptions and indications of barrier challenge and failure that serve as EAL statements.

- **ERO**. The nature and severity of the events analyzed should provide the basis for both on-shift and on-call ERO staffing. Qualified staff should be designated to perform all response functions. Staffing levels and expertise for performing functions such as consequence assessment and medical support are directly determined by the hazards present at the site/facility.

- **Notification and Communications.** For facilities subject to hazardous material operational emergencies, the potentially affected areas, the transport times, and the impacts of hazardous material releases will define the need for systems, procedures, and staff to carry out notifications. The level of sophistication and redundancy in communications systems should be directly related to the potential need for performing rapid onsite and offsite notifications and requests for assistance.

- **Offsite Response Interfaces.** In addition to identifying the offsite parties to whom prompt emergency notifications must be made, the Hazards Assessment should be used to define needs for specialized offsite support such as ambulances, medical facilities and personnel, hazardous materials response teams, firefighting support, and public affairs interfaces.

- **Consequence Assessment.** Developing the source term data and performing the consequence calculations required in the Hazards Assessment will help establish that the consequence assessment models and/or techniques available for use during actual emergencies are appropriate for specific hazardous materials over the range of possible release and transport conditions. The Hazards Assessment Document, or a summary thereof, should be available to responders as a ready source of data on each facility's hazardous material inventory, barrier descriptions and failure modes, monitoring instruments, and emergency event scenarios.

- **Emergency Medical Support.** The hazards analyzed in the Hazards Assessment will define the medical support required. The Hazards Assessment should be used to determine the need for special preparations such as decontamination supplies; chelating, neutralizing and blocking agents; and medical staff training in treatment of victims exposed to site/facility specific hazards.

- **Protective Actions and Reentry.** EALs for Alert through General Emergency are based on calculated event consequences at various distances and the applicable protective action criteria. The consequence calculation results should be used directly to determine EAL-specific protective actions (onsite) and offsite Protective Action Recommendations to be used until real-time event information is available to perform consequence assessment.

- **Emergency Public Information.** The hazards analyzed in the Hazards Assessment and the extent of their impacts will directly dictate the content and geographical coverage of the Emergency Public Information program. The public information program should address the nature of the potential hazardous materials releases, the notifications and information systems in place, and protective actions most likely to be implemented (e.g., evacuation routes, guidelines for sheltering in place).

- **Emergency Facilities and Equipment.** The nature and potential for release of the hazards analyzed in the Hazards Assessment should dictate many of the specifications for facilities and equipment. Overall facility and site emergency potential will help define general needs, such as communications equipment and EOC size, while specific hazards may indicate need for specialized equipment such as protective clothing, portable monitoring instruments, decontamination supplies, consequence assessment computers, Hazardous Materials (HAZMAT) response vehicles and supplies, and facility data acquisition systems.

- **Drills, Training, and Exercises.** The Hazards Assessment combined with the Hazardous Waste Operations and Emergency Response (HAZWOPER) and SAR programs provide a ready source of scenarios and source terms for use in developing facility-specific drills and exercises. Training, ranging from “general employee training" to ERO Manager, training should be customized around the Hazards Assessment and the HAZWOPER programs and their associated program elements.

Other uses of the Hazards Assessment results, beyond developing specific elements of the Operational Emergency Management Program, include the following.

- Comprehensive and defensible inventory of all hazardous material.
- Quantitative accident analysis for use as a cross check of or input to the SAR process.
- Development of recommendations for minimizing or segmenting hazardous materials inventories.
- Quantitative inputs to the fire preplanning and hazardous material spill prevention/cleanup plans.
- Accident range effluent monitoring capability evaluation and recommendations for upgrades.
- Identification of facility hardware and/or procedures modifications which would be beneficial in the avoidance and mitigation of events analyzed.

7. BIBLIOGRAPHY

DOE O 151.1 Chg 2. *Comprehensive Emergency Management System*. August 21, 1996.

DOE M 232.1-1A. *Occurrence Reporting and Processing of Operations Information*. July 21, 1997.

DOE O 420.1. *Facility Safety*. October 13, 1995.

DOE O 440.1 Chg 2. *Worker Protection Management for DOE Federal and Contractor Employees.* October 21, 1996.

DOE O 470.1. *Safeguards and Security Program*. September 28, 1996.

DOE 5480.5. *Safety of Nuclear Facilities*. September 23, 1986.

DOE 5480.6. *Safety of Department of Energy-owned Reactors*. September 23, 1986.

DOE 5480.21. *Unreviewed Safety Questions.* December 24, 1991.

DOE 5480.22. *Technical Safety Requirements*. February 25, 1992.

DOE 5480.23. *Nuclear Safety Analysis Reports*. April 10, 1992.

DOE-STD-1027-92. *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE 5480.23, Nuclear Safety Analysis Report.* 1992.

DOE-STD-3009-94. *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Report.* 1994.

DOE-HDBK-1062-96. *Fire Protection Handbook.* 1996.

DOE-HDBK-3010-94. *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. 1994.

Title 10 CFR 30.72, Schedule C. *Quantities Requiring Consideration of the Need for Emergency Planning,*

Title 29 CFR 1910.119. *Process Safety Management of Highly Hazardous Chemicals.*

Title 29 CFR 1910.120. *Hazardous Waste Operations and Emergency Response.*

Title 40 CFR 68. *Chemical Release Prevention Requirements*.

Title 40 CFR 355. *Emergency Planning and Notification.*

Manual of Protective Action Guides and Protective Actions for Nuclear Incidents, EPA 400-R-92-001. Environmental Protection Agency. May 1992.

Technical Guidance for Hazards Analysis. EPA-OSWER-88-0001. Environmental Protection Agency. December 1987.

Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants, NUREG-0396/EPA 520/1-78-016. Nuclear Regulatory Commission and Environmental Protection Agency. 1978.

Criteria for Preparation And Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants. NUREG-0654/FEMA-REP-1, Rev. 1. Nuclear Regulatory Commission and Federal Emergency Management Agency. November 1980.

Atmospheric Dispersion Modeling Resource. DOE Emergency Management Advisory Committee Subcommittee on Consequence Assessment and Protective Actions. 1995. (NOTE: Information on how to obtain this document is available on the SCAPA Internet Web site at: http://www.sep.bnl.gov/es/scapa.htm)

American Industrial Hygiene Association (AIHA) 1996. *The AIHA 1996 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook*.

Shleien, B. *Preparedness and Response in Radiation Accidents,* Health and Human Services Publication, FDA 83-8211. August 1983.

Acronyms

AED	Aerodynamic Equivalent Diameter
ARF	Airborne Release Fraction
ARR	Airborne Release Rate
CEDE	Committed Effective Dose Equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DCF	Dose Conversion Factor
DOE	Department of Energy
DOT	Department of Transportation
DR	Damage Ratio
EAL	Emergency Action Level
EHS	Extremely Hazardous Substance
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPZ	Emergency Planning Zone
ERAP	Emergency Readiness Assurance Plan
ERO	Emergency Response Organization
ERPG	Emergency Response Planning Guideline
FEMA	Federal Emergency Management Agency
FHA	Fire Hazards Analysis
HAZMAT	Hazardous Materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
LEPC	Local Emergency Planning Committee
LPF	Leak Path Factor
MAR	Material at Risk
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NWS	National Weather Service
OSHA	Occupational Safety & Health Administration
PAG	Protective Action Guide
PRA	Probabilistic Risk Assessment
RCRA	Resource Conservation & Recovery Act
RF	Respirable Fraction
RQ	Reportable Quantities
SAR	Safety Analysis Report
ST	Source Term
TEDE	Total Effective Dose Equivalent
TSD	Treatment, Storage, or Disposal

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APPENDIX A
FACILITY AND SITE BOUNDARY GUIDELINES

A.1 Discussion

Chapter V of the Order defines the Alert class of operational emergencies in terms of releases of hazardous materials to the environment for which it is expected that "...the applicable Protective Action Guide or Emergency Response Planning Guideline will be exceeded at or beyond 30 m from the point of release to the environment, <u>or</u> a site-specific criterion corresponding to a small fraction of the applicable PAG or ERPG at or beyond the facility boundary or exclusion zone boundary. . . ." The terms "releases" and "environment" clearly indicate that the receptor location is to be in the "environment" (i.e., <u>outside</u> the facility). For the Hazards Assessment, the receptor location is interpreted to be the point of maximum ground-level impact (in terms of concentration or radiation dose) outside the facility. For a ground-level, neutrally buoyant release to the atmosphere, the point of maximum impact will be the location <u>outside the facility</u> that is nearest to the potential point of release.

The "facility boundary" concept is easy to apply to a facility that consists of a single building or structure. However, many DOE facilities consist of large laboratory or manufacturing complexes that may include several buildings, structures, or installations. These large and complex facilities, such as accelerators, weapons development and test facilities, nuclear fuel reprocessing plants, and uranium enrichment plants, require a flexible and consistent approach to the definition of the facility boundary.

For many facilities and activities, there will be little or no question about what constitutes the facility operational and physical boundaries. Where operational or physical boundaries do not exist or are not suitable for Hazards Assessment purposes, these guidelines are intended to help establish appropriate facility boundary distances for use in the emergency management Hazards Assessment process.

The "facility boundary" selected in accordance with this guidance is intended for use in hazardous material emergency planning and analysis. It is not intended to correspond to the exclusion zone normally established by the on-scene Incident Commander for a fire response.

The boundary definition that is adopted for a given facility may determine whether certain events and conditions are classified as Alert or Site Area Emergency. In selecting a facility boundary distance, it must be kept in mind that the process of determining emergency classes should always enhance communications and promote common understanding of the general level of severity or magnitude of the event, both within the DOE and contractor community, and for the general public and news media.

Implicit in the DOE Order emergency class definitions and discussion is the assumption that DOE facilities are located within larger tracts (sites) over which DOE has access control authority. There is a logical progression in severity from events that affect the facility but not the larger site (Alert), to those that affect the site outside the facility but not offsite areas (Site Area Emergency), to those that affect offsite areas (General Emergency). This progression reflects the assumption that a buffer of DOE-controlled land exists between each DOE facility and the site boundary. Some DOE facilities may not have this buffer, and the relationship between facility boundary, site boundary and the emergency classes should be carefully considered when defining facility boundaries and determining the emergency classes that best describe facility events.

A.2 Selection of Facility Boundary Distance

For emergency planning purposes, several structures or component units with a common or related purpose may constitute a single facility. On the other hand, a complex of dissimilar buildings, processes, and equipment may be considered as a single facility if they are physically adjacent, under common management, and contribute to a common programmatic mission.

If a single building or structure contains several tenant activities or units, such as process lines, hot cells, or hazardous material storage, it may be reasonable to consider the entire structure as one facility even though the constituent units may have little to do with one another.

Use of standard “facility boundary distances” (analysis radii) for all facilities at a given site is encouraged. Using the same facility boundary analysis radius for all facilities ensures that the relationship between emergency class and consequences is consistent across the site.

- The facility boundary analysis radius should not be less than about 100 m or greater than about 200 m. This range of distances is suggested for the following reasons.
  - It ensures that the relationship between emergency class and event consequences is reasonably consistent across the DOE complex.
  - It approximates the distance to physical, administrative, or security boundaries that exist at many of the larger DOE facilities.

- It encompasses the 152 m (500 ft) initial isolation zone distance recommended in the DOT Emergency Response Guidebook for small spills of more than 80 percent of the hazardous materials listed.

- Inside 100 m, personnel who might be exposed to the hazardous material at levels exceeding the applicable protective action criterion are likely to be associated with the subject facility. This suggests that the impact of such an event should be characterized as "local" rather than "sitewide."

- If the facility boundary (or the analysis radius) coincides with or crosses a site boundary, or encompasses a significant number of other site workers or any area routinely accessible to the general public, a higher classification for any given event is indicated. An event that would be a SAE for a facility embedded in a large DOE site might be a GE for a facility located where the facility and site boundaries coincide.

- It may be useful to define a facility to include the entire fenced security area that surrounds the facility of interest. This approach is reasonable if the security area:

  - is small with respect to the size of the site (i.e., distance to the facility boundary is short with respect to the site boundary distance); and

  - includes few personnel not directly involved with the operations and management of the facility.

  If the facility boundary is defined in this way, the <u>minimum</u> distance from a likely release point to the facility boundary should be used as the analysis radius for all consequence calculations.

The following are examples of what should <u>not</u> be considered as a facility for Hazards Assessment purposes.

- Individual rooms, process areas, or laboratories within a larger building or structure. Even if the room/laboratory is different (in terms of hazardous materials or operations) from the rest of the building or it is under different programmatic control or management, it is preferable that the room/laboratory be treated as a component of a readily recognizable physical entity (building or complex) for which there are established landlord and building manager/building emergency director functions. Where more than one contractor occupies the same facility or complex, primary responsibility for the facility Hazards Assessment and emergency plan should be assigned to one organization. All other contractors' Hazards

Assessments and plans should then be subordinate to those of the primary contractor.

- Separate storage or support structures that are physically near and functionally subordinate to a facility having a Hazards Assessment. Examples include a warehouse or waste storage building on the site of a major material processing facility. It is preferable that the support structure be treated, for Hazards Assessment purposes, as a component of the material processing facility. However, if the support structure occupies a large area compared to the area occupied by the rest of the facility, or if its functions are significantly different, the support structure should be treated as a separate facility. Examples include a tank farm that receives waste from a fuel reprocessing plant, or a storage yard for uranium hexafluoride cylinders adjacent to an enrichment plant. Separate facilities may share a common EPZ.

- Large geographic areas enclosing multiple structures, operating areas or components, or distances between individual structures that exceed a few hundred meters, indicate the need for a finer facility definition.

A.3 Definition of Site Boundaries

In general, the perimeter enclosing the area where DOE has the responsibility for implementing protective action will be the site boundary. DOE facilities occupied by vendors or contractors with which agreements have been reached regarding emergency notification and protective action responsibilities should be considered "onsite" for purposes of analysis and event classification. However, there are several possible situations that could require adjustments to achieve overall consistency with the intent of DOE Orders and with sound emergency management principles.

- If the general public can gain unescorted access to areas of the DOE site, such as public highways or visitor centers, those areas should be considered as offsite for purposes of emergency class definition, unless it is ensured that those areas can be evacuated and access control established within about one (1) hour of any emergency declaration.

- Any non-DOE facility or activity located within a DOE site may be considered as offsite for purposes of emergency class definition. The potential effect on the non-DOE facility of a hazardous material emergency originating at a DOE facility may necessitate the type of coordinated response characteristic of a General Emergency.

Acronyms

EPZ	Emergency Planning Zone
ERPG	Emergency Response Planning Guideline
GE	General Emergency
PAG	Protective Action Guide
SAE	Site Area Emergency

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APPENDIX B
CONSEQUENCE THRESHOLDS FOR USE IN FACILITY HAZARDS ASSESSMENT

B.1 Introduction

The purpose of this Appendix is to provide additional guidance regarding the definition and use of the terms, "Protective Action Guides (PAGs)," "Emergency Response Planning Guidelines (ERPGs)," and "Threshold for Early Lethality (TEL)," as consequence thresholds for hazardous material effects. PAGs and ERPG-2 values (or alternatives) are referred to generically and collectively, in this chapter and elsewhere, as "protective action criteria" (PAC).

The Order specifies the consequences of an actual or potential hazardous material release as a key determinant of the emergency class. Specifically, the PAGs published by the Environmental Protection Agency (EPA) are cited as the applicable consequence thresholds for radiological exposures, and the ERPGs published by the American Industrial Hygiene Association (AIHA) are identified as the corresponding consequence thresholds for non-radiological hazards. The Order does not address the limitations of these standards or describe the precise manner in which they are to be used for Hazards Assessment and emergency planning.

Section 3.6 of this volume directs the user to calculate the consequences of hazardous material releases at several locations and compare the results with the applicable PAG or ERPG-2 value in order to determine the appropriate emergency class. The user is also directed to calculate the maximum distance at which protective action criteria and TELs would be expected and to use those distances in determination of EPZs.

B.2 Protective Action Criteria

Protective action criteria are levels of hazardous material impact that, if observed or predicted, indicate action is needed to prevent or limit exposure of people to the hazard. As detailed in this section, protective action criteria for DOE facility emergency planning and response are to be based on the PAGs published by the EPA (radiological) and the AIHA ERPGs (non-radiological).

B.2.1 Radiological Protective Action Criteria

General. Chapter V of the Order specifies that the PAGs published by the EPA in its *Manual of Protective Action Guides and Protective Actions For Nuclear Incidents* (EPA-400) are to be used for comparison with exposures resulting from radiological releases to determine the appropriate emergency class. These PAGs are intended to apply only to projected doses resulting from exposures to airborne releases of radioactive materials during the early phase of an emergency. The pathways considered include external gamma and beta dose from direct exposure to airborne and deposited material, and the committed dose to internal organs from inhalation of radioactive material. Although beta dose is discussed in EPA-400, it is not expected to be limiting for atmospheric releases from DOE facilities and is not included in the dose conversion factors (DCF) tables in Chapter 5 of EPA-400.

The projected dose value for initiating protective actions (evacuation or sheltering) specified in Table 2.1 of EPA-400 is 1-5 rem, where the projected dose represents the sum of the effective dose equivalent (EDE) resulting from exposure to external sources and the 50-year committed effective dose equivalent (CEDE) from all significant inhalation pathways during the early phase. The sum of the EDE and CEDE is the Total Effective Dose Equivalent (TEDE). It should be noted that the EPA methodology uses a 4-day ground shine component (from deposited plume material) in computing the EDE values. The PAG values for committed dose equivalent to the thyroid and the skin are 5-25 and 50-250 rem, respectively.

The EPA PAGs are stated in terms of projected dose for the entire early phase of an event, and are based on the assumption that half the projected dose can be avoided by evacuation.

The EPA PAGs are stated in terms of the TEDE, which includes the 50-year CEDE from material inhaled. However, there is a large body of scientific opinion to the effect that the 50-year CEDE is inappropriate for use in setting PAGs for long-lived radionuclides, such as those found at many DOE facilities. For some long-lived radionuclides deposited in the body, the dose received in the first year (i.e., the highest annual dose from a one-time intake) may be only about 1/50 of the CEDE. For example, if a CEDE of 1 rem from a long-lived internally deposited radionuclide is calculated, the actual dose equivalent received in the first year could be as little as 20 mrem, a small fraction of the natural background radiation dose equivalent received annually by every human being on earth. It is debatable whether it is appropriate to classify an event and recommend a protective action based on a projected dose equivalent far less than that received from natural background sources in any given year. A useful treatment of the relationship of the dosimetric units involved is found in *Dosimetric Quantities and Their Relationship to Risks to Individuals*.

Guidance. The terms "PAG" and "EPA Protective Action Guides" used in the Order should be interpreted as follows.

- A projected dose equivalent of 1 rem TEDE to standard man, where the projected TEDE is the sum of the EDE from exposure to external sources and the CEDE from inhalation during the early phase; or

- a projected committed dose equivalent (CDE) to the adult thyroid of 5 rem; or

- a projected CDE to the skin of 50 rem.

EPA-400 provides for use of a TEDE ground shine component of less than 4 days, and for not including exposure pathways contributing less than 10 percent of the TEDE. The following procedure is recommended for determining how (or if) the ground shine component of the EDE is to be computed.

- If the full 4-day ground shine component of TEDE can be shown to represent less than 10 percent of the TEDE, it may be excluded.

- If the full 4-day ground shine component cannot be eliminated by applying the 10 percent rule above, the ground shine should be included for a period of time equal to the estimated EPZ evacuation time. If no official estimate of EPZ evacuation time exists, conservative estimates should be used.

- If ground shine values of less than 4 days are to be used, then the 4-day DCFs in Section 5.6 of EPA-400 should be reduced proportionately (e.g., a 16-hour estimate of evacuation time would call for use of 16/96, or 0.17 times the DCF values.

If a large fraction (i.e., more than half) of the projected TEDE addressed above in this section results from inhalation of radionuclides with long effective half lives in the body, the fact that the dose will be delivered over a long period of time should be considered. For such cases, DOE facilities may choose to use the higher (5 rem) PAG value for planning and Hazards Assessment purposes.

Facilities having substantive and persuasive arguments for the use of other protective action threshold values may propose values that are specific to their radioactive material holdings and operations. Requests for exemption from the Order requirement should be submitted in accordance with Paragraph 3c of the Order. Any exemption request should be supported by an analysis that addresses the four principles that form the basis for the selection of the EPA PAG values and the other considerations utilized in the selection process, as discussed in Appendix C of the EPA-400.

For ingestion pathway exposure, the protective action guides adopted by the U.S. Food and Drug Administration (FDA), in FDA 83-8211, should be used for planning purposes as follows.

- The "Preventive PAG," 1.5 rem projected dose commitment to the thyroid or 0.5 rem projected dose commitment to the whole body, bone marrow, or any other organ, is the value at which officials should take protective actions having minimal impact, to prevent or reduce the radioactive contamination of human food or animal feeds.

- The "Emergency PAG," 15 rem projected dose commitment to the thyroid or 5 rem projected dose commitment to the whole body, bone marrow, or any other organ, is the value at which responsible officials should isolate food containing radioactivity to prevent its introduction into commerce and determine whether condemnation or another disposition is appropriate.

- Response levels corresponding to these PAGs should be derived for the specific radionuclides, foodstuffs, and animal feeds of interest according to the FDA recommendations.

B.2.2 Non-radiological Protective Action Criteria

General. Chapter V of the Order specifies that ERPGs developed and approved by the AIHA are to be used for comparison with exposures resulting from non-radiological releases to determine the appropriate emergency class. Within the ERPG system, three biological reference values are defined for each material as follows.

- **ERPG-1** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.

- **ERPG-2** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

- **ERPG-3** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

ERPGs have been issued for approximately 70 chemicals as of early 1996. There are no ERPG values for many of the hazardous chemicals of particular interest to DOE and its operations.

A number of sets of chemical exposure guidelines have been issued by other agencies and are sometimes used as emergency planning criteria. Besides the ERPGs, these include the short-term public emergency guidance levels (SPEGLs) and emergency exposure guidance levels (EEGLs) developed by the National Research Council, and the levels of concern (LOCs) published jointly by the EPA, FEMA, and DOT.

The Chemical Exposures Working Group of the DOE Emergency Management Advisory Committee (EMAC) Subcommittee on Consequence Assessment and Protective Action (SCAPA) devised and published a method for determining alternative planning values for chemicals without AIHA-approved ERPG values. Table 1 summarizes the method, which uses a hierarchy of sources to determine alternatives to the ERPG-1, 2, and 3 values.

Table 1. Recommended Hierarchy of Alternative Concentration Guidelines.

Primary Guideline	Hierarchy of Alternative Guidelines	Source of Exposure Limit Concentration
ERPG-3		AIHA
	EEGL (30-min)	NAS
	IDLH	NIOSH
ERPG-2		AIHA
	EEGL (60-min)	NAS
	LOC	EPA/FEMA/DOT
	TLV-C	ACGIH
	PEL-C	OSHA
	TLV-TWA x 5	ACGIH
ERPG-1		AIHA
	TLV-STEL	ACGIH
	PEL-STEL	OSHA
	TLV-TWA x 3	ACGIH

<u>Abbreviations</u>

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association ERP Committee
DOT	U. S. Department of Transportation
EEGL	Emergency Exposure Guidance Level
EPA	U. S. Environmental Protection Agency
IDLH	Immediately Dangerous to Life and Health
LOC	Level of Concern
NAS	National Academy of Sciences Committee on Toxicology
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration

PEL-C	Permissible Exposure Limit - Ceiling
PEL-STEL	Permissible Exposure Limit - Short Term Exposure Limit
TLV-C	Threshold Limit Value - Ceiling
TLV-STEL	Threshold Limit Value - Short Term Exposure Limit
TLV-TWA	Threshold Limit Value - Time Weighted Average

The AIHA ERPG values, or alternative values determined in accordance with Table 1, should be compared with the predicted maximum 15-minute average concentration. For exposure periods of less than 15 minutes, concentrations for comparison with the guidelines may be calculated over a shorter time period (e.g., the exposure duration). Some consequence assessment dispersion codes will calculate the desired maximum 15-minute average concentration directly, by allowing the analyst to specify the averaging period. To determine the average concentration manually, the following formula can be used.

$$TWA = \frac{C_1T_1 + C_2T_2 + C_nT_n}{T_1 + T_2 + T_n} = \frac{\Sigma\, C_nT_n}{\Sigma\, T_n}$$

where: *C* = Concentration (ppm or mg/m^3)
T = Time period of exposure (min)

It is not recommended that individual time intervals of less than 1 minute be used in the numerator of the above formula for calculating the TWA. For the peak 15-minute TWA, the 15-minute period of maximum exposure (concentration) is selected and input (as 15 one-minute segments) into the above formula. For exposure periods of less than 15 minutes, the product of C_xT_x may equal zero during the exposure period. These "zero" results may be factored into the 15-minute average or the use of a shorter averaging duration, such as the actual exposure period, may be warranted depending on the acute toxicity of the chemical of interest and the peak concentration observed.

Guidance. For purposes of applying the Order emergency class definitions, the terms, "ERPG" and "appropriate ERPG exposure levels" should be interpreted to mean the following.

> *A 15-minute TWA concentration of the substance in air that equals or exceeds the published ERPG-2 value, or its alternative value, for that substance.*

If ERPG values have not been published by the AIHA for a substance of interest, the method described in this section should be used to develop an alternative value.

B.3 Threshold for Early Lethality (TEL)

General. Chapter 4 of this volume specifies use of the maximum distance at which facility emergency consequences could exceed a threshold for early (acute) lethality as one element in the determination of EPZ size.

In general, early lethality is equated with deterministic processes (i.e., a threshold of exposure exists below which the effect is not observed and the severity of the effect is related to the dose or exposure).

As used here, the early lethality threshold applies to the general population and is intended to approximate the level of dose or exposure at which the sensitive groups within any large population would begin to show an increase in mortality. The definitions below are intended only for use in the facility Hazards Assessment process.

Guidance. For purposes of conducting facility Hazards Assessments, the term "threshold for early lethality (TEL)" should be interpreted as follows.

- For radiological releases:

  A projected dose (TEDE) of about 100 rem to reference man, where the projected TEDE is the sum of the EDE from exposure to external sources and the CEDE from inhalation during the early phase.

  The use of 100 rem TEDE as an approximation of the lethality threshold is quite conservative. Radiation effects studies have estimated a 5 percent risk of early fatality following an acute dose of 140 rem, with a smaller but indeterminate risk expected for doses below that level. Little if any risk of early fatality would be associated with 100 rem TEDE if the dose were received over a period of time from radioactive material taken into the body.

- For non-radiological releases:

  A projected 15-minute average concentration of the substance in air that equals or exceeds the ERPG-3 or alternative value for that substance.

B.4 References

The AIHA 1996 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook. American Industrial Hygiene Association. 1996.

D. K. Craig et. al. *Alternative Guideline Limits for Chemicals Without Emergency Response Planning Guidelines*. AIHA Journal. pp 919-925. September 1995.

Manual of Protective Action Guides and Protective Actions For Nuclear Incidents. EPA 400-R-92-001. Environmental Protection Agency. October, 1991.

L. Gephart and S. Moses. *An Approach to Evaluate the Acute Impacts from Simulated Accidental Releases of Chlorine and Ammonia*. Eastman Kodak Company. Rochester, NY. January 1989.

R.L. Hill and J. R. Johnson. *Dosimetric Quantities and Their Relationship to Risks to Individuals*. PNL-SA-18260. Pacific Northwest Laboratory. Richland, WA. June 1990.

Report to the General Assembly, *Sources, Effects and Risks of Ionizing Radiation*. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1988.

Acronyms

AIHA	American Industrial Hygiene Association
CDE	Committed Dose Equivalent
CEDE	Committed Effective Dose Equivalent
DCF	Dose Conversion Factor
EDE	Effective Dose Equivalent
EEGL	Emergency Exposure Guidance Levels
EMAC	Emergency Management Advisory Committee
EPA	Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
FDA	U.S. Food and Drug Administration
LOC	Level of Concern
PAG	Protective Action Guide
SCAPA	Subcommittee on Consequence Assessment and Protective Action
SPEGL	Short-term Public Emergency Guidance Levels
TEDE	Total Effective Dose Equivalent
TEL	Threshold for Early Lethality
TWA	Time Weighted Average

APPENDIX C
EXAMPLE APPLICATION OF THE HAZARDS SURVEY GUIDANCE TO A HYPOTHETICAL DOE SITE

C.1 Introduction

The purpose of this appendix is to illustrate the application of the Hazards Survey guidance described in the main body of this volume. Chapter 2 describes the steps of a suggested approach to conducting a facility Hazards Survey. The steps were described quite briefly and in sufficiently general language that they could be applied to a broad variety of facility types. It is believed that the intent of the guidance can be made much clearer by use of examples than by any other method.

This appendix is presented in the format of a Hazards Survey Document for a hypothetical DOE facility and site, prepared in accordance with the suggested methodology. Numbered sections (i.e., 1, 2, 2.1, etc.) are parts of the example Hazards Survey Document.

The format and content of the example application, presented in the following pages, should be viewed as an acceptable means of meeting the Hazards Survey requirement of DOE O 151.1 and documenting its results. The table of contents for the example Hazards Survey is given below.

C.2 Example Hazards Survey

123 AREA Hazards Survey

1. Introduction

This report documents the Hazards Survey for facilities in the 123 Area of the DOE Erlenmeyer Site. The Hazards Survey was conducted in accordance with Volume I, Chapter 2 of the DOE Emergency Management Guide, *Guidance for Hazards Surveys and Hazards Assessments,* to fulfill the DOE O 151.1 requirement that a Hazards Survey be done to identify the conditions to be addressed by the comprehensive emergency management program.

2. Scope

2.1 Site Description

The Erlenmeyer Site is described in Section 3 of the Site Comprehensive Emergency Plan. The 123 Area is described in Section 3.2.2 of that document.

2.2 Facilities Covered

This Hazards Survey covers all facilities and operations within the 123 Area. Included are research and development laboratories, warehouses, utility services, and administrative offices. The facilities and the results of the survey are presented in Table 2.1.

3. Summary

As a result of the qualitative Hazards Survey documented in Table 2.1, facilities in the 123 Area can be grouped according to their emergency potential as detailed below.

3.1 Facilities Having Potential For Operational Emergencies Requiring Classification

Based on hazardous material inventory information sources listed in Table 3.1, the ABC Facility and the Water Treatment Plant (Building 152) are determined to have the potential for operational emergencies that would be classified as Alert, Site Area Emergency, or General Emergency. Quantitative Hazards Assessments are required for these facilities. The Hazards Assessment for the ABC Facility is documented in (reference) and for Building 152 in (reference).

Because of the potential for operational emergencies requiring classification, the planning and preparedness requirements of DOE O 151.1, Chapter IV, apply to the ABC Facility, Building 152, and the site as a whole. The Erlenmeyer Site Emergency Plan, ERL-EM-0001, provides for comprehensive and integrated site planning, preparedness, and response for all potential emergency conditions involving the release of hazardous materials on the site. The site plan and implementation procedures, together with the Building/Facility Emergency plans and procedures for the ABC Facility and Building 152, address each of the planning, preparedness, and response requirements of DOE O 151.1, Chapter IV.

3.2 Facilities Having No Potential for Operational Emergencies Requiring Classification

The following facilities are determined to have the potential for events or conditions that would be categorized as operational emergencies in accordance with the criteria of

DOE O 151.1, Chapter V, but not require classification. The organization component listed is responsible for maintaining planning and preparedness in accordance with the "applicable requirements" identified in Table 2.1 and for making specific provisions for timely recognition and reporting of operational emergencies originating in or affecting the facility.

Building Number	**Responsible Organization and Organization Code**
101	Craft Services (SL40)
102	Emergency Services (SE55)
103, 104, 106, 108, 109	XYZ Operations (TK41)
113, 151, 152	Site Utilities Engineering (TZ30)
114	ABC Operations (TK44)
117, 118, 121	PQR Laboratory Operations (MX72)
999	Contract Services (CZ00)

Table 2.1. 123 Area Hazards Survey Summary

Bldg ID	Type/ Use	Occupancy (total/ other than ground floor)	Classified Materials	Special Conditions/ Designations	Hazardous Materials	Emergency Conditions	Potential Impacts	Applicable Reqmts
101	Craft shop	12/0	No	Haz. waste satellite collection point	Paints, solvents, lubricants (< screening qty.)	1. Structure fire 2. Malevolent acts 3. Structure collapse 4. Industrial/ process accident 5. Haz. mat. from other sources 9. Environmental release	1 - 5. worker death/ injury 9. Pollution of water-way	OSHA Employee notification & evac. plan; 40 CFR 117 notification of release to waters
102	Fire Station	8/0	No	Buried natural gas main ~30 m west	None	1. Structure fire 2. Malevolent acts 3. Structure collapse 5. Haz. mat. from other sources	1 - 3, 5. worker death/ injury	OSHA Employee notification & evac. plan
103, 104, 108, 109, 114, 117	Offices, modular	24/0 (each)	No	No	None	1. Structure fire 2. Malevolent acts 3. Structure collapse 5. Haz. mat. from other sources	1 - 3, 5. worker death/ injury	OSHA Employee notification & evac. plan
106, 113, 118, 121	Offices, multistory	106: 45/20 113: 60/30 118: 45/15 121: 90/48	No	No	None	1. Structure fire 2. Malevolent acts 3. Structure collapse 5. Haz. mat. from other sources	1 - 3, 5. worker death/ injury	OSHA Employee notification & evac. plan

Table 2.1. 123 Area Hazards Survey Summary (continued)

Bldg ID	Type/Use	Occupancy (total/other than ground floor)	Classified Materials	Special Conditions/ Designations	Hazardous Materials	Emergency Conditions	Potential Impacts	Applicable Requirements
ABC	Laboratory process	140/50	Yes	TSD facility	Rad. & nonrad >screening values	1. Structure fire 2. Malevolent act 3. Structure collapse 4. Industrial/ process accident 5. Haz. mat. from other sources 7. Haz. mat. releases 8. Fac. damage/ classified material compromise 9. Environ. release	1-5. Worker death/ injury 7. Onsite & offsite personnel death/ injury 8. Loss/ compromise of classified material 9. Pollution of water-way and land areas	OSHA Employee notification & evac. plan; 40CFR302 reporting; 40CFR355 reporting; 40CFR117 notification of release to waters
999	Offices, multistory	310/150	Yes	No	None	1. Structure fire 2. Malevolent act 3. Structure collapse 5. Haz. mat. from other sources 8. Fac. damage/ classified material compromise	1,2,3,5. Worker death/injury 8. Loss/compromise of classified material	OSHA Employee notification & evac. plan
151	River water pump station	No routine occupancy	No	No	No	1. Structure fire 2. Malevolent act 3. Structure collapse 5. Haz. mat. from other sources	1,2,3,5. Worker death/injury, degraded safety of 123 Area facil., & processes due to loss of service & fire water.	OSHA Employees notification & evac. plan

Table 3.1. Sources of 123 Area Hazardous Material Inventory Information

Building	Hazardous Material Inventory Information Sources
101	Site Hazardous Material Inventory and Tracking System (MIST), 6/5/96. Facility walk-through on 6/23/96.
102	MIST, 6/5/96. Facility walk-through on 6/23/96.
103, 104, 108, 109, 114, 117	MIST, 6/5/96. Facility walk-throughs on 6/23/96.
106, 113, 118, 121	MIST, 6/9/96. Facility walk-throughs on 6/24/96.
ABC	MIST, 6/4/96. ABC Hazards Assessment dated 1/94 and supplement dated 7/95. MWUPPPP Process safety assessment dated 5/95. Facility walk-through on 6/22/96.
999	MIST, 6/11/96. Facility walk-through on 6/19/96.
151	MIST, 6/4/96. Facility walk-through on 6/19/96.
152	MIST, 6/4/96. Bldg 152 Hazards Assessment dated 4/94. Facility walk-through on 6/19/96.

APPENDIX D
EXAMPLE APPLICATION OF THE HAZARDS ASSESSMENT METHOD TO A HYPOTHETICAL DOE FACILITY

D.1 Introduction

The purpose of this Appendix is to illustrate the application of the Hazards Assessment process described in the main body of this volume. Chapter 3 describes the steps of a suggested integrated approach to conducting a facility Hazards Assessment. The steps were described quite briefly and in sufficiently general language that they could be applied to a broad variety of facility types. It is believed that the intent of the guidance can be made much clearer by use of examples than by any other method.

This Appendix is presented in the format of a Hazards Assessment Document for a hypothetical DOE facility and site, prepared in accordance with the suggested methodology. Numbered sections (i.e., 1.1, 1.2, etc.) are parts of the example Hazards Assessment Document. *Explanatory notes and background information, which appear in italics, are included for the benefit of the user.*

The format and content of the example application, presented in the following pages, should be viewed as an acceptable means of meeting the Hazards Assessment requirement of DOE O 151.1 and documenting its results. The table of contents for the example Hazards Assessment is given below.

9. MAINTENANCE/REVIEW OF THIS HAZARDS ASSESSMENT

D.2 Example Hazards Assessment

HAZARDS ASSESSMENT FOR THE ABC FACILITY

1. Introduction

This report documents the Hazards Assessment for the ABC Facility located on the DOE XYZ Site. The Hazards Assessment was conducted in accordance with DOE Headquarters guidance to fulfill the DOE O 151.1 requirement for a facility-specific Hazards Assessment to provide the technical basis for facility emergency planning efforts.

2. Facility and Site Description

Detailed descriptions of the ABC Facility and the XYZ Site are found in Sections 2 and 3, respectively, of the ABC Facility Safety Analysis Report (Reference _). The following summary is derived from that description.

Note: It is not intended that the facility and site description section be voluminous. If suitable facility and site descriptions are not available for reference, a maximum of 5 to 10 pages of text plus 2-4 maps or figures showing the facility and site layout should suffice for most facilities. If a reasonably complete and current facility and site description is available in a published SAR or similar document, it should be introduced by reference and summarized as shown here. Note that the site description should include a description of the climate, geography, hydrology, seismology, and land use on and near the site.

2.1 Facility Mission

The ABC Facility is a chemical and materials engineering laboratory that provides a diversified capability for radioactive chemical processing and materials engineering studies. Among the activities in progress are development of treatment processes for hazardous wastes and fabrication of prototype thermal-electric generators powered by long-lived radioisotopes. The ABC Facility is operated by the Operating Contractor under prime contract with the DOE.

2.2 Location

The ABC Facility is located in the southeast part of the 123 Area of the DOE's XYZ Site. The 123 Area is a limited access area of about 200 hectares (500 acres) located about

10 km (6 miles) north of Anytown. Figure 2.1 shows the location of the ABC Facility with respect to the other facilities in the 123 Area and the immediate surrounding area. Figure 2.2 shows the location of XYZ Site and approximate distances to cities and towns in the region.

2.3 Facility Description

For purposes of this Hazards Assessment, the ABC Facility is defined as consisting of the main ABC Building and the ABC Vent Stack (both described the SAR) plus the ABC Warehouse Annex and office trailers ABC1 through ABC6. The facility boundary is defined as shown in Figure 2.1.

Figure 2.1. Location of the ABC Facility in the 123 Area.

(Local area map showing facility, facility boundary, adjacent facilities and occupancy, receptors of interest identified in Section 6, and site boundary.)

Figure 2.2. Location of the XYZ Site.

(Map showing location of the site with respect to the state, towns, and offsite receptors identified in Section 6.)

NOTE: The facility boundary in this example is configured to illustrate the inclusion of ancillary structures as part of the facility for purposes of Hazards Assessment. In the case of both the warehouse and the office trailers this is judged to be reasonable because the ancillary structures are: (1) physically close to the main building, (2) within the same protected area fence, (3) directly in support of the facility mission (storage for equipment and materials used routinely in the main building and office space for facility staff), and (4) under the responsibility of the same functional (line) organization and building manager. There is another major facility only 75 m away within the same protected area, and for purposes of this Hazards Assessment, the facility boundary is defined as a 100-m radius from the point of release. See Appendix A for additional discussion of the considerations in establishing facility boundaries.

The ABC Building is a 62-m × 70-m (200-ft × 240-ft) two-story structure (with partial basement and third floors) constructed of insulated steel panels on a structural steel frame. The foundation is poured, reinforced concrete. The roof is gravel-finished, class II, 20-year built-up roofing. The building was constructed in 1964 and was designed to the requirements of the Uniform Building Code.

The ABC Stack is a 2-m diameter, 60-m (195 ft) tall reinforced concrete stack, located 30 m north of the northeast corner of the ABC Building proper. Ventilation exhaust fans in the basement of the building exhaust through a tunnel to the stack. A 2.4-m × 4-m concrete block structure at the base of the stack houses effluent sampling and air flow measuring instruments.

The ABC Warehouse Annex is a 10-m × 30-m steel frame and panel single-story structure built on a concrete floor slab. It is located inside the protected area adjacent to the southeast corner of the ABC Building proper. Its primary use is the receipt and storage of materials and equipment used in the ABC Building operations. Among the materials and equipment normally stored there are industrial chemicals and gases, packaged samples of hazardous waste for use in process testing, shipping casks used for transporting radioactive material specimens, and packaged low level and mixed waste awaiting transportation to disposal sites.

Office trailers ABC1 through ABC6, clustered near the southwest corner of the building, are of conventional modular (mobile) home frame construction on concrete-block foundations. Of the approximately 80 offices in the trailers, about half are assigned to employees directly associated with the ABC Building operations. The office trailers are served by the ABC Building fire alarm and public address/announcing systems.

The protected area security fence shown on Figure 2.1 encloses the ABC Facility as well as two adjacent facilities, a radiometallurgical laboratory, and the 123 Area water treatment plant. Entry for both personnel and vehicles to the protected area is gained by way of the central access portal, which is manned full-time by site security forces. Persons entering through the central access portal require valid identification with a special access authorization and are screened for weapons or prohibited articles. Once inside the protected area, a key card is required to gain access to the ABC Building, the warehouse annex, or office trailers.

Figure 2.1 shows the facilities and other features of the 123 Area, including the number of persons normally present during working hours and off hours. The nearest site boundary, and hence, the point closest to the ABC Facility where members of the public can gain uncontrolled access, is the near bank of the Big River, 300 m to the east. The nearest public road access is a parking lot 350 m to the southwest.

The potential effects of natural phenomena and external hazards on the ABC Facility are described and analyzed in Section _ of reference __ (the SAR).

2.4 Processes and Operations

NOTE: For purposes of illustration, this section describes two separate hypothetical processes that involve hazardous materials. The processes described are not intended to resemble any specific operations carried out at DOE sites. The example is intended to illustrate the possibility of two or more basically different types of operations coexisting in the same facility and being treated in one facility Hazards Assessment.

Process Number 1 (Non-radiological). Process number 1 involves the development and testing of methods for treating hazardous waste to reduce its volume and facilitate its storage and disposal. Specifically, soil and building materials contaminated with polychlorinated biphenyls (PCBs) and heavy metals are used to develop and demonstrate the treatment processes.

The process begins with the receipt of samples of contaminated materials packaged in 208-L (55-gal) steel drums with plastic liners, at the ABC Warehouse Annex. The containers are inspected and stored in the warehouse until needed as feed material for the development process. Typically, 12 to 30 drums containing 50 to 150 kg (110 to 330 lb) of soil, concrete, brick, wallboard, lumber, and insulation material are stored in the warehouse at any time. These materials contain from 100 to 5000 parts per million (ppm) by weight of PCBs and up to 2000 ppm of lead and cadmium.

The waste material is transported, one drum at a time, into Room 101 of the ABC Building. There, the drums are opened in a ventilation booth and emptied on a sorting conveyer where the contents are characterized. The sorting conveyer carries the material into a rotating drum incinerator. The incinerator, fueled by propane gas, heats the material to 1000°C for 60 minutes, destroying all PCBs and other organic contaminants. The off-gas from the incinerator is passed through HEPA filters and scrubbed prior to being released to the environment by way of the building main stack.

After cooling to 200°C, the solid residue from the incinerator is passed through a grinder that reduces it to particles of 5 mm or less in size. The residue then is injected into a continuous mixer with various prepolymers, catalysts, and stabilizers and extruded as durable, high-density plastic shapes suitable for landfill disposal or other use.

A detailed description and material flow diagram for Process No. 1 is in reference _____.

Process Number 2 (Radiological). Process number 2 involves the fabrication and testing of prototype thermal-electric generators powered by Pu-238, a long-lived radioisotope.

The process begins with the receipt of Pu-238 as a nitrate solution. The nitrate solution is received in 1-L bottles in large shipping containers and subjected to receipt inspection and assay in another facility. The bottles are then transferred directly to the ABC Building storage vault, Room 109.

As needed, the nitrate solution is removed from the storage vault to Cell A, where it is converted to an oxide powder by the MAGIC process. The powder is then calcined, blended, pressed with a binder, and granulated in Cell B. The granulated material is then pressed into pellets and sintered in Cell C. The sintered pellets are transferred to the grinding and inspection glovebox in Room 110, where they are ground to final dimensions, weighed, and visually inspected for defects.

The finished pellets then are transferred to the RTG fabrication area, Room 111, where they are incorporated into RTG assemblies. The assemblies, of various designs, may contain from 4 to 800 g of Pu-238 pellets each.

Following fabrication, the RTGs are transferred to the RTG test laboratory, Room 115, where they are subjected to a variety of mechanical, thermal and electrical performance tests. First the electrical output of the RTG is measured and compared to design performance specifications. Then the device is subjected to the temperature extremes (24 hours in a 300°C oven followed by 24 hours in a liquid nitrogen bath), vibration (10 × gravity at 20 Hertz for 24 hours), impact (equivalent to being dropped on concrete 8000 times from a height of 10 m), and penetration (equivalent to being struck by 12 armor-piercing 7.62-mm bullets).

If the electrical performance of a device is satisfactory after the tests, it is placed under long-term evaluation, where the output is monitored under a variety of expected operating conditions for up to 5 years. Devices that fail one or more of the physical integrity or performance tests are disassembled and the Pu-238 pellets recovered for reuse.

A detailed description and material flow diagram for Process No. 2 is in reference __.

3. Identification and Screening of Hazards

The hazardous materials stored, used, and produced in the ABC Facility have been identified from the sources below and are listed in Table 3.1, along with the applicable screening threshold.

- Annual inventory of Extremely Hazardous Substances, dated ___.
- ABC Facility Safety Analysis Report, Section _, Facility Hazards.
- ABC Facility Operations Safety Requirements, dated ___.
- Process No. 1 Operating Procedures and Process Standards, dated __.
- Process No. 2 Operating Procedures and Process Standards, dated __.
- ABC Facility Annual Fire Protection Review, dated ___.

In addition, a walk-through of the facility was conducted on (date) with representatives of the Industrial Safety and Fire Protection, Radiological Safety, Process No. 1 and Process No. 2 Operations and Facility Management (landlord function) to verify that the list developed from the above sources was complete and accurate.

Table 3.1. ABC Facility Hazardous Materials List

Material	Location	Maximum Quantity	Threshold	Basis
Acetone	Warehouse Room 101	10 kg 1 kg	2270 kg	(1)
HF (anhydrous)	Warehouse Cell A	400 kg (880 lb) 200 kg (440 lb)	45.4 kg	(2)
Toluene Diisocyanate	Warehouse Room 101	1000 kg 100 kg	45.4 kg	(2)
Styrene monomer	Warehouse Room 101	200 kg 100 kg	454 kg	(1)
PCBs	Warehouse	2.25 kg	10 kg	(3)
Plutonium-238	Room 109 Cell A Cell B Cell C Room 110 Room 111 Room 115	3 kg 2 kg 1 kg 1 kg 1 kg 1 kg 1 kg	0.0001 kg	(4)

(1) Screening threshold established on basis of 40 CFR 302, Table 302.4 (List of Hazardous Substances) Reportable Quantity.

(2) Screening threshold established on basis of 40 CFR 355 Appendix A (List of Extremely Hazardous Substances) Threshold Planning Quantity.

(3) Facility-specific screening threshold established on basis of low acute toxicity and low dispersibility of the material as it is found in this particular facility (i.e., as a contaminant in large volumes of solid waste).

(4) Screening threshold established on basis of 10 CFR 30.72, Schedule C, value of 2 Curies for “all other alpha emitters” (0.12 gm for Pu-238).

NOTE: The above notes are intended to illustrate the use of (1) established reporting or planning threshold values and (2) locally developed values based on the properties of the material to set screening thresholds that eliminate the need to further consider many substances that are of no real concern.

4. Hazard Characterization

The screening process described in the preceding section identified three substances that exceeded the screening thresholds. They are anhydrous hydrogen fluoride, toluene diisocyanate, and Pu-238.

4.1 Anhydrous Hydrogen Fluoride

Anhydrous hydrogen fluoride (or hydrofluoric acid, HF) is an extremely hazardous substance used in Process No. 2. It is received and handled in sealed steel pressure cylinders containing 100 kg (220 lb) each when full.

Inventory. The maximum quantity of HF in the facility at any time is six full cylinders containing 600 kg (1320 lb). Of these six cylinders, four cylinders (400 kg) are located within the warehouse and two cylinders (200 kg) are located in the operating gallery outside Cell A.

Properties of HF. HF is a nearly colorless, fuming liquid or gas with a pungent irritating odor. It is perceptible by smell above about 5 ppm. The boiling point of HF at 1 atmosphere is 19.5°C (67.1°F). HF is highly reactive and will attack glass, concrete, certain metals, natural rubber, and many organics. HF itself is not flammable but in its concentrated form it can attack certain metals and release explosive hydrogen gas. It is hygroscopic, forming an acid solution when it reacts with water and releasing large amounts of heat. Water contamination of pressurized containers or piping systems can permit formation of an acid solution with subsequent acid attack on metals and generation of hydrogen.

Conditions of Storage and Use. The inventory in the warehouse is limited to four cylinders by the number of specially designed storage racks to which the full cylinders are bolted. One cylinder at a time is removed from the storage rack and transported by forklift into the ABC Building, where it is bolted to a storage rack outside Cell A and connected to the manifold serving Process No. 2. A second full cylinder is kept connected to the same manifold, ready to be placed in service when the on-line cylinder is empty. The inventory limits are maintained by a combination of engineered means (i.e., limited by the number of special storage racks for the cylinders) and facility procedures, which prohibit the keeping of the HF cylinders except in the special storage racks.

The warehouse is open to the atmosphere much of the time. Although heated in the winter to keep temperatures above the freezing point, the building is cooled only by the use of roof ventilators. Except during inclement weather, one or both of the large roll-up doors (located at the north and south ends of the building) is normally open during working hours to facilitate access.

The Cell A operating corridor is part of ventilation Zone B of the ABC Building. It is maintained at 19-22°C and 40-60% relative humidity by the building heating, ventilating, and air conditioning (HVAC) system. The volume of the operating corridor is 375 m^3, and it is exhausted by way of the Zone A (cell) exhaust system at a rate of 12 m^3 per minute. The Zone A exhaust flow passes through double HEPA filters and is discharged to the building stack.

4.2 Toluene Diisocyanate

Toluene diisocyanate (toluene-2,4-diisocyanate, TDI) is an extremely hazardous substance used in the plastic production stage of Process No. 1. It is received and handled in 208-L (55-gal) steel drums that hold 256 kg (564 lb) when full.

Inventory. The normal maximum quantity of TDI in the facility at any time is five full drums containing 1280 kg (2820 lb), divided between the warehouse (four drums, 1024 kg) and Room 101 (one drum, 256 kg).

Properties of TDI. TDI is a white to pale yellow liquid with a pungent odor, recognizable at a concentration of about 2 ppm in air. It has a boiling point of 251°C (485°F). It is stable in sealed containers at room temperature for normal storage and handling. It is combustible and reacts readily with oxidizing agents and compounds containing hydrogen (water, alcohols, amines). It can be extremely dangerous in a fire situation, as sealed containers can rupture violently when heated. Oxidation in air can produce oxides of carbon and nitrogen and toxic nitrogen-containing decomposition products.

Conditions of Storage and Use. The TDI stored in the warehouse is stored in the drums on wooden pallets in a 5 m × 8 m curbed area segregated from other potentially reactive materials. Conditions in the warehouse are described in the previous section.

One drum of TDI at a time is moved by forklift into Room 101 where it is opened and a pump installed to inject the material into the plastics process equipment. Room 101 is part of ventilation Zone B of the ABC Building HVAC system. It has a once-through ventilation pattern with four air changes per hour and is exhausted by way of the Zone B exhaust fans to the building stack.

The inventory limits are maintained by administrative means only. The designated storage area in the warehouse is marked and labeled to prohibit storing more than the allowed number of drums of TDI. The inventory limit in Room 101 is maintained by procedure and process specification. A practical physical limit also exists because the plastics process machinery has only one drum receiving station and designed injection point for the TDI.

4.3 Plutonium-238

Plutonium-238 (Pu-238) is an alpha-emitting radionuclide with a half-life of 87.7 years. Its high specific activity, 6.3 E+11 Bq/g (17.1 Ci/g) makes it very useful as a long-lived heat source for thermal-electric generating devices. The Pu-238 is received as a nitrate solution and later converted to an oxide powder and pellets before being incorporated into generating devices.

Inventory. The maximum inventory of Pu-238 allowed in the ABC Building under the current operations safety requirements is 10 kg or 6.3 E+16 Bq (1.7 E+5 Ci). The operations safety requirements further limit the quantities in each location as follows.

Location	kg	Bq
Room 109 (vault)	3	1.9E+16
Cell A	2	1.3E+16
Cell B	1	6.3E+15
Cell C	1	6.3E+15
Room 110	1	6.3E+15
Room 111	1	6.3E+15

Location	kg	Bq
Room 115	1	6.3E+15

Properties of Pu-238. The Pu-238 is received and stored as a 200 g/L nitrate solution. It is then converted to PuO_2 powder and pellets in a series of steps. The density, particle size distribution, and solubility characteristics of the oxide at each stage of the process are detailed in section _ of reference __ (the facility SAR).

Conditions of Storage and Use. All areas where Pu-238 is authorized to be stored and handled in the ABC Building are within ventilation Zone B. These areas are at negative pressure with respect to adjoining areas and are exhausted through two stages of HEPA filtration to the building stack. All activities involving conversion, powder, or pellet preparation are carried out in glove boxes or shielded cells which are exhausted to the Zone A exhaust plenum through individual glove box HEPA filters.

The nitrate solution is received for storage in 1-L plastic bottles sealed in metal cans (for physical protection during handling). The cans are not opened until the nitrate solution is needed in the conversion process. At that time, they are removed one at a time and transferred into Cell A by way of a transfer lock. Inside Cell A, the bottles are removed from the can and opened using remote manipulators, and the contents are emptied into the process feed tank.

The oxide powder produced in Cell A is placed in steel cans and sealed with tape. The cans are then bagged out of Cell A and into Cell B for the calcining, blending, pressing, and granulation steps. The granulated material is again sealed in steel cans, and bagged out of Cell B and into Cell C, where the pellet press and sintering furnace are located. The sintered pellets are sealed in cans, bagged out of Cell C, and into the grinding and inspection glovebox in Room 110. The finished pellets then are sealed in cans, bagged out of the grinding and inspection glovebox, and into one of the assembly gloveboxes in Room 111. When RTG assemblies are completed, the finished units, containing 4 to 800 g of Pu-238 pellets each, are decontaminated, surveyed, and removed from the assembly gloveboxes for testing.

In addition to the protected area security controls described previously, only specifically authorized workers are permitted access to the Pu processing areas within the ABC Building. Card-key controls on each room ensure that only authorized workers gain access to these areas.

5. Analysis of Emergency Conditions

The barriers that maintain control over each of the hazardous materials discussed in Section 4 have been analyzed and possible failure modes considered. The barrier analyses and resulting release scenarios are described in this section. The results are summarized in Tables 5.1a-f.

NOTE: A brief analysis section should be presented for each material and failure mode. For purposes of illustration, only two the possible analyses sections are presented here.

Table 5.1a. Material: Hydrogen Fluoride; Location: Warehouse

Primary Barrier	Failure Modes and Causes	Release From Primary Barrier	Other Barriers and their Effects	Possible Initiating Events and Scenarios	Release Designation
Cylinder	Puncture	100% of 1 cylinder	Essentially none	External impact by forklift or missile	HF-1*
		100% of 2 cylinders	Essentially none	Forklift or missile impact	HF-2
	Overpressure	100% of 4 cylinders	Essentially none	Fire, high temp. in warehouse	HF-4
	Fracture	100% of 1 cylinder	Essentially none	Drop during handling, design or fabrication flaw	HF-1
	Corrosion	100% of 1 cylinder	Essentially none	Spill of corrosive material in warehouse or in truck during shipping	HF-1
	Valve(s) opened	100% of 1 cylinder	Essentially none	Inadvertent operation of valve	HF-1
		100% of 4 cylinders	Essentially none	Sabotage	HF-3

**Note that a number of failures and conditions can lead to approximately the same postulated release. By identifying those combinations of conditions of about the same severity level, the number of separate calculations required can be minimized, and dissimilar events with similar consequences can be recognized more readily. "Release designation" is a shorthand notation for a set of source term specifications such as might be used to calculate consequences at various receptors. In this example, HF-1 means "instantaneous ground level release of 35 kg HF, followed by 0.11 kg/sec for the next 10 minutes." (See Section 5.1.3)*

NOTE: These tables are intended to illustrate a spectrum of possible events; they are not all-inclusive of the events, conditions, and malfunctions that could befall the hypothetical facility and process. For purposes of discussion, we will assume that the table <u>is complete</u>.

Table 5.1b. Material: Hydrogen Fluoride; Location: Cell A Operating Corridor

Primary Barrier	Failure Modes and Causes	Release From Primary Barrier	Other Barriers and their Effects	Possible Initiating Events and Scenarios	Release Designation
Cylinder	Puncture	100% of 1 cylinder	Room and HVAC system. If HVAC operating, HF will be held up in room and released from stack over 30-60 min.	External impact by forklift or missile	HF-5
			Bldg integrity lost; HVAC off -- release at ground level.	External impact on building, explosion	HF-1
		100% of 2 cylinders	Same as above	Forklift or missile impact	HF-6 (or HF-2)
	Overpressure	100% of 2 cylinder	Same as above	Fire, high temperature	HF-6
	Fracture	100% of 1 cylinder	Same as above	Drop during handling; design or fabrication flaw	HF-5
	Corrosion	100% of 1 cylinder	Same as above	Spill of corrosive mater. in warehouse or truck during shipping	HF-5
	Valve(s) opened	100% of 1 cylinder	Same as above	Inadvertent operation of valve	HF-5
		100% of 2 cylinders	Same as above	Sabotage	HF-6
Process piping	All	All piping contained within cell. Release from any failure would be HF-4 or less.			

Table 5.1c. Material: Toluene Diisocyanate; Location: Warehouse.

Primary Barrier	Failure Modes and Causes	Release From Primary Barrier	Other Barriers and their Effects	Possible Initiating Events and Scenarios	Release Designation
Drum	Puncture	100% of 1 drum	Physical state. Evaporation from floor at rate depending on area, temperature and wind speed.	External impact by forklift or missile	TDI-1
		100% of 2 drums	Same as above	Forklift or missile impact	TDI-2
	Overpressure	100% of 4 drums	Fire creates dispersive effect but consumes part of the TDI	Fire in warehouse	TDI-3
	Corrosion	100% of 1 drum	Evaporation from floor at rate depending on area, temperature and wind speed.	Corrosive material spilled in warehouse or during shipping	TDI-1

Table 5.1d. Material: Toluene Diisocyanate; Location: Room 101.

Primary Barrier	Failure Modes and Causes	Release From Primary Barrier	Other Barriers and their Effects	Possible Initiating Events and Scenarios	Release Designation
Drum	Puncture	100% of 1 drum	Physical state. Evaporation from floor at rate depending on area, temperature and air velocity. If building integrity and HVAC are intact, material will be released to stack over 30-60 min. If building integrity is lost, release will be at ground level.	Impact by forklift or missile External impact on building	TDI-4 TDI-1
	Overpressure	100% of 2 drums	Fire creates dispersive effect but consumes part of the TDI. May breach building if not controlled.	Fire in process area	TDI-4
	Corrosion	100% of 1 drum	Evaporation from floor at rate depending on area, temperature, and air velocity.	Corrosive material spilled in warehouse or during shipping	TDI-1

Table 5.1e. Material: Plutonium-238 (nitrate solution); Location: Room 109.

Primary Barrier	Failure Modes and Causes	Release From Primary Barrier	Other Barriers and their Effects	Possible Initiating Events and Scenarios	Release Designation
Bottle	Breach of bottle	1 L (200 g Pu)	Can: (no credit taken). Physical State: fraction airborne from spilled nitrate solution is <1E-5 (ref.__) Room and bldg HVAC HEPA filters: fraction of airborne material passing through double HEPAs is <2.5E-6 (ref. _) If room and bldg HEPAs are degraded, will pass 1% of airborne material.	Human error, flaw in bottle Filter misinstalled, degraded by moisture.	Pu-1 Pu-2
	Collapse of storage rack with 15 bottles	50% of contents	Same as above Degraded HEPAs Building integrity lost (hole in vault wall)	Earthquake, human error Same as above External impact on building. Sabotage	Pu-3 Pu-4 Pu-5

Table 5.1f. Material: Plutonium-238 (oxide powder and pellets); Location: Cells A, B, C.

Primary Barrier	Failure Modes and Causes	Release From Primary Barrier	Other Barriers and their Effects	Possible Initiating Events and Scenarios	Release Designation
Cell A	Overpressure	0.2 g PuO_2 powder (to operating corridor)	Zone B HVAC system HEPA filter reduction factor 2.5E-6 (ref. _)	Controller malfunction. Damper sticks.	Pu-6
		0.04 g PuO_2 powder (to operating corridor)	Same as above	Flash fire in cell	Pu-7
		0.06 g PuO_2 powder (to Zone B exhaust)	Zone A HEPAs filter factor of 2.5E-6	Flash fire, damage to cell exhaust HEPA	Pu-8
Transfer can	Crushing, puncture	8 g PuO_2 powder (to operating corridor)	Same as above	Can dropped, crushed by transfer lock door during bag-out/transfer operation	Pu-9
Cell B	Overpressure, explosion/fire in hydraulic press	26 g PuO_2 powder (to operating corridor)	Same as above	Hydraulic fluid leak, ignition by electric motor fault	Pu-10
		380 g powder suspended in cell atmosphere	If pressure pulse damages one stage of HEPA filter, release fraction goes to 5E-3.	Same as above	Pu-11
			If a HEPA stage damaged and second stage compromised by misinstallation, release fraction goes up to 2E-2	Same as above	Pu-12

5.1 Hydrogen Fluoride in the Warehouse

5.1.1 Primary Barrier Failure Modes and Release Estimates

Hydrogen fluoride is handled and stored in the warehouse only in the standard pressure cylinders. The cylinder is therefore the primary barrier to be considered. It could fail by one of several possible modes, as described below.

- **Puncture.** Puncturing by external impact, such as being rammed by a forklift tine, caught in a hydraulic lift during unloading, or being struck by a stray bullet.

  Release Estimate. Once the puncture has occurred, the entire contents of the cylinder will leak out at a rate limited by the size of the hole and the ambient temperature, which determines the rate of vaporization of the liquid after the initial depressurization. At 20°C, a 2-cm equivalent diameter hole in a 100-kg cylinder will release about 35 kg almost instantaneously (within the first 10-30 seconds), and the remainder will leak out at a rate of about 0.11 kg/sec over the ensuing 10 minutes. Because of the storage rack spacing, it is possible that a single event could lead to the puncture of two cylinders, producing a combined release of twice that described above.

- **Overpressure.** Overpressure caused by external temperatures exceeding design limits of the cylinder, as in a fire, is the only applicable overpressure scenario, since the cylinders in the warehouse are not hooked to any equipment or system that could increase their internal pressure.

  Release Estimate. Overheating in a fire will increase the rate of vaporization and could theoretically lead to 100 percent vapor release at the time of cylinder rupture. Since any fire in the warehouse will likely affect all the stored cylinders equally, it must be assumed that all will rupture within a short period of time, releasing their entire contents as vapor.

- **Fracture.** Fracture, by impact or metal defect in the cylinder, is essentially the same type of failure as the puncture; however, it could occur as a result of different mishandling events.

  Release Estimate. Release characteristics would be about the same as for the puncture failure mode.

- **Corrosion.** Cylinder failure could occur as a result of attack on the cylinder, as by some acid spilled in the truck during shipping or in the warehouse. In theory, the cylinder could be weakened or breached by corrosion, leading to leakage of the contents.

Release Estimate. The limiting case of this mode would resemble a puncture or rupture, i.e., rapid loss of the entire contents of the cylinder.

- **Misoperation of the cylinder stop valve.** The cylinders are shipped and stored with protective caps in place, thus misoperation of the cylinder stop would require two separate deliberate acts. If a cylinder cap were inadvertently removed, the valve could conceivably be operated or damaged by accident.

  Release Estimate. The limiting case of this mode would resemble the puncture or rupture in that the entire contents of the cylinder would be leaked at a rate determined by the degree to which the valve was opened and the ambient temperature. However, if the opening of the valves is a malevolent act, the perpetrator could be assumed to open all the available cylinders to maximize the impact, producing a combined release four times that from a single cylinder.

5.1.2 Effects of Other Barriers and Mitigative Features

In the case of HF cylinders stored in the warehouse, there are no other physical barriers. The warehouse structure is very leaky and the doors are normally wide open to the atmosphere. No credit can be taken for the structure as a confining barrier to dispersion of HF gas. The form of the material, a pressurized liquid with a boiling point of 19.5°C, limits the rate at which it can be released as a gas following breach of the cylinder, as discussed in Section 5.1.1. This characteristic can be used to predict a realistic release rate as a function of time and ambient temperature.

5.1.3 Source Term Estimates

The range of possible source terms resulting from the failure modes and causes discussed above can be summarized as follows.

- Rupture or breach of a single cylinder at normal ambient temperature, resulting in near-instantaneous ground-level release of 35 kg HF, followed by 0.11 kg/sec for the next 10 minutes. (Release designation HF-1)

- Rupture or breach of two cylinders at normal ambient temperature, resulting in near-instantaneous ground-level release of 70 kg HF, followed by 0.22 kg/sec for the next 10 minutes. (Release designation HF-2)

- Opening of all four cylinder stop valves, resulting in near-instantaneous ground-level release of 140 kg HF, followed by 0.44 kg/sec for the next 10 minutes. (Release designation HF-3)

- Rupture (due to high temperature and pressure) of all four cylinders, producing a ground level release of 400 kg HF gas in less than 1 minute. (Release designation HF-4)

5.2 Pu-238 in Cell A

5.2.1 Primary Barrier Failure Modes and Release Estimates

For PuO_2 in Cell A, the cell itself and the ventilation system that serves it is the primary barrier. The material is in the form of a dispersible powder that is subject to mechanical and thermal effects that cause a small fraction of it to be suspended in the cell atmosphere at any given time. Infrequent operations or occurrences (such as a fire) in the cell could dramatically increase this fraction for a short period of time. The cell itself is a massive, shielded structure, and the only failure modes judged to be of significance are overpressure and failure of the HEPA filters.

- **Overpressure.** The pressure in Cell A could be increased above that in the operating corridor and surrounding area by one of several means. First, a malfunction (return spring failure or seizure of the actuator shaft) of the pneumatic controller on the cell exhaust system pressure control damper could cause the pressure to build up to 2 mm Hg greater than the operating corridor. Also, Cell A pressure could be increased as a result of a flash fire or other energetic event in the cell.

  Release Estimate. For a maximum airborne dust loading of 60 mg/m^3 (reference _) and a duration of the pressure reversal of 45 minutes (reference _), the predicted airborne release to the operating corridor is 200 mg of PuO_2 powder. A flash fire would produce a transient or pulse of pressure that would last no more than 4 seconds (reference _) and discharge an estimated 40 mg of powder into Zone B.

5.2.2 Effects of Other Barriers and Mitigative Features

Air from Zone B is exhausted through the Zone B HEPA filters, which have a design attenuation factor for particulate materials in the ___ size range of 2.5E-6. The total release to the environment would be 5E-7 grams, 98 percent in the first hour at the design ventilation exhaust rate.

In the case of a flash fire in the cell, the Zone B filters would attenuate the release as described previously. However, a significant pressure pulse could breach the cell exhaust HEPA filter, causing a pulse of 60 mg of airborne dust to challenge the Zone A dual HEPA filter bank (reference _). At design efficiency, the release to the environment by way of the stack is 3E-6 g over a 10-minute period.

5.2.3 Source Term Estimates

The range of possible source terms resulting from the failure modes and causes discussed above can be summarized as follows.

- Release of 5E-7 g of PuO_2 powder of (size range or distribution) from the building stack over a 1-hour period. (Release designation Pu-6).

- Release of 1E-7 g of PuO_2 powder of (size range or distribution) from the building stack over a 1-hour period. (Release designation Pu-7).

- Release of 3E-6 g of PuO_2 powder of (size range or distribution) from the building stack over a 10-minute period. (Release designation Pu-8).

NOTE: The following tables demonstrate one way of summarizing a thorough and systematic consideration of barrier failures and potential releases. Note that the tables present the results of <u>*all*</u> *the analyses for the ABC Facility, not just the two material/location combinations that were detailed in Sections 5.1 and 5.2. This sort of summary can be very useful in making the correlation between initiating events and conditions, magnitude of the actual or potential release, consequences, event class, and observable indications (EALs). The logic used to develop the EALs and select protective actions may be documented here or in Section 8.*

6. Event Consequences

6.1 Calculational Models

Consequences of the events and conditions identified in Section 5 were estimated using two primary computational models. The Chemical Model was used to calculate the dispersion of non-radioactive hazardous material, while the Radiological Model was used for radiological dose calculations.

The Chemical Model was developed by the Software Giant Company for use in hazardous material emergency planning and response. Its features are documented in Reference _. It makes use of a straight-line Gaussian dispersion model and (brief summary of the model features, applicability, and limitations).

The Radiological Model was developed by the Operating Contractor for use in radiological emergency planning for the XYZ Site operations. It is documented in reference __ and (brief summary of the model features, applicability, and limitations).

6.2 Receptor Locations

Consequences at several receptor locations were calculated.

Facility Boundary Receptors. With the calculational models used, 100 m is the minimum distance at which a concentration or dose projection can be made. It is recognized that there are great uncertainties associated with predicting dispersion over short distances, particularly in the vicinity of large structures. Because the distance to the occupied facilities nearest to the ABC Facility is roughly 100 m, this distance is used to define the "facility boundary impact" for purposes of assigning an emergency class to each of the postulated events.

Other Onsite Receptors. Other onsite receptors were defined as follows.

OS-1: Building 999, 300 m SE, occupied by 1200 persons during working day.

OS-2: Main parking lot, 350 m SW. Accessible to general public in cars, evacuation staging area for site.

OS-3: Highway 101, 870 m W. Accessible to general public, crosses the site.

OS-4: Area fire station and Emergency Control Center, 1200 m NW.

OS-5: Facility LNM, 3.5 km N. Over 2500 people during working day, 275 people during off hours.

Site Boundary Receptors. The distances to the site boundary receptors in each of the 16 compass sectors are as follows.

SB-N	12 km	SB-S	3.5 km
SB-NNE	4.2 km	SB-SSW	3.9 km
SB-NE	2.0 km	SB-SW	5.0 km

SB-N	12 km	SB-S	3.5 km
SB-ENE	0.7 km	SB-WSW	6.3 km
SB-E	0.3 km	SB-W	8.9 km
SB-ESE	0.9 km	SB-WNW	11.2 km
SB-SE	1.1 km	SB-NW	15.1 km
SB-SSE	2.4 km	SB-NNW	12.9 km

The consequences calculated at the minimum site boundary distance (0.3 km) was used to assign an emergency class to each postulated event.

Other offsite receptors. Other offsite receptors have been defined at points of interest. These include the two nearest residences, the nearest school, an industrial park where some 4000 persons are employed, the State Home in Wheresville, and the communities of Anytown and Ong. These are abbreviated as follows.

OFF-R1:	Nearest residence, 2.1 km SSE.
OFF-R2:	Next nearest residence, 3.1 km SE.
OFF-SCH:	The Anytown school, 6.5 km S.
OFF-IND:	Industrial park, 5.5 km S.
OFF-ANY:	Anytown town center, 8.0 km S.
OFF-WHR:	Wheresville State Home, 15.2 km SE.
OFF-ONG:	Ong town center, 12 km SW.

The results of the consequence calculations are summarized in Tables 6.1a - d.

NOTE: The calculated consequences at the above receptor points under each dispersion condition analyzed should be summarized separately and used for planning, training and response purposes. Such consequence tables may be included in this section or in an appendix.

Table 6.1a. Event Consequences at Key Receptors with Severe Meteorology[1]

Release Designation	Maximum Consequences at: Facility Boundary	Maximum Consequences at: Site Boundary	Distance[2] to Consequence Thresholds: PAC (20 ppm)[3]	Distance[2] to Consequence Thresholds: TEL (50 ppm)[3]	Time to PAC[4]	Probable Event Class[5]	Possible EALs
HF-1	200 ppm	90 ppm	0.9	0.5	15 minutes	GE	Warehouse fire not controlled.
HF-2	450 ppm	240 ppm	1.5	0.7	25 minutes	GE	Breach of HF cylinder in warehouse.
HF-3	800 ppm	350 ppm	2.8	1.3	47 minutes	GE	Same as above.
HF-4	1100 ppm	500 ppm	4.2	1.9	70 minutes	GE	Warehouse fire not controlled.
HF-5	N.A.[6]	11 ppm[6]	N.A.[6]	N.A.[6]	N.A.	Alert	Any breach, puncture, or sabotage of HF cylinder in ABC Building AND building integrity and HVAC function maintained.
HF-6	N.A.[6]	15 ppm[6]	N.A.[6]	N.A.[6]	N.A.	Alert	Same as above

Notes: [1] Wind speed of 1 m/s, stability class F.
[2] All distances in kilometers.
[3] Hypothetical numbers for illustration only. Information in this table presumes that the facility has adopted these values as consequence thresholds for planning purposes.
[4] Plume transit time at 1 m/s wind speed.
[5] Alert: PAC exceeded at distances ≥30 m from release point but ≤ facility boundary distance (100 m).
Site Area Emergency: PAC exceeded at distances ≥ facility boundary distance but ≤ site boundary distance (0.3 km).
General Emergency: PAC exceeded at distances > site boundary distance.
[6] HF-5 and HF-6 are elevated releases. Point of maximum ground-level impact is 0.6 -1.8 km from the stack. Since the maximum potential impact to persons outside the facility boundary is below the protective action threshold, the conditions for Site Area Emergency (or General Emergency) are not met.

Table 6.1b. Event Consequences at Key Receptors with Severe Meteorology[1]

Release Designation	Maximum Consequences at: Facility Boundary	Maximum Consequences at: Site Boundary	Distance[2] to Consequence Thresholds: PAC (10 ppm)[3]	Distance[2] to Consequence Thresholds: TEL (25 ppm)[3]	Time to PAC[4]	Probable Event Class[5]	Possible EALs
TDI-1	15 ppm	6 ppm	0.2	<0.1	3.3 min.	SAE	Breach of 1 drum in warehouse; breach of 1 drum in Room 101 with building integrity lost.
TDI-2	20 ppm	8 ppm	0.2	<0.1	3.3 min.	SAE	Breach of 2 or more drums in warehouse or in Room 101 with building integrity lost.
TDI-3	15 ppm	5 ppm	0.2	<0.1	3.3 min.	SAE	Fire in warehouse not controlled by sprinklers.
TDI-4	5 ppm	2 ppm	<0.1	<0.1	N.A.	Alert	Any breach of TDI drum in Room 101 or fire involving TDI in process area with building and HVAC intact.

Notes: [1] Wind speed of 1 m/s, stability class F.
[2] All distances in kilometers.
[3] Hypothetical numbers for illustration only. Information in this table presumes that the facility has adopted these values as consequence thresholds for planning purposes.
[4] Plume transit time at 1 m/s wind speed.
[5] Alert: PAC exceeded at distances ≥ 30 m from release point but ≤ facility boundary distance (100 m).
Site Area Emergency: PAC exceeded at distances ≥ facility boundary distance but ≤ site boundary distance (0.3 km).
General Emergency: PAC exceeded at distances > site boundary distance.

Table 6.1c. Event Consequences at Key Receptors with Severe Meteorology[1]

	Maximum Consequences at:		Distance[2] to Consequence Thresholds				
Release Designation	**Facility Boundary**	**Site Boundary**	**PAC (5 rem - TEDE)[3]**	**TEL (550 rem-lung)[3]**	**Time to PAC[4]**	**Probable Event Class[5]**	**Possible EALs**
Pu-1	<0.1 rem (TEDE)	<0.1 rem (TEDE)	NA	NA	NA	< Alert	Any breach of Pu nitrate bottle in room 109 or spill of liquid with HVAC operating
Pu-2	0.1 rem	0.04 rem	NA	NA	NA	Alert	Any breach of Pu nitrate bottle in room 109 with stack alpha monitor indicating _ or higher
Pu-3	0.1 rem	0.06 rem	NA	NA	NA	Alert	Collapse of storage rack in room 109 with breach of bottles
Pu-4	0.9 rem	0.4 rem	NA	NA	NA	Alert	Same as above with stack alpha monitor indicating _ or higher
Pu-5	8.5 rem	4.2 rem	0.24	NA	4 hours[5]	SAE	Same as above (breach of several bottles) with vault wall breached; external impact that breaches vault

Notes: [1] Wind speed of 1 m/s, stability class F.
[2] All distances in kilometers.
[3] Hypothetical numbers for illustration only. Information in this table presumes that the facility has adopted these values as consequence thresholds for planning purposes.
[4] Plume transit time at 1 m/s wind speed.
[5] Alert: PAC exceeded at distances ≥30 m from release point but ≤ facility boundary distance (100 m).
Site Area Emergency: PAC exceeded at distances ≥ facility boundary distance but ≤ site boundary distance (0.3 km).
General Emergency: PAC exceeded at distances > site boundary distance.
[6] A person would have to be exposed to the release at a distance of 0.24 km from the facility for 4 hours (after the start of the event) to exceed the 5-rem TEDE criterion.

Table 6.1d. Event Consequences at Key Receptors with Severe Meteorology[1]

Release Designation	**Maximum Consequences at:**		**Distance[2] to Consequence Thresholds**		**Time to PAC[4]**	**Probable Event Class[5]**	**Possible EALs**
	Facility Boundary	**Site Boundary**	**PAC (5 rem -TEDE)[3]**	**TEL (550 rem -lung)[3]**			
Pu-6,7,8	0.1 rem (TEDE)	<0.1 rem (TEDE)	NA.	NA	NA	<Alert	Cell pressure control lost and operating corridor CAM alarms
Pu-9	3.1 rem	1.2 rem	NA	NA	NA	Alert	Breach of Pu powder can outside cell and operating corridor CAM alarms OR stack alpha monitor indicates _ or higher
Pu-10	7.8 rem	3.6 rem	0.24	NA	2.5 hrs[6]	Site Area Emergency	Explosion/fire in cell B and operating corridor CAM alarms; stack alpha monitor indicates _ or higher
Pu-11	19 rem	12 rem	2.2	NA	4.5 hrs[6]	General Emergency	Same as above with stack alpha monitor indicating off scale high
Pu-12	25 rem	17 rem	3.0	NA	4 hours[6]	General Emergency	Same as above

Notes: [1] Wind speed of 1 m/s, stability class F.
[2] All distances in kilometers.
[3] Hypothetical numbers for illustration only. Information in this table presumes that the facility has adopted these values as consequence thresholds for planning purposes.
[4] Plume transit time at 1 m/s wind speed.
[5] Alert: PAC exceeded at distances ≥30 m from release point but ≤ facility boundary distance (100 m).
Site Area Emergency: PAC exceeded at distances ≥ facility boundary distance but ≤ site boundary distance (0.3 km).
General Emergency: PAC exceeded at distances > site boundary distance.
[6] A person would have to be exposed to the release for this length of time at the distance given in the "distance to PAC" column to exceed the 5-rem TEDE criterion.

7. The Emergency Planning Zone

The EPZ is an area within which the Hazards Assessment results indicate a need for specific and detailed planning to protect people from the consequences of hazardous material releases. The choice of EPZ is supposed to be based on an objective analysis of the hazards associated with a facility and not on arbitrary factors such as historical precedent or distance to the site boundary. In this section, the results of the consequence calculations presented in Section 6 are used to develop a proposed ABC Facility EPZ, in accordance with the method outlined in the Emergency Management Guide.

7.1 Applying the Guidance to Choice of Emergency Planning Zone Radius

- **Analysis:** The results tabulated in Table 6.1a - 6.1d indicate several emergency conditions that would be classified as Site Area Emergency or General Emergency. Therefore, an EPZ needs to be defined for the facility.

- **Analysis:** Table 6.1a indicates a threshold for early lethality could be exceeded for release HF-4 at distance of 1.9 km under severe meteorological conditions. Therefore, 1.9 km is the smallest EPZ radius that will be considered.

- **Analysis:** Table 6.1a indicates a protective action criterion could be exceeded for release HF-4 at distance of 4.2 km under severe meteorological conditions. Therefore, 4.2 km is the largest EPZ radius that will be considered.

- **Analysis:** Quantitative estimates of the probabilities and risk contributions from the postulated ABC emergencies are not available. However, because of the variety of materials stored in the warehouse, the fire condition that could cause a release similar to HF-4 can not be considered extremely improbable. Therefore, this factor will be considered to weigh in favor of an EPZ radius closer to the maximum.

- **Analysis:** The contribution of HF-1 and the other HF releases to the total offsite risk has not been calculated. Therefore, this factor does not clearly favor either choice of EPZ radius.

- **Analysis:** The contribution of HF-1 and the other HF releases to the total offsite risk has not been calculated. However, because only non-radiological release scenarios (specifically, HF) produced consequences exceeding the lethality threshold offsite, it will be assumed that the HF releases contribute heavily to the total offsite risk. If this is the case, an EPZ radius closer to the maximum than the minimum is justified.

- **Analysis:** Approximately half of the land area between 1.9 km and 4.2 km of the ABC Facility is offsite and is within areas for which the site has been carrying out planning and preparedness activities for some years, primarily because of the hazards arising from operation of production facilities that are now shut down. Thus, most of the cost of implementation of the larger EPZ has already been expended (sirens on the river, mutual aid arrangements with offsite response agencies, public information program for nearby residents). This consideration weighs in the direction of selecting the larger EPZ radius, because the site is already supporting a range of preparedness measures and is committed to continuing that support.

- **Analysis:** Regardless of whether the larger or smaller EPZ radius is selected, additional expenditures to protect the population within the EPZ will be minimal. Because there are no permanent residents within the 1.9-km radius, there is no close-in population who might be better protected by concentrating use of the available planning/preparedness resources. Therefore, this consideration weighs in the direction of selecting the larger EPZ radius.

- **Analysis:** The area within the larger EPZ radius would be subject to plume impacts within 70 minutes, even at very low wind speeds. Under the best of conditions, this may be enough time to carry out, on an *ad hoc* basis, protective measures for the nearest residents. However, because the population in the area is dispersed on farms and often transient (fishermen, campers), planning for notification and implementation of protective actions will continue to require significant attention if they are to be timely and effective. Therefore, this consideration weighs in the direction of the larger EPZ radius.

- **Analysis:** Both the 1.9- and 4.2-km radii extend across the site boundary and into the surrounding county. In the NNE, NE, and ENE sectors, the 4.3-km radius coincides approximately with the site boundary. In the ESE and SE it coincides approximately with Fish Hatchery Road, and in the SSE, S, and SSW sectors, it coincides approximately with East-West Road, the main county road that parallels the river. There are no other significant physical or jurisdictional features between the 1.9- and 4.2-km radii that are logical choices of EPZ. Therefore, an EPZ based on a radius of approximately 4.2 km could be defined in terms of physical features and jurisdictional boundaries over approximately half of its circumference.

7.2 Preliminary Conclusion

Based on this analysis, it is concluded that a nominal radius of about 4.2 km surrounding the ABC Facility should be defined as the EPZ for that facility. Various parts of the boundary can be approximated by sections of the site boundary and county roads.

7.3 Tests of Reasonableness

The EPZ size should give confidence that planning and preparedness will be sufficiently flexible and detailed to deal with a wide range of types and magnitudes of emergency conditions. Four significant considerations that cannot be readily stated as quantitative guidance are presented in the form of questions to be used as "tests of reasonableness" for the proposed EPZ size.

- Is the EPZ large enough to provide a credible basis for extending response activities outside the EPZ if conditions warrant?

  Analysis: The preliminary EPZ takes in approximately 18 km^2 of Granola County. Regular planning interactions and exercises will provide a reasonable expectation that response actions can be successfully extended to other areas of the county, if necessary. To the NNE, NE, and ENE, the preliminary EPZ boundary follows the jurisdictional boundary between the site and Rutabaga County. Rutabaga County is a party to the Tri-County Mutual Aid Agreement and portions of the county are included within the EPZs for other site facilities. Thus, a planning relationship exists that will serve as a basis for extending response actions into the county for an ABC Facility emergency if conditions warrant.

- Is the EPZ large enough to support an effective response at and near the scene of the emergency (i.e., preclude interference from uninvolved people and activity, facilitate onsite protective actions, optimize on-scene command and control and mitigation efforts)?

  Analysis: Facilities on the XYZ Site are well separated from the ABC Facility. The preliminary EPZ encompasses major road intersections and access routes by which the public could gain access to the site. For these reasons, emergency response teams should not be hindered by uninvolved people or activities.

- Does the proposed EPZ conform to natural and jurisdictional boundaries where reasonable, and are other expectations and needs of the offsite agencies likely to be met by the selected EPZ?

Analysis: The preliminary EPZ makes use of natural or jurisdictional boundaries that are reasonable boundaries. The expectations and needs of offsite agencies are not likely to be a factor because the jurisdictions affected by the EPZ definition have been involved in joint planning for emergencies with the site for over 30 years.

- What enhancement of the facility and site preparedness stature would be achieved by increasing the size of the EPZ? What resources, costs, and liabilities might a larger EPZ engender? Would a larger EPZ result in a significant increase in preparedness without correspondingly large increases in cost or other detriment?

  Analysis: Increasing the size of the EPZ would entail significant costs and resources because beyond the 4.2-km radius, area population begins to increase significantly. Existing county comprehensive emergency plans and warning/notification processes provide reasonable assurance that *ad hoc* response measures in the surrounding areas would have a high likelihood of success. Increasing the size of the EPZ would also be inconsistent with the overall reduction in the level of site risk that is resulting from shutdown of operations and facilities.

7.4 Final Conclusion

The proposed EPZ for the ABC Facility should include the area within a nominal 4.2-km radius of the facility, approximated by the site boundary in the NNE, NE, and ENE sectors, Fish Hatchery Road in the ESE and SE sectors, and East-West Road in the SE, SSE, S, and SSW sectors.

8. Emergency Classes, Protective Actions, and EALs

NOTE: This section may be used to document the correlation of the consequence assessment with the requirements to classify events and take protective actions where and when appropriate. Tables 6.1a-d present summary correlations; however, additional documentation of the rationale for specific EALs, automatic protective actions, etc., may be needed. Documenting the "technical basis" ensures that when changes in the facility operation, response capability, and other conditions occur, the impact on event classes, EALs, and protective action planning can be addressed in a consistent and orderly manner.

An example correlation section is presented below.

8.1 Hydrogen Fluoride Release Events

Because of the high acute toxicity of HF and the proximity of the ABC Facility to the site boundary, any actual or likely sudden release of the contents of one or more cylinders of HF in the warehouse is cause for a General Emergency declaration. Early severe health effects and deaths may be expected in the facility and nearby onsite areas unless rapid action (within 5-10 minutes for some releases scenarios) is taken to protect personnel.

There are no installed systems or instruments to detect release of HF; thus, early recognition by personnel of actual or potential releases is essential. This is particularly important during those times when the warehouse is open and activity is going on that increases the likelihood of a cylinder being damaged. A major fire in the warehouse is one identified condition that could lead to release of part or all of the HF stored there. Sabotage or accidental misoperation are other possible release initiators.

8.1.1 General Emergency EALs

From the analyses in Section 6, the following possible EALs are identified for the General Emergency class.

- Puncture, breach, or opening of HF cylinder in the Warehouse.

  Basis: No mitigating barriers exist and no means of quantifying the release in the time within which action is needed to protect personnel. Must assume entire contents will be released and use precalculated consequences.

- Fire in the Warehouse not immediately controlled by first responder (or not controlled within a few minutes of detection).

  Basis: Fire is an identified failure mechanism for HF cylinders. Impossible to accurately characterize threat or damage to cylinders <u>during</u> a fire. If fire is controlled early, no damage to cylinders is likely. If fire persists, damage is almost ensured, along with release of various other toxic materials. Therefore, the event must be classified on the basis of the <u>observable condition that threatens</u> the integrity of the storage cylinders.

- Sabotage of HF cylinders.

  Basis: If there is evidence of actual or possible sabotage involving the HF, it must be assumed that the perpetrator intends to cause the maximum damage/injury and has the necessary knowledge. Such an act would be highly dangerous or fatal to the perpetrator.

- Any breach, puncture or rupture of HF cylinder in ABC Building with direct release to atmosphere possible (i.e., breach of building wall).

  Basis: In the unlikely event that a HF cylinder is breached in the ABC Building and the integrity of the building is compromised, (such as through an explosion or fire), the release and consequences could approximate the warehouse fire case and should be classified accordingly.

8.1.2 Site Area Emergency EALs

Because of the proximity of the ABC Facility to the site boundary, there are no analyzed HF release events that would fall in the Site Area Emergency Class.

8.1.3 Alert EALs

From the analyses in Section 6, the following possible EALs are identified for the Alert class:

- Any breach, puncture, or rupture of an HF cylinder in the ABC Building and the building integrity and HVAC operation are maintained.

  Basis: As long as the building walls are intact and the HVAC system functions normally, any release of HF into the building will be exhausted by way of the stack. The increased dispersion that will be achieved with an elevated release will cause the maximum potential impact to persons outside the facility to be below the protective action threshold. Thus, the conditions for a Site Area Emergency are not met.

8.1.4 Protective Actions

Action to protect personnel on and near the site will be required in the event of a large HF release. Because the time for the health impact to accrue is short (perhaps only a few seconds or minutes at high concentrations), evacuation will probably not be practical within the 123 Area. Sheltering in place within the 123 Area is the immediate protective action of choice if a release of HF is in progress or imminent. Sheltering should be implemented automatically if any EAL for a General Emergency due to HF release is exceeded. Because of the limited inventory available for release, personnel should not have to remain sheltered for more than about an hour, during which time the direction and magnitude of the release should be assessed and personnel evacuated if it can be done safely.

Building emergency plans for the 123 Area facilities should (1) ensure that occupants understand the HF hazard, (2) are aware of alarms, signals, and proper response to the "take shelter" warning, (3) identify the areas of their building that are likely to offer the most protection to an airborne hazardous material, and (4) provide for securing ventilation to maintain habitability for the personnel sheltered there for as long as possible.

In the event of a large HF release, the area within which early severe health effects could occur may extend to 1.9 km from the ABC Facility. This distance encompasses the surface of the Big River, adjacent to the 123 Area. The 123 Area sirens are clearly audible to boaters on the river who might be in the affected area. Signs or notices on the river banks and/or loudspeakers should be used to direct boaters to leave the area.

9. Maintenance and Review of this Hazards Assessment

The Operating Contractor Manager of Emergency Planning is responsible for ensuring that this Hazards Assessment is regularly reviewed and maintained current. The review requirement and schedule is spelled out in the Site Emergency Readiness Assurance Plan, Section ______.

Acronyms

EAL	Emergency Action Level
EPZ	Emergency Planning Zone
HEPA	High Energy Particulate Air
HF	Hydrofluoric Acid
HVAC	Heating, Ventilating, and Air Conditioning
PCB	Polychlorinated Biphenyls
RTG	Radioisotopic Thermal-electric Generator
TDI	Toluene-2,4-diisocyanate

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