NOT MEASUREMENT SENSITIVE

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TECHNICAL PLANNING BASIS
Emergency Management Guide

[This Guide describes suggested nonmandatory approaches for meeting requirements. Guides are not requirements documents and are not to be construed as requirements in any audit or appraisal for compliance with the parent Policy, Order, Notice, or Manual.]

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DOE G 151.1-2, *Technical Planning Basis*
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1. HAZARDS SURVEYS

1.1 Introduction

The purpose of this Chapter is to assist Department of Energy (DOE) and National Nuclear Security Administration (NNSA) field elements in complying with the DOE O 151.1C requirement that a hazards survey be prepared, maintained, and used for emergency planning purposes. The Order requires that emergency management efforts begin with the identification and qualitative assessment of the facility- or site-specific hazards and the associated emergency conditions that may require response, and that the scope and extent of emergency planning and preparedness at a DOE facility reflect these facility-specific hazards. The first step in the implementation of this "commensurate with hazards" approach to emergency management is a Hazards Survey.

The Hazards Survey, which is based on an examination of the features and characteristics of the facility, identifies the generic types of emergency events and conditions (including natural phenomena such as earthquakes and tornadoes, wildland fires, and other serious events involving or affecting health and safety, the environment, and safeguards and security at the facility) and the potential impacts of such emergencies to be addressed by the DOE Comprehensive Emergency Management System. The Hazards Survey also identifies key components of the Operational Emergency Base Program that provide a foundation of basic emergency management requirements and an integrated framework for response to serious emergency events or conditions. Much of the information to be used in the Hazards Survey, and included in its documentation, should have already been collected in the course of meeting other DOE, NNSA, and Federal, State, tribal, and local authority requirements. For facilities involved in producing, processing, handling, storing, or transporting hazardous materials that have the potential to pose a serious threat to workers, the public, or the environment, the Hazards Survey provides a hazardous material screening process for determining whether further analysis of the hazardous materials in an Emergency Planning Hazards Assessment (EPHA) is required.

This guidance is directed at operations and emergency management staff responsible for DOE and NNSA facilities at field offices, service centers, and operating contractor organizations. It is expected that emergency management staff will obtain support from site and facility management and from a variety of scientific and technical disciplines within their respective organizations to conduct and document the analyses described herein. Appendix A provides a recommended screening approach for radioactive and chemical hazardous materials. Appendix B illustrates the application of the suggested Hazards Survey method to a hypothetical facility and site.

This guide cancels and supersedes DOE G 151.1-1, Volume 2, *Hazards Survey and Hazards Assessments*, dated 8-21-97.

1.2 General Approach

Every facility and activity on a DOE/NNSA site should be included in a documented Hazards Survey. Much of the information necessary to generate a Hazards Survey will already have been developed and documented 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 will not be met by simply defining existing documents or analyses as the Hazards Survey document.

The Hazards Survey document should be a distinct document and should contain, or incorporate by reference, the information specified in this chapter. A tabular/matrix presentation can be used to efficiently summarize and document the survey information.

The recommended steps in the Hazards Survey process are:

Step 1 Briefly describe each facility and identify its hazards

Step 2 Screen hazardous materials to determine the need for further analyses in a facility-specific quantitative EPHA.

Step 3 Identify the generic types of emergency events and conditions that apply to each facility.

Step 4 Qualitatively describe the potential health, safety, environmental, or national security impacts of the applicable emergencies.

Step 5 Identify and document the applicable Base Program planning and preparedness requirements.

A Hazards Survey may address one or more facilities. A single Hazards Survey document may even cover an entire site. The tabular/matrix presentation format is a particularly efficient method for documenting the survey information for a large number of facilities.

1.3 Describe the Facility and Identify its Hazards (Step 1)

Each facility or activity covered by the Hazards Survey should be identified and a brief description of its operations provided. Any detailed descriptive information should be included by reference. Sufficient information to provide a general understanding of the facility and its associated hazards can be adequately presented in a table or matrix. This information should include:

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

- 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.

The use or storage of radioactive or chemical hazardous materials in the facility should be noted and described. Sources of information on hazardous materials include documents such as Basis for Interim Operations (BIO) and Safety Analysis Reports/Safety Assessment Documents/Documented Safety Analyses (SARs/SADs/DSAs), process safety management/risk management analyses documentation, and databases, such as, chemical and radioactive material inventories. In addition, facility walk-downs enable emergency management staff and hazards analysts to familiarize themselves first-hand with actual facility systems, processes, practices, equipment and, especially, material inventories. Periodic walk-downs can provide checks on the accuracy of documentation and material inventory databases and may identify additional hazards from by-products of chemical processes or potential accidental mixing interactions.

If hazardous materials other than office products/cleaning supplies are identified, further screening should be done in accordance with Section 1.4 to determine whether a facility-specific quantitative EPHA is required.

1.4 Screen Hazardous Materials to Determine Need for a Hazards Assessment (Step 2)

Because of the myriad forms and quantities of hazardous materials in use throughout DOE/NNSA facilities and activities, the Comprehensive Emergency Management System provides the opportunity to use a screening process to reduce the number of hazardous materials quantitatively analyzed for emergency planning purposes. Use of the screening process described here is not intended to avoid analyses of hazardous materials that have the potential to harm workers or the public, but to allow emergency management resources to be focused on analyzing materials that, because of their quantity, toxicity and dispersibility, have the potential to harm people who are outside the immediate workplace where the materials are used or stored. The hazardous material screening process identifies inventories of specific materials in a facility/site or activity whose release could cause a hazard significant enough to warrant specific consideration in an Operational Emergency Hazardous Material Program.

To determine whether a facility requires a quantitative analysis of its hazardous materials in an EPHA, the screening process must identify at least ***one hazardous material*** that requires further analysis. The results of the EPHA will then determine if the release of each identified material will cause a hazard significant enough to be included as part of the Hazardous Material Program planning basis.

DOE O 151.1C requires a quantitative hazards assessment if the hazards survey screening process identifies specific hazardous materials and quantities that could produce impacts consistent with the definition of an Operational Emergency (OE). In general, an OE involving an uncontrolled release of a hazardous material must: immediately threaten or

endanger those in close proximity of the event; have the potential for dispersal beyond the immediate vicinity of the release in quantities that threatens the health of onsite personnel or the public in collocated facilities, activities, and/or offsite; and have a potential rate of dispersal sufficient to require a time-urgent response to implement protective actions for workers and the public.

All radioactive materials and chemicals with known or suspected toxic properties should be subjected to a hazardous material screening process, which identifies all hazardous materials in a facility/site or activity that are to be considered for further analysis in an EPHA. Some materials may be excluded from analysis in an EPHA based on use, form, dispersibility, or toxicity. Radioactive materials requiring further analysis include those listed in DOE-STD-1027-92 in quantities greater than Category 3 values. Chemicals assigned Health Hazard Ratings 0, 1, or 2 based on the handbook of the National Fire Protection Association (NFPA), NFPA 704, *Standard System for the Identification of Hazardous Materials for Emergency Response*, may be excluded from further EPHA analysis. With some exceptions for extraordinarily high toxicity, chemicals in quantities less than those that can be "easily and safely manipulated by one person," also referred to as "laboratory scale" quantities, may be excluded from further analysis.

In accordance with DOE O 151.1C, Chapter III, 3.b(2)(d), the possibility that excluded materials "could initiate, through fires or explosions, the release of other hazardous materials must be considered." Although fires and explosions are the most obvious examples, the release of other hazardous materials (e.g., materials with health hazard rating <3) that could cause temporary incapacitation of workers resulting in a process upset that releases a material with an NFPA health hazard rating = 3 or 4 should be considered in the analysis. The release of a material with a health hazard rating that in large quantities could pose an asphyxiation hazard to collocated workers should also be considered in the analysis.

Appendix A provides a discussion of the hazardous material screening process and describes a recommended screening approach. If the screening process identifies at least one hazardous material requiring further quantitative analysis, the Hazards Survey should indicate that an EPHA is needed for that facility/site or activity. A description of the screening process and the results of its application should be provided in the Hazards Survey or supporting documents.

1.5 Identify Applicable Types of Emergency Events and Conditions (Step 3)

The generic types of emergency events and conditions that may occur at each facility for which some level of planning and preparedness may be required should be identified and documented. Hazardous materials not specifically addressed in a quantitative EPHA should also be considered when identifying the emergency conditions. As a minimum, the following types of emergency conditions should be considered:

- Structure fires and explosions;

- Natural phenomena impacts (wind, tornados, flood, earthquake, wildfire, snow storms);
- Environmental releases (of oil or other pollutants that degrade the environment);
- Hazardous material (HAZMAT) releases;
- Malevolent acts (hostage-taking, sabotage, armed assault, initiation of hazardous materials release);
- 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.

The emergency condition of particular emphasis in the DOE/NNSA Comprehensive Emergency Management System is the *release of hazardous materials*. The inventories of materials in facilities will be subject to the screening process discussed above. If there is the possibility that a potential release may cause a classified OE, then an EPHA is required. If, on the other hand, the facility contains an ***aggregation of small quantities*** (i.e., less than screening thresholds) that may be released during large-scale destructive events, such as a fire or explosion in a laboratory, an aircraft crashing into a building, or an earthquake that collapses a structure, this should also be indicated in the Hazards Survey. A site may consider defining such events as categorized [but not classified] OEs, if it appears that the condition would meet all the aspects of an OE. The potential "**HAZMAT**" aspect of these destructive events may be used as a ***qualitative factor*** or ***criterion*** (i.e., without the support of detailed quantitative calculations of consequences) in defining specific OEs related to these events. However, even without the inclusion of this category, a site may be required to categorize such an event as an OE under one of the existing definitions contained in the Order.

Some types of emergency conditions will apply to nearly every facility (e.g., fires), while others will only apply to facilities that exceed a threshold inventory of some hazardous material or environmental pollutant 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.

Facility and site hazards can be identified by utilizing subject matter experts (SMEs), BIO reports, SARs/SADs/DSAs, Vulnerability Assessments (VAs), chemical and radioactive material inventory databases, etc. Also, Federal Emergency Management Agency (FEMA), National Weather Service (NWS), and insurance industry documents are all potential sources of information.

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 (LEPC) 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 (ERG). Protective Action Zone distances may need to be calculated for hazardous substances not covered by the ERG. Once this information is collected, determine whether specific arrangements should be made for protection of onsite personnel. As a minimum, if no specific information can be obtained, the transportation arteries should be identified as potential sources of hazards to onsite personnel.

1.6 Qualitatively Describe Potential Impacts (Step 4)

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 OEs identified in 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***	***Qualitative Description of Impact Condition***
Office building	Structure fire	Workers killed/injured by smoke inhalation and burns.
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.
Onsite Transportation Activity	Collision	Actual or potential release of hazardous materials; exposures exceeding Protective Action Criteria (PACs).

1.7 Identify and Document the Applicable Planning and Preparedness Requirements (Step 5)

Various Federal, state, and local regulations include requirements that pertain to planning and preparedness for emergencies. The Order recognizes these as Base Program requirements and directs that they be incorporated into the site emergency management programs. Emergency planners should correlate Hazards Survey results with the relevant planning and preparedness requirements from other Federal, state, or local regulations

that apply to a particular facility, providing a summary of the required scope of emergency planning and preparedness at the site. Examples of possible Base Program planning and preparedness requirements are listed in the Order. When completed, the Hazards Survey should document and serve as a guide for assessing site compliance with a variety of DOE and non-DOE emergency planning and preparedness requirements that are integral parts of the Comprehensive Emergency Management System.

1.8 Maintenance of Hazards Surveys

Hazards Surveys should be maintained to accurately reflect changes in the facility design, operations, safety features, inventories of hazardous materials, and features of the surrounding area. According to DOE O 151.1C, Hazards Surveys must be periodically reviewed and, as necessary, updated prior to significant changes to the facility/site or to hazardous material inventories, but not less than every 3 years. Examples of significant changes are those changes which result in an Unreviewed Safety Question (USQ), as defined in 10 CFR 830.3(a), or in an unreviewed safety issue for accelerator facilities, as defined in DOE O 420.2B. This definition also applies to non-nuclear facilities. Changes that result in a reduction of hazards with no adverse effect on safety or emergency preparedness or response may be included in the next scheduled review and update. The Hazards Survey can be effectively maintained through monitoring of existing administrative processes and tracking systems [e.g., Integrated Safety Management Systems (ISMS), hazardous material inventory systems, facility authorization basis documentation].

Although most generic types of emergency conditions identified in a Hazards Survey will remain unchanged throughout the useful life of a facility, the status of hazardous material inventories within a facility may be the most variable and critical. The hazardous material screening process provides the mechanism that examines facility hazardous material inventories to determine the need for an EPHA, both on a periodic basis and, as required, when notified of changes in operations and/or inventories.

1.9 Hazards Survey Documentation

As noted in Section 1.2, a single Hazards Survey document may address multiple facilities and the results may be presented in any of several ways. The tabular/matrix presentation format is a particularly efficient method of summarizing and documenting the survey information for a large number of facilities. Using this approach, the Hazards Survey document can consist of brief descriptions of the facilities, types of hazards that apply, potential impacts of those hazards, applicable regulations, and other common information, followed by a table or matrix indicating which items apply to each facility. If the number of facilities is small, separate text section(s) can be devoted to each. For facilities with hazardous materials, the Hazards Survey document should identify the sources of inventory information and summarize the hazardous material screening methods and results.

Sites are not expected to reproduce extensive texts from original sources to incorporate in the Hazards Surveys. Existing site documents or record systems, such as facility

descriptions, building pre-fire plans, or hazardous material inventories, may be incorporated into the Hazards Survey by reference in the table or matrix. Hazardous material inventory information for a facility/site or activity should be documented to support the results of the hazardous material screening process. However, the inventory information need only be documented in the Hazards Survey to the extent necessary to indicate whether a quantitative EPHA is required. If an EPHA is required, then the results of the screening process for all materials in a facility/site or activity should be included in the EPHA. Otherwise, the screening results can be included as part of the supporting documentation for the Hazards Survey.

Sites should ensure that EPHA documentation is reviewed for classified or unclassified controlled information prior to release, with particular emphasis on the quantity and location of hazardous materials (especially nuclear materials) and malevolent event scenarios associated with these materials.

APPENDIX A. Hazardous Material Screening Process

A.1 Introduction

The purpose of this appendix is to provide background information on hazardous material identification and to present a recommended approach for screening radioactive materials and hazardous chemicals. The hazardous material screening process is intended to identify specific hazardous materials and quantities that, if released in an uncontrolled manner, could produce impacts consistent with the definition of an OE involving the airborne release of a hazardous material. Specifically, the uncontrolled release of such a hazardous material would:

- Immediately threaten or endanger those who are in close proximity;
- Have the potential to disperse beyond the immediate vicinity of the release point and threaten the health and safety of onsite personnel or the public; and
- Disperse at a rate that requires time-urgent response to implement effective protective actions for workers and the public.

Of primary concern are hazardous materials that are highly dispersible and have high acute toxicity or high radio-toxicity. Adverse health effects, which "threaten or endanger" the health and safety of workers or the public, occur where the consequences of the release of a hazardous material approach or exceed the applicable Protective Action Criterion (PAC). Such materials include, but are not limited to —

- Radioactive materials listed in DOE-STD-1027-92 Attachment 1, Table A-1.
- Chemicals assigned a Health Hazard Rating of 3 or 4 based on NFPA 704, *Standard System for the Identification of Hazardous Materials for Emergency Response.*

Some materials may be excluded from analysis in an EPHA based on use, form, dispersibility, or toxicity. The criteria specified in this appendix can be used to make definitive (yes-no) decisions on excluding materials from further consideration. The screening criteria are sufficiently conservative that it is unlikely that a substance screened out using those criteria could cause an OE. However, because the screening criteria are generic and do not reflect exactly the hazard associated with each individual substance, there may be facility-specific circumstances (e.g., specific release scenarios or mechanisms, large quantities of asphyxiates or cryogenic materials) recognized prior to application of the screening criteria, under which a particular substance that would otherwise be excluded from consideration using the criteria might cause impacts consistent with the OE definition. If, during the screening process, the facility/site or activity recognizes the existence of process conditions or release mechanisms that might exaggerate the impact of a particular substance, they may choose to analyze the material in an EPHA even though it could meet one of the stated criteria for exclusion.

This appendix also recommends fixed minimum screening values for chemicals determined in accordance with the provisions of 29 CFR 1910.1450 and referred to as quantities that are "easily and safely manipulated by one person" (commonly referred to as "laboratory scale" quantities.) The Order allows sites to determine values locally, appropriate to the activities and operations at their facilities, but still satisfying the provisions expressed in the CFR. Specific values will be recommended in this appendix to demonstrate the intent of the Order. Use of those screening values will exclude from further consideration small quantities of most hazardous materials that, in practice, have little or no potential to cause impacts consistent with the general definition of OEs given in DOE G 151.1-4, Chapter 4, and the specific OE definition given above for the airborne release of hazardous materials.

Using this screening process, any chemical or radionuclide, which is identified as a potential candidate for further analysis, should be examined in an EPHA. After further consideration and analysis of the specific quantities and release scenarios, some materials may be subsequently excluded from quantitative analysis in the EPHA. Hazardous materials that are not identified as candidates for analysis should be considered as possible initiators or promoters of a release of other toxic substances.

The following sections contain background information on hazardous material screening requirements and methods and present recommended screening approaches for radioactive materials and hazardous chemicals.

A.2 Radioactive Material Screening

A.2.1 General Screening Discussion

All radioactive materials are to be initially considered for possible analysis in an EPHA. However, DOE-STD-1027-92 allows exclusion of some materials for facility hazard categorization purposes and the Nuclear Regulatory Commission (NRC) provides for similar exclusions when determining the need for material licensee radiological contingency plans. Consistent with those precedents, the following materials may be excluded from consideration during the screening process:

- Sealed radioactive sources that are engineered to pass the special form testing specified by the Department of Transportation (DOT) in 49 CFR 173.469 or testing specified by the American National Standards Institute (ANSI) standard, ANSI N43.6, *Sealed Radioactive Sources - Classification*.

- Materials in solid form for which there is no plausible dispersal mechanism.

- Materials stored in DOT Type B shipping containers with overpack, provided the Certificates of Compliance are current and the Certificates authorize the stored materials.

- Radioactive materials used in exempted, commercially available products as described in 10 CFR 30.11-30.19 (e.g., timepieces, illumination devices, thermostats, etc.).

Small quantities of most radionuclides can be excluded from further consideration by the use of threshold screening quantities. DOE-STD-1027-92, Attachment 1, Table A-1, Category 3 threshold values were derived from the Reportable Quantities (RQs) developed by the Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Whereas the EPA based the RQs on a maximum individual dose of 0.5 rem (5m/Sv) by the most limiting exposure pathway, DOE applied a dose criterion of 10 rem (100 mSv), consistent with the EPA recommended dose limit for emergency workers engaged in "protecting valuable property." Accordingly, DOE multiplied the limiting release values from the EPAs RQ background document by a factor of 20 (i.e., 10 rem/0.5 rem [100 mSv/ 5 mSv]) to arrive at the Category 3 radionuclide thresholds. DOE-STD-1027-92 allows for some exclusions and adjustments based on the material form and dispersiblity when applying Category 3 thresholds.

In a few circumstances, the chemical toxicity of a radioactive substance may actually be of greater health concern than the potential radiation dose. Because the DOE Category 3 radionuclide thresholds are based on radiation dose alone, chemical toxicity may need to be considered when applying the screening values to very low-specific-activity radionuclides (or mixtures) that are known to also be chemically toxic. For practical purposes, the concern is limited to uranium of low enrichment in the form of compounds that are relatively soluble in body fluids (such as nitrates, fluorides, and sulfates). Depending on the exact proportions of the different uranium isotopes, the chemical toxicity concern becomes dominant as the nominal enrichment (^{235}U weight percent) decreases through the range from about 16 percent to 5 percent. [Cf. Stannard, J. N., *Radioactivity and Health – A History*, Chapter 2, IV. DOE/RL/01830-T59. Battelle Memorial Institute. 1988].

A.2.2 Recommended Screening Approach

This section presents a recommended screening approach that embodies the general principles and considerations discussed previously in Section A.2.1. **Figure A-1** shows the steps in the radioactive material screening process.

From available process records and documentation, identify all radioactive materials stored, used or produced within the facility/site or activity. Some materials that do not represent the type or magnitude of hazard that is intended to form the technical basis for hazardous material emergency management programs should be excluded from further consideration, as follows:

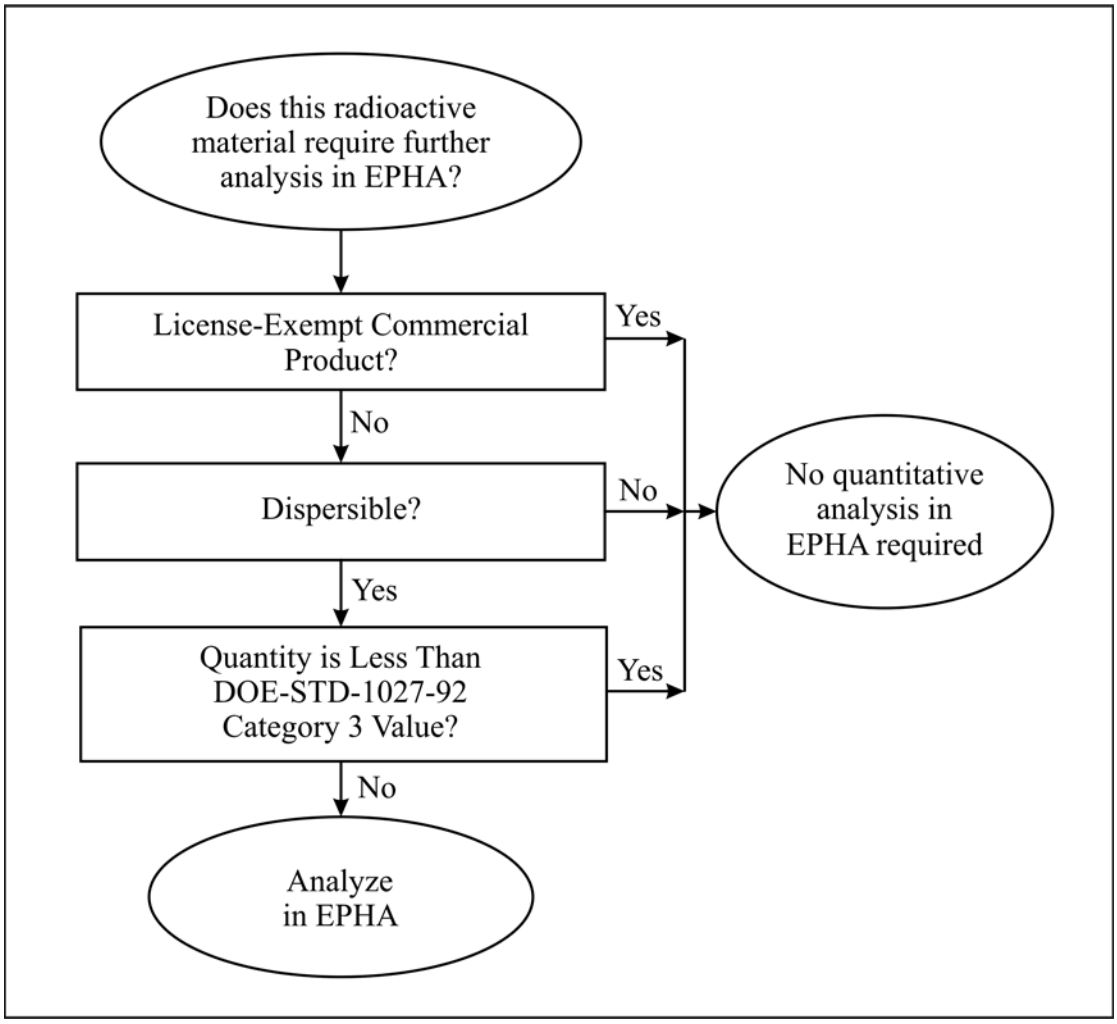

Figure A-1. Radioactive Hazardous Material Screening Process

License-Exempt Commercial Products. Radioactive materials used in license-exempted, commercially available products as described in 10 CFR 30.11-30.19 (e.g., timepieces, illumination devices, thermostats, etc.) should be categorically excluded from consideration.

Non-Dispersible Materials. The degree to which a substance represents an acute airborne health hazard to humans is a major consideration in determining the need for further analysis in an EPHA. Sealed sources and other materials engineered to meet "special form" requirements may be excluded from consideration with documented justification. Materials in solid form that cannot be reduced to small particles (less than about 10 microns in diameter) by some plausible mechanism can be excluded from quantitative analysis because they cannot be suspended and transported in air. Materials stored in DOT Type B shipping containers with overpack may be excluded, if the Certificates of Compliance are current and authorize the specific materials stored.

Apply Threshold Screening Quantities. Compare facility allowable radioactive material inventories against Category 3 values in DOE-STD-1027-92, Attachment 1, Table A-1; exclude from further consideration quantities less that those thresholds. The DOE-STD-1027-92 Category 3 values should be used for initial hazards screening and when updating existing Hazards Surveys. Widely separated units of inventory can be considered separately for comparison to the screening list, even if the "facility" total exceeds the listed quantity. Only the quantity that could realistically be considered part of the Material-At-Risk (MAR) for a single release event should be compared to the screening quantity. The threshold screening quantities should not be used to eliminate from consideration very low-specific-activity substances such as depleted, natural or low-enriched uranium in soluble forms. For those materials, chemical -- not radiological -- toxicity may actually be the dominant concern.

If the physical properties of the material or the manner in which it is stored or packaged indicate that the respirable release fraction would be significantly lower than the value used in calculating the threshold screening quantity, those factors should be considered in the quantitative analyses of release consequences in the EPHA.

When more than one radionuclide is present in the same location, it is appropriate to use the summation-of-radionuclide-threshold-ratios approach specified in DOE-STD-1027-92, Attachment 1. A quantitative hazards assessment is required if the sum of the fractions of all radionuclides subject to the same release event equals or exceeds one (1).

A.3 Chemical Screening

A.3.1 General Screening Discussion

For any chemical, the overriding emergency management concern is the acute human toxicity of the substance by the airborne pathway (inhalation, dermal contact, absorption through eyes and mucosa, etc.). Hazardous chemicals with local impacts on workers *in the immediate event scene* (e.g., asphyxiation, frostbite) are not the primary concern of an *emergency management system*, but are among the hazards addressed by worker health and safety programs. The screening process examines potential chemical hazards and eliminates materials from further consideration if they are commonly found in public use, are not readily dispersed in the atmosphere, are not hazardous (***toxic***) to humans, or exist in limited quantities. For such materials, response to any accidental release should be within the management scope and technical capabilities of ordinary workplace safety and hazard control programs. It is not expected that the hazardous material conditions following such an accidental release would constitute a hazardous material (classifiable) OE, the basic definition of which suggests that outside technical support, planning and preparedness measures are needed to ensure an effective response [cf. DOE G 151.1-4, Chapter 4].

Chemicals that do ***not*** represent the type or magnitude of hazard that is intended to form the technical basis for hazardous material emergency management programs are excluded from further consideration, as follows:

Public Use. In general, materials should be eliminated as candidates for analysis if the materials are commonly available to and 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 distributed for use by the general public (for example, bleach, motor oil, gasoline).

Dispersibility. The degree to which a substance represents an acute airborne health hazard (***toxic***) to humans is a major consideration in determining the need for further analysis in an EPHA. Solids that cannot be reduced to small particles (less than about 10 microns in diameter) by some plausible mechanism can generally be excluded from quantitative analysis because they cannot be suspended and transported in air.

The volatility of a chemical (i.e., how readily it evaporates) is normally expressed as the vapor pressure (or partial pressure, if in a solution) at a given temperature. For liquid *spills,* the rate at which the substance becomes airborne increases with increasing vapor pressure and increasing pool surface area. As part of the creation of the Clean Air Act, the EPA was chartered to create a list of hazardous substances and thresholds to focus accidental release prevention efforts on those sources and substances that pose the most significant risks to the community. The EPA established a vapor pressure cut-off value of 10 millimeters (mm) of mercury (40 CFR 68.115) for chemicals to be listed. However, experience indicates that some substances with lower vapor pressures may represent a significant airborne source if the potential spill volume is sufficiently large. Accordingly, a value of 1 mm of mercury is recommended as the cut-off value for EPHA purposes. Substances with vapor pressures below this value pose little potential for air releases due to an accidental spill. Although focused on the liquid ***spill*** scenario, a vapor pressure below 1 mmHg at about 25^{o}C can be used as a general criterion for excluding liquids from EPHA analysis.

Human Health Hazard. The Occupational Safety and Health Administration (OSHA) hazard communication standard (29 CFR 1910.1200) requires that all chemicals in the workplace be labeled in a manner that warns of any hazards the chemical may present. The actual format and method of labeling is not specified, so there are several different formats in use. The NFPA hazard diamond is one such method. NFPA 704 specifies a system for identifying the hazards associated with materials.

The NFPA hazard ratings can be used for initial screening to determine when the acute health affects of a chemical are severe enough to consider evaluation. Although the system was developed primarily to serve the needs of fire protection agencies, it is useful to anyone involved in the handling of potentially hazardous substances. The system identifies the hazards of a material in terms of three principal categories: "health," "flammability," and "instability." It indicates the degree of severity by a numerical rating that ranges from four (4), indicating severe hazard, to zero (0), indicating no hazard. In general for each of the categories, levels 3 and 4 represent effects that are the most severe, have the longest lasting impacts, impact the largest area and/or involve the largest energy release. Chemicals without a ***health hazard rating*** should be retained for further consideration. For purposes of screening, therefore, any chemical with a ***health hazard rating of 0, 1, or 2*** is presumed not to represent a significant toxic health hazard to

humans and may be excluded from further analysis. Any chemical assigned a health hazard rating of 3 based solely on cryogenic properties and the resulting frostbite hazard may likewise be excluded.

Quantity. Hazardous materials should be eliminated as candidates for analyses if the materials are stored and used only in small quantities. From the definitions in 29 CFR 1910.1450, *Occupational exposure to hazardous chemicals in laboratories*, "laboratory scale" means work with substances in which the containers, used for reactions, transfers, and other handling of substances are designed to be "***easily and safely manipulated by one person***." The Order allows sites to determine values appropriate to the activities and operations at their facilities, but still satisfying the provisions expressed in the CFR. In general, about 5 gallons (19 L) of liquid or the corresponding weight of solid material (about 40 pounds [18 kg]) is the maximum that can be safely handled by one person. For compressed gases, cylinders with a full gross weight of 40 pounds (18 kg) will typically contain 10 pounds (4.5 kg) or less of most common toxic gases. Hence, it is consistent with the intent of the Order to screen out *individual containers* with capacities less than approximately 5 gallons (19 L) for liquids, 40 pounds (18 kg) for solids, or 10 pounds (4.5 kg) for compressed gases.

Individual containers that are being used, and small numbers of such containers kept in ready storage within or very near an end-user facility, may be screened out. However, larger numbers of such containers (capacity totaling greater than about 5-10 times the applicable "laboratory scale" threshold) in warehouses or other storage locations should be examined closely before screening them out. In these situations, if there are plausible scenarios (excluding *extreme* malevolent acts and *catastrophic* release scenarios such as major fires, airplane crashes and building collapse) that could release the contents of multiple containers, the material should be retained for analysis.

A one (1) pound (0.45 kg) threshold value is recommended for substances that, because of high acute toxicity and dispersibility, may represent an *extraordinary toxic hazard* beyond the local event scene. Those substances should include, but may not be limited to: chemical warfare nerve agents; any substance of similar toxicity [e.g., Acute Exposure Guideline Level (AEGL)-3, Emergency Response Planning Guideline (ERPG)-3, or Temporary Emergency Exposure Limit (TEEL)-3 values less than about 3 ppm] that has been *"weaponized"* or designed for efficient dispersal as a gas, vapor or aerosol; and, compressed gases with acute toxicity in the same range.

The fact that a substance is flammable, combustible, or explosive is not by itself sufficient cause to analyze it in an EPHA. However, a substance should be considered a potential release initiator or promoter if it is combustible or capable of a violent chemical reaction that could cause or enhance the release of other hazardous materials with the ability to cause severe injury or death beyond the immediate vicinity of the release. If a substance meets the following conditions, its flammable or explosive properties should be noted for possible consideration in the EPHA as a factor potentially influencing the release of existing toxic materials:

- The substance is flammable or explosive and capable of a violent/energetic reaction (e.g., BLEVE, deflagration, explosion, etc.), and

- The energy available in the substance could cause significant damage to facilities/equipment and disperse other substances stored or used in close proximity to it.

The fact that a chemical reacts with other substances is not by itself sufficient cause to analyze it in an EPHA. If an energetic reaction involving substance A could cause the release of hazardous material B, then the reaction should be considered as a potential initiator during the analysis of substance B. If an identified reaction creates an acute inhalation hazard as a by-product and if the quantity created could be a significant hazard beyond the immediate vicinity of the event, then the reaction and its by-product should be considered for analysis in the EPHA. If a substance meets the following test, its chemically reactive properties should be noted for possible consideration in the EPHA, as the source of a toxic release:

- The substance will react with other chemicals or materials used or stored in the same location, and

- The reaction could be sufficiently energetic to cause significant damage to facilities/equipment and disperse other toxic substances stored or used in close proximity to it, or

- The reaction products are toxic and pose an acute airborne hazard.

NOTE: The initial identification of potential chemical reactions could be made using the *Chemical Reactivity Worksheet* developed at the Office of Response and Restoration, National Ocean Service (NOS)/National Oceanic and Atmospheric Administration (NOAA) in cooperation with the Chemical Emergency Prevention and Preparedness Office of the EPA. For chemicals not listed in the *Chemical Reactivity Worksheet* database, information from the MSDS, *SAX's Dangerous Properties of Industrial Materials*, project documentation, and other available sources can be used to determine potential interactions. Application of the Worksheet has some limitations. For example, there is no way to adjust the results to account for specific chemical form, quantity, or concentration, and reaction by-products are not explicitly identified. As a result, some potential reactions identified by the Worksheet may require additional investigation to determine if they are possible, to identify the toxic airborne by-products, and to estimate the resulting consequences. Additional information on the limitations and possible misapplications of reactivity worksheets can be found in the article titled *Use and Misuse of Chemical Reactivity Worksheets*, published in the September/October 2006 Journal of Chemical Health and Safety.

A brief statement of the rationale for the application of these exclusions should be included in the Hazards Survey or EPHA to document which materials were considered and excluded. The possible effect of such materials as an initiator or promoter of a

release (for example, due to their combustible, explosive or corrosive properties) of other more hazardous material should still be considered.

A.3.2 Recommended Screening Approach

This section discusses a recommended facility/site or activity chemical screening approach that embodies the general principles and considerations discussed previously in Section A.3.1. **Figure A-2** shows the steps in the recommended screening process, as applied to a single chemical.

All chemicals with known or suspected toxic properties should be subjected to screening. Facility chemical inventory records, permits, licenses, shipping/receiving records, Technical Safety Requirements (TSRs), process standards and equipment specifications and any other relevant sources should be used to identify such materials and the maximum quantities of each.

Chemicals should be excluded from further consideration if they do not represent the type or magnitude of hazard that is intended to form the technical basis for hazardous material emergency management programs, as follows:

Public Use. Eliminate from further consideration any material that is commonly available to and used by the general public, if the formulation and concentration is the same as for products that are distributed without significant restrictions to the public. Examples include cleaning products, bleach, motor oil, gasoline, and pesticides not designated "restricted use" by the EPA.

Dispersibility. Eliminate from further consideration any material that does not present an airborne exposure hazard due to its physical form or other factors. Materials may be eliminated if they meet one of the following tests:

- The substance is a solid at normal temperatures and does not contain or include a significant fraction of small particles (less than about 10 microns in diameter) that can readily be suspended in air.

- No plausible release mechanism/process is identified by which a *large fraction* of a solid material can be reduced to small particles (less than about 10 microns in diameter) to be suspended and transported in air.

- The substance is a liquid that exhibits a vapor pressure (or partial pressure of a hazardous material in a solution) of less than 1 mmHg at about 25 degrees C.

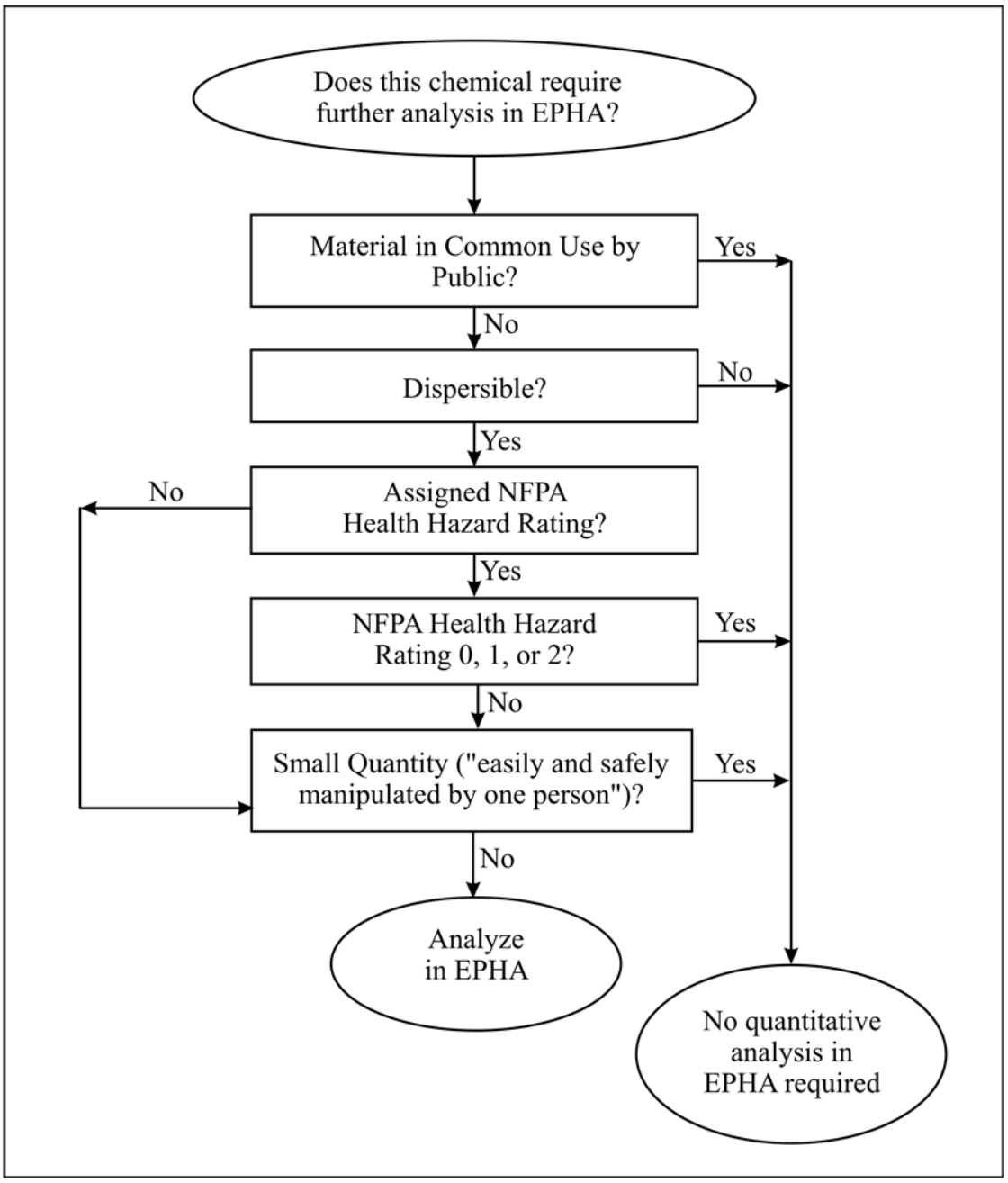

Figure A-2. Chemical Hazardous Material Screening Process

These tests should be applied to a substance as it exists under normal conditions of use or storage (i.e., temperature, pressure, particle size, concentration, etc.). The dispersiblity determination should not assume any energetic or dispersive event/condition unless it results from the inherent qualities of the material (such as pyrophoric properties) or process conditions (for example, liquid pumped at high pressure that could, in event of a leak, produce aerosol-sized droplets). To ensure that the dispersibility tests are applied

correctly, the storage and use conditions may need to be determined (by physical inspection, document review, or other means) during the screening process. Any reactive properties that could result in a substance being converted from a non-dispersible to dispersible state should also be understood before screening it out.

Human Health Hazard. Materials that have been assigned a NFPA health hazard category rating (or a health hazard rating assigned locally using the criteria published in NFPA 704) 0, 1, or 2 are presumed to not represent significant toxic health hazards to humans. Such materials do not have toxic properties of the type that need to be considered in a quantitative EPHA. Materials that have no assigned value for the health hazard rating should be analyzed in the EPHA, if they exceed the small quantity thresholds discussed below.

Quantity. Unit quantities (individual containers) smaller than those "easily and safely manipulated by one person" (i.e., "laboratory scale" quantities) should not be analyzed quantitatively in an EPHA. As used here, containers with capacities of no more than 5 gallons (19 L) for liquids, 40 pounds (18 kg) for solids, or 10 pounds (4.5 kg) for compressed gases are defined as being "easily and safely manipulated by one person." Individual containers that are being used, and small numbers of such containers kept in ready storage within or very near an end-user facility, may be screened out. As previously noted, a one (1) pound (0.45 kg) threshold value should be used for substances that, because of high acute toxicity (i.e., AELG-3, ERPG-3, or TEEL-3 < 3 ppm) and dispersibility, may represent an *extraordinary toxic hazard* beyond the local event scene.

APPENDIX B. Example Application of the Hazards Survey Guidance to a Hypothetical DOE Facility

B.1 Introduction

The purpose of this appendix is to illustrate the application of the Hazards Survey guidance described in the main body of DOE G 151.1-2. Section 1.2 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. An example application of the approach is presented in this appendix.

This appendix is presented in the format of a Hazards Survey Document for a single operating area of a hypothetical DOE 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 151.1C and documenting its results. The main sections of the example Hazards Survey are:

1. INTRODUCTION

2. SCOPE

3. HAZARDOUS MATERIAL SCREENING

4. SUMMARY

B.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 the DOE Emergency Management Guide (EMG), DOE G 151.1-2, *Hazards Surveys and Hazards Assessments*, Chapter 1, to fulfill the DOE O 151.1C requirement that a Hazards Survey be conducted 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. Hazardous Material Screening

Hazardous material screening for the 123 Area facilities was conducted in accordance with the DOE G 151.1-2, Appendix A. **Table 3-1** summarizes the information sources used to determine the hazardous material status of each facility. Each item or unit of radioactive material and potentially toxic chemical encountered on the facility inventory records or during the walk-down was evaluated using the screening guidelines from DOE G 151.1-2, Appendix A, Section A.2 or A.3, as applicable. Radioactive items or quantities were eliminated from further consideration (screened out) if they were:

- Part of a license-exempt commercial product,
- In a solid, non-dispersible form, or
- In a quantity less than the DOE-STD-1027-92 Category 3 value.

A chemical was eliminated from further consideration if:

- It was generally available without restriction to the public in the same form/size,
- It was not dispersible,
- The health hazard rating was 2 or less, or
- The quantity was less than the applicable "laboratory scale" value (5 gallons [19 L] for liquids, 40 pounds [18 kg] for solids, 10 pounds [4.5 kg] for gases).

Based on hazardous material inventory information sources listed in Table 3-1, only the ABC Facility and Building 152 (Water Treatment Plant) are determined to have hazardous material inventories that require quantitative analysis. No hazardous biological agents or toxins are used or stored in any facility within the 123 Area. The screening processes for facilities found to contain hazardous materials are summarized in **Tables 3-2** and **3-3**. The results of the screening found that the following substances should be quantitatively analyzed in an EPHA:

Building 152 Chlorine (facility total = 600 pounds/272 kilograms)

ABC Facility Heat source Pu-238 (facility total = 10 kg (4.9E+15 Bq)

Anhydrous hydrogen fluoride

(facility total = 1320 lbs/600 kg)

Methyl Ethyl Badstuff (275 gallons/[1041 L])

NOTE: Facilities are advised to list materials screened out, which are perceived as being "high visibility" or of special interest to the site, facility or public, and to give the specific reasons for the decisions. Examples include plutonium, beryllium and any substance previously analyzed in an EPHA that is being screened out using the most recent guidance. A complete list of the materials considered and the basis for the screening disposition of each should be included or referenced in the survey.

4. 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.

4.1 Facilities Having Potential for OEs Requiring Classification

Based on hazardous material inventory information sources listed in Table 3-1, the ABC Facility and the Building 152 (Water Treatment Plant) are determined to have the potential for OEs that would be classified as Alert, Site Area Emergency,

or General Emergency. Quantitative EPHAs are required for these facilities. The EPHA for the ABC Facility is documented in (reference) and for Building 152 in (reference).

Because of the potential for OEs requiring classification, the planning and preparedness requirements of DOE O 151.1C, 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 151.1C, Chapter IV.

4.2 Facilities Having No Potential for OEs Requiring Classification

The following facilities are determined to have the potential only for events or conditions that would be categorized as OEs not requiring classification in accordance with the criteria of DOE O 151.1C, Chapter V. 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 OEs 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)*	*Special Conditions/ Designations*	*Hazardous Materials*	*Emergency Conditions* [a]	*Potential Impacts*	*Applicable Requirements*
101	Craft shop	12/0	Haz. waste satellite collection point	Paints, solvents, lubricants	1. Structure fire/explosion 2. Natural phenomena 3. Environmental release 5. Malevolent acts 7. Workplace accident 8. External hazards	1,2,5,7,8 - Worker death/injury. 3 -Pollution of water-way	Occupational Safety and Health Administration (OSHA) Employee notification & evac. plan; 40 CFR 117 notification of release to waters
102	Fire Station	8/0	Buried natural gas main ~30m west	None	1. Structure fire/explosion 2. Natural phenomena 5. Malevolent acts 7. Workplace accident 8. External hazards	1,2,5,7,8 - Worker death/injury	OSHA Employee notification & evac. plan
103 104 108 109 114 117	Offices, modular	24/0 (each)	No	None	1. Structure fire/explosion 2. Natural phenomena 5. Malevolent acts 8. External hazards	1,2,5,8 - Worker death/injury	OSHA Employee notification & evac. plan
106 113 118 121	Offices, multistory	45/20 60/30 45/15 90/48	No	None	1. Structure fire/explosion 2. Natural phenomena 5. Malevolent acts 8. External hazards	1,2,5,8 - Worker death/injury	OSHA Employee notification & evac. plan
ABC	Laboratory process	140/50	TSD Facility	Radioactive materials Toxic chemicals	1. Structure fire/explosion 2. Natural phenomena 3. Environmental release 4. Haz. Mat. release 5. Malevolent acts 6. Workplace accident 7. External hazards	1,2,5,7,8 - Worker death/injury 3 - Pollution of water-way 4 - Onsite & offsite personnel death/injury	OSHA Employee notification & evac. plan; 40 CFR 302 reporting; 40 CFR 355 reporting; 40 CFR 117 notification of release to waters

Table 2-1. 123 Area Hazards Survey Summary (cont'd)

Bldg ID	*Type/Use*	*Occupancy (total/other than ground floor)*	*Special Conditions/ Designations*	*Hazardous Materials*	*Emergency Conditions* [a]	*Potential Impacts*	*Applicable Requirements*
999	Offices, multistory	310/150	No	None	1. Structure fire/explosion 2. Natural phenomena 5. Malevolent acts 8. External hazards	1,2,5,8 - Worker death/injury	OSHA Employee notification & evac. plan
151	River water pump station	No routine occupancy	No	None	1. Structure fire/explosion 2. Natural phenomena 5. Malevolent acts 7. Workplace accident 8. External hazards	1,2,5,7,8 - Worker death/injury	OSHA Employee notification & evac. plan
152	Water treatment plant	No routine occupancy	No	Water treatment chemical (chlorine)	1. Structure fire/explosion 2. Natural phenomena 4. Haz. Mat. Release 5. Malevolent acts 7. Workplace accident 8. External hazards	1,2,5,7,8 - Worker death/injury	OSHA Employee notification & evac. Plan

[a] Descriptions of emergency conditions are taken from DOE G 151.1-2, Section 1.5, where:
1= Structure fires and explosions; 2 = Natural phenomena impacts; 3 = Environmental releases; 4 = Hazardous material releases; 5 = Malevolent acts; 6 = Workplace accidents; 7 = External hazards.

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 (MITS), 6/5/06. Facility walk-through on 6/23/06.
102	MITS, 6/5/06. Facility walk-through on 6/23/06.
103, 104, 108, 109, 114, 117	MITS, 6/5/06. Facility walk-through on 6/23/06.
106, 113, 118, 121	MITS, 6/9/06. Facility walk-through on 6/24/06.
ABC	MITS, 6/4/06. ABC Hazards Assessment dated 1/05 and supplement dated 7/06. MWUPPPP Process safety assessment dated 5/05. Facility walk-through on 6/22/06.
999	MITS, 6/11/06. Facility walk-through on 6/19/06.
151	MITS, 6/4/06. Facility walk-through on 6/19/06.
152	MITS, 6/4/06. Bldg 152 Hazards Assessment dated 4/05. Facility walk-through on 6/19/06.

Table 3-2. 123 Area Chemical Screening Summary

Bldg ID	*Type/Use*	*Hazardous Chemical(s)*	*Public Use*	*Dispersible*	*NFPA Health Hazard Category*	*Less than Laboratory Scale Quantity?*	*Analyze in EPHA?*	*Notes*
101	Craft Shop	Paints Solvents Lubricants Adhesives	Yes	N/A	N/A	N/A	No	Commercial products that are used and stored in formulations and quantities commonly available to and used by the general public.
102	Fire Station	Pesticides Herbicides	Yes	N/A	N/A	N/A	No	Used to control mice and eliminate weeds. Commercial products used and stored in formulations and quantities commonly available to and used by the general public.
103 104 108 109 114 117 106 113 118 121 999	Offices, modular & multistory	Janitorial Supplies (Dry/Liquid)	Yes	N/A	*N/A	N/A	No	Commercial products used and stored in formulations and quantities commonly available to and used by the general public.

Table 3-2. 123 Area Chemical Screening Summary (cont'd)

Bldg ID	*Type/Use*	*Hazardous Chemical(s)*	*Public Use*	*Dispersible*	*NFPA Health Hazard Category*	*Less than Laboratory Scale Quantity?*	*Analyze in EPHA?*	*Notes*
ABC	Laboratory process	Anhydrous Hydrogen Fluoride	No	Yes	4	No	Yes	Stored in sealed steel pressure cylinders containing 100 kg (220 lb) each. Maximum inventory allowed 6 cylinders.
		Dimethylfor-mamide	No	Yes	Not Rated	Yes	No	Used as a solvent for small-scale resin production. Typically 1 – 2 gallons in inventory. Therefore, less than laboratory scale.
		Isopropyl Alcohol	No	Yes	1	Yes	No	NFPA health hazard rating less than 2. Used for cleaning, total quantity typically less than 1 gallon. Therefore, less than laboratory scale.
		Methyl Ethyl Badstuff	No	Yes	4	No	Yes	Used in plastic production. Received and handled in 55-gal steel drums, which hold 256 kg (564 lb). Maximum inventory is 5 drums.
152	Water treatment plant	Chlorine	No	Yes	3	No	Yes	Used for water purification. Stored in 150-lb cylinders of liquefied compressed gas. Typical inventory is 4 cylinders.
ABC	Laboratory process	Cs-137	No	No	6.0E+01	No	No	100 mCi sealed source that is part of densitometer instrumentation used for testing components within Process Number-2. The source has met sealed source testing requirements specified in ANSI N43.6.
		Pu-238	No	Yes	6.2E-01	Yes	Yes	Used as the heat source in the manufacture of prototype thermal-electric generators in Process Number-2. Maximum inventory allowed in the facility is 10 Kg (1.3E+05 Ci).
		Tritium	Yes	N/A	1.6E+04	N/A	No	Facility exit signs containing tritium. Typical source strength ~0.5 Ci (~20 GBq)/sign. NRC License-exempt per 10 CFR 30.19.

Table 3-3. 123 Area Radiological Screening Summary

Bldg ID	*Type/Use*	*Radioactive Material(s)*	*License Exempt*	*Dispersible*	*DOE-STD-1027-92 Cat 3 Threshold (Ci)*	*Exceeds Threshold?*	*Analyze in EPHA?*	*Notes*
ABC	Laboratory process	Cs-137	No	No	6.0E+01	No	No	100 mCi sealed source that is part of densitometer instrumentation used for testing components within Process Number-2. The source has met sealed source testing requirements specified in ANSI N43.6.
		Pu-238	No	Yes	6.2E-01	Yes	Yes	Used as the heat source in the manufacture of prototype thermal-electric generators in Process Number-2. Maximum inventory allowed in the facility is 10 Kg (1.3E+05 Ci).
		Tritium	Yes	N/A	1.6E+04	N/A	No	Facility exit signs containing tritium. Typical source strength ~0.5 Ci (~20 GBq)/sign. NRC License-exempt per 10 CFR 30.19.

2. HAZARDS ASSESSMENTS

2.1 Introduction

The purpose of this Chapter is to assist DOE and NNSA field elements in complying with DOE O 151.1C whenever a facility-specific quantitative assessment of the potential release of hazardous materials is required. A hazards assessment must be performed for a facility/site or activity when at least one hazardous material requiring quantitative analysis is identified through the hazardous material screening process conducted as part of the Hazards Survey. The Order requires special planning and preparedness for DOE emergency management programs that need to respond to emergency events or conditions involving the unplanned release of hazardous materials. The scope and extent of these programs will be based on facility-specific hazards through a "commensurate with hazards" approach. The first step in the implementation of this approach for hazardous materials is the quantitative analysis of potential emergencies in an EPHA.

EPHAs involve the application of rigorous hazards analysis techniques that provide sufficient detail to assess a broad spectrum of postulated events or conditions involving the potential release of hazardous materials and to analyze the resulting consequences. The screening process and the analysis of identified hazardous materials in a facility/site or activity determine the potential for producing an OE classified as an Alert, Site Area Emergency, or General Emergency. If a potential classifiable OE associated with a facility/site or onsite activity is identified, an Operational Emergency Hazardous Material Program needs to be developed and maintained that establishes additional, more detailed emergency management program requirements than those imposed by the Operational Emergency Base Program.

The EPHA performs ***three roles*** in a DOE emergency management program. First, by summarizing the processes and systems associated with the hazardous materials, together with the nature and magnitude of the hazards, the EPHA provides the technical planning basis for determining the necessary plans/procedures, personnel, resources, equipment, and analyses [e.g., determination of an Emergency Planning Zone (EPZ)] that comprise the Operational Emergency Hazardous Material Program. Second, the documented EPHA provides an archival record of the data, assumptions, and methods used in developing the technical planning basis for the program; it also reflects the reasoning used to modify the program in response to changes in operations and hazards. The documented EPHA should enable an emergency management program to survive the inevitable turnover of hazards assessment personnel without the loss of continuity that can result from uncertainty about past analyses and decisions. Third, the EPHA performs a key readiness assurance role by providing clear and convincing evidence that facility-specific hazards are well understood by the responsible emergency management planners, and that, if used correctly, the EPHA represents a valid technical foundation for developing an emergency management program that is "commensurate with hazards."

Of particular importance in performing hazards assessments, especially for sites with multiple facilities, is consistency in the selection and application of analysis techniques, hazardous material release scenarios, and the assumptions and input data used in consequence calculations. A recommended approach for ensuring consistency is to standardize and document ground rules and criteria prior to performing the hazards assessment analyses. The selection and subsequent documentation of EPHA release criteria and analysis techniques, beforehand, ensures both consistency between EPHAs for common scenarios and analyses and consensus among diverse site functions.

An effective method for accomplishing consistency and for ensuring consensus among diverse disciplines involved with the EPHAs is through interaction and coordination with a broad scope of interested facility and/or site functions, including operations, programs, Safeguards and Security (S&S), safety, fire protection, and authorization basis and emergency management analysts. Most sites, especially those with multiple facilities, can benefit from the issuance of a formal site-wide procedure for performing hazards assessments. Such a procedure should specify standard analysis methods, inputs, and criteria for performing the hazards assessment analyses, as well as a step-by-step hazards assessment approach and documentation standard that will ensure consistency among the site's EPHAs. This documented procedure can also streamline the required DOE review and approval process for revised and updated EPHAs, which should significantly decrease the time required to implement approved changes in emergency plans and procedures and emergency response tools [e.g., Emergency Action Levels (EALs)], based on updated and approved EPHAs.

To the maximum extent possible, the hazards assessment process should make use of facility description and accident scenarios from SARs/SADs/DSAs, consequence assessment methods used during emergency response, and existing hazardous materials inventories maintained for other purposes. Information available from sources such as SARs/SADs/DSAs, BIO documents, Probabilistic Risk Assessments (PRAs), VAs, Fire Hazard Analyses (FHAs), Environmental Impact Statements (EISs), and other documents that address facility/site or activity hazards or potential consequences may be used to ensure consistency of basic input data. The analyses contained in these sources should be used with caution, however, because the assumptions and methodology applicable to their intended purposes may not be fully compatible with emergency management planning needs.

When scheduling EPHA preparation, the schedules for the preparation, review and update of other safety and regulatory compliance documents should be considered. Integrating the EPHA effort with these schedules can increase preparation efficiency and reduce cost. Where possible, the same release parameters and analyses techniques may be used to minimize the differences between the EPHAs and safety/authorization-basis analyses.

In order to advance the level of understanding and the capability of performing integrated hazards analysis, a handbook was developed by DOE to emphasize the efficiencies and advantages associated with integrating the numerous hazard analysis methodologies performed under various requirements. This handbook, DOE-HDBK-1163-2003,

Integration of Multiple Hazard Analysis Requirements and Activities, focuses on data exchange among the various analysis methodologies under multiple standards and requirements, where applicable. It is the intention of the handbook to promote further discussion and hands-on experience in encouraging the concept of the integration of hazards analysis. The hazards assessment process for emergency management discussed in this guide promotes this concept of analysis integration.

The guidance in this Chapter is directed at operations and emergency management staff responsible for DOE and NNSA facilities at field offices, service centers, and operating contractor organizations. It is expected that emergency management staff will obtain support from site and facility management and from a variety of scientific and technical disciplines within their respective organizations as they conduct and document the analyses described herein.

Appendix C provides specific guidance related to the practical definition of "facilities," "facility boundaries," and "site boundaries" for use in developing DOE emergency management programs. Appendix D addresses the necessary modifications of the hazards assessment guidance when applying the methodology to onsite transportation activities. Appendix E addresses the development of malevolent event scenarios for the analysis of potential hazardous material releases. Appendix F contains guidance on selecting consequence criteria, computing time-weighted average concentrations, and using the chemical mixture methodology. Appendix G provides backup analysis and documentation supporting guidance related to the treatment of toxic combustion products in EPHA analyses. Appendix H illustrates the application of the suggested hazards assessment method to a hypothetical facility and site.

2.2 General Approach

DOE Emergency Management System policy and Order require that hazardous material emergency management programs are responsive to the full range (spectrum) of potential hazardous material release scenarios, including applicable hazardous material types, release magnitudes, and initiating events. The term "release" is used here to mean, primarily, an airborne release. The airborne release 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.

For a single facility (or activity), there may be hundreds of different possible hazardous material release scenarios. To address this range of possibilities, facilities should develop and document a technical planning basis for the facility-specific emergency management program consisting of a manageable number of systematically selected and realistically analyzed release scenarios to represent a spectrum of severity and initiators. The purpose

of this Chapter of the EMG is to provide guidance that will address the process for conducting and documenting the selection and quantitative analysis of potential release scenarios associated with the hazardous materials identified by the Hazards Survey screening process.

The recommended steps in the EPHA process are the following:

Step 1 Define and describe the facility and operations.

Step 2 Characterize the hazardous materials.

Step 3 Select scenarios for analysis.

Step 4 Analyze scenarios
- Estimate source term,
- Calculate consequences,
- Identify recognition factors, and
- Finalize technical planning basis scenarios.

Step 5 Document the results of the analysis.

Although the basic steps of the process should be accomplished and documented in the order presented, 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 EPHA should address factors such as initiating events, contributing events, accident mechanisms, equipment or system failures, engineered safety system failures, source terms, material release chemistry and characteristics, environmental transport and diffusion, emergency event or condition observable indicators, exposure considerations, and health effects. Conservative consequence calculations should be performed for the purposes of event classification, initial protective action determinations, response decision-making, and special planning (e.g., collocated facilities, special offsite populations, EPZ determination). The results of the hazards assessment are to be used to determine the EPZs for each facility and site, as well as the emergency classification and initial protective actions for each analyzed event. The observable indicators, or recognition factors, of each analyzed event or condition are identified for use as event classification criteria (i.e., EALs).

EPHAs should be prepared and documented in a manner that permits critical review of the analyses and results and, if necessary, reconstruction by independent analysts. However, detailed descriptions of the methods, assumptions, and models need not be included if they are documented elsewhere and referenced (e.g., site-wide procedure for EPHAs).

In the remainder of this chapter, the steps in the EPHA process will be discussed. Sections 2.3 and 2.4 address the facility description and the characterization of the hazardous materials associated with the facility, respectively. The selection and analysis

of a spectrum of scenarios is covered in Sections 2.5 and 2.6. Finally, Section 2.7 provides guidance related to documentation requirements for EPHAs. The treatment of several special hazards in the EPHA is discussed in Section 2.8, and Section 2.9 provides guidance on using other sources of safety basis information to accomplish the steps in the EPHA process.

2.3 Define and Describe Facility and Operations (Step 1)

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

In some cases, the boundaries of the facility and operations in question will have been previously defined (e.g., by a security boundary or fence). Facility "definitions" used for SAR/SAD/DSA purposes may be applicable. However, the boundaries should be reexamined with the objectives of the EPHA in mind.

Sites may group their facilities, activities, and hazards in any of several ways for hazards assessment purposes. Several structures or component units with a common or related purpose may be defined as single "facility," such as a waste tank farm consisting of a number of units of approximately the same nature and purpose under common management and operational control. On the other hand, a group of dissimilar buildings, operations, and equipment, such as a research reactor with its associated cooling tower, fuel handling and waste storage buildings, laboratory, and hot machine shop may also be considered as one facility for purposes of the hazards assessment. Finally, all the hazards within a single building or structure containing several tenant activities or units, such as process lines, hot cells, or hazardous material storage may be analyzed and documented as one facility, even though the tenant activities have little in common, technically or organizationally. Additional guidance on facility definition is presented in Appendix C.

The written facility description should include general 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. Particular attention should be paid to including facility specific information critical to understanding and reconstructing the consequence calculations and to information necessary to aid emergency planners in using the analysis results to develop other emergency management program elements. This information should include, but not necessarily be limited to: descriptions and physical parameters for facility containment/ confinement systems; potential leak paths and release points; protective/mitigative systems or features; technical, physical or administrative limits on use/storage of hazardous materials; and, installed process monitors, alarms and/or detection systems.

2.4 Characterize the Hazardous Materials (Step 2)

After the facility hazards have been screened, information that describes and quantifies the identified hazards should be assembled and documented to support the development of scenarios and analysis of possible releases. During this step, some substances originally retained for analysis during the Hazards Survey screening may be eliminated from the EPHA scope based on a better understanding of their properties and quantities. In this respect, another level of hazard screening may actually take place as part of the characterization activity. The characterization of both radioactive and chemical hazardous materials should include the following information:

- The maximum quantity of the material in appropriate units (pounds or kilograms, curies or 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. Instruments and systems that would detect actual or potential emergency conditions should be identified.

- 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 criticality accidents, 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 would generally be available in the facility SAR, SAD, or DSA.

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, burn-up, 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 a potential 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, energy sources, and non-toxic hazardous materials (i.e., NFPA health hazard rating < 3), should also be included in the characterization. The potential for these materials/hazards initiating releases of radioactive or chemically toxic materials contributing to the dispersal of those materials, degrading the effectiveness of safety systems, incapacitating workers causing a process upset, or posing an asphyxiation hazard to *collocated workers*, should be considered. Available information concerning the reactive properties of the hazardous materials should be assessed and the possibility of interactions between substances considered.

2.5 Select Scenarios for Analysis (Step 3)

The objective of this step in the hazards assessment process is to select, for detailed analysis, potential release scenarios associated with the hazardous materials characterized in Step 2. These analysis cases will ultimately represent a spectrum of possible scenarios that will serve as the technical planning basis for the facility/site or activity emergency management program.

The specific scenarios/cases to be analyzed in the EPHA should be chosen through a ***systematic examination*** of:

- All the hazardous materials in the facility;
- Primary barrier(s) that maintain each material in a safe condition
- Modes by which each primary barrier could fail
- Initiating events or conditions that could cause barrier failure modes
- Release conditions associated with the failure mode or the initiating event, including pathways and mitigation devices through which the substance could be released to the environment

Applicable combinations of the hazardous materials in the facility and potential scenario characteristics will define a set of analysis cases, where each release scenario will be represented by combinations of the following four terms:

- Hazardous material [MAR]

- Failure mode
- Initiating event or condition
- Release condition(s)

This process of developing potential scenarios by constructing combinations of these four parameters will ultimately lead to a complete listing of the ***applicable*** cases.

The next section introduces a recommended minimum set of event or condition types to be considered for analyzing hazardous material releases. A systematic approach for developing a manageable number of representative scenarios for each hazardous material in a facility is introduced in Section 2.5.2.

2.5.1 Types of Events and Conditions to Be Considered

A set of events and conditions should be postulated and analyzed that represents the full spectrum of possible initiators and severity levels involving releases of hazardous materials that could affect workers, the public, or the environment. A spectrum of potential events ranging from low-consequence, high-probability events to high-consequence, low-probability events, including those considered to be beyond-design-basis, should be postulated and realistically analyzed. The spectrum of events and conditions analyzed should include those exclusively affecting onsite personnel, as well as those also affecting the offsite public. Analysis of a spectrum of events does not mean analysis of every imaginable event. The goal is to create a comprehensive picture of the ***types of events*** and a ***range of associated consequences*** that could occur at a facility. This comprehensive picture of events and consequences will then serve as the basis for emergency response planning.

The Hazards Survey described in Chapter 1 identifies the types of emergency events and conditions and the potential impacts of such emergencies to be addressed by the DOE emergency management program for the facility. If facilities have sufficient quantities of hazardous materials, some of those types of emergencies (e.g., accidents, natural phenomena, fires) will have the potential to cause the airborne release of hazardous materials with significant health and safety consequences outside the facility. Thus, the Hazards Survey for a facility provides an initial set of *potential release events and initiators* to be considered for analysis.

Initiating events and failure mechanisms considered in the hazards assessment should include traditionally defined “accidents,” as well as events arising from external causes and malevolent acts. Scenarios should be included that represent both the success and the failure of control measures and engineered safety systems (e.g., containment systems, fire suppression systems, filters, administrative controls, safeguards and security systems). A minimum set of events is recommended for analyzing hazardous material releases identified as candidates for a hazards assessment. The events that are appropriate to the specific facility should be selected from the following groups:

1. **"Accident" Events**:

   - Fire
   - Explosion
   - Loss of confinement or containment (i.e., spill or atmospheric release)
   - Process upsets
   - Criticality
   - Onsite transportation accidents

   "Accident" event initiators include failure causes such as corrosion, manufacturing defects, malfunctioning equipment or control systems, interaction of reactive materials, external impact, incapacitation of workers, and procedural or human error. (The analysis of onsite transportation accidents is addressed in Appendix D).

2. **Natural Phenomena Events**:

   - Earthquakes
   - Tornadoes
   - Lightning and Hail
   - Floods
   - Winter Storms

   Most natural phenomena events to be analyzed can be selected from the SAR/SAD/DSA (if available) for the facility. Typically, two events are defined for each type of natural phenomenon - DBE used to determine safety control systems, as well as an "extreme," beyond-DBE, considered "incredible" in SAR/SAD/DSA analysis. Both events are derived from historical data. If no SAR/SAD/DSA is available, the event(s) can be obtained directly from historical data for the region.

3. **External Events**:

   - Wildland fires
   - Aircraft crash
   - Offsite transportation accidents
   - Offsite commercial facility or utility accidents

External events have the potential to be the initiating event for the onsite release or loss of control of hazardous material, either directly or by disruption of operations or processes onsite. Historical data can provide information on the susceptibility of the area to wildland fires and potential aircraft sizes can be determined from experience with aircraft operating in the vicinity. A review of road, river, and railway transportation networks near the site boundary (or through the site) provides indications of potential hazardous material transport accidents. In addition, nearby commercial facilities or utilities (e.g., chemical plants, pipelines, water treatment plants) may contain hazardous materials that pose a threat to facilities onsite.

4. **Malevolent Events**:

   - "Minor" Scenario
   - "Moderate" Scenario
   - "Extreme" Scenario

   Malevolent events (e.g., vandalism, sabotage, terrorism), including the use of explosives or flammable material, are possible hazardous material release initiators within the scope of the emergency planning and the EPHA. Appendix E provides guidance on the selection of malevolent event scenarios.

High-probability, low-consequence events should be addressed in facility emergency plans (and in EPHAs) because of their potential impacts on workers in the affected facility and those nearby. Both malevolent events, which are seldom analyzed in SARs/SADs/DSAs, and beyond-DBEs should also be included in the EPHA. "Extreme" malevolent events and beyond-DBEs typically represent the upper end of the consequence spectrum for which prompt recognition and response may be essential to the mitigation of both the event and its health and safety consequences. Emergency management represents the "last line of defense" in protecting workers and the public, and, hence, emergency events or conditions ***should not*** be excluded from EPHA analysis, based solely on calculated occurrence probabilities or designation as "*incredible*" or "*beyond extremely unlikely*".

Some catastrophic events (e.g., a dam failure that floods an entire site, meteor strike, nuclear detonation) may be candidates for exclusion from emergency management planning, not simply based on a probability criterion, but on the grounds that the consequences of the initiating event will effectively overwhelm or negate the planned initial (early) phase response to any resulting release of hazardous materials. In such circumstances, the initiating event itself and its immediate safety implications become the overriding priority and focus of any initial response activities. For such events, mitigation of which is expected to be well beyond any site's response capabilities, the principal function of the local (site/field element) emergency management component is to recognize the occurrence and initiate earliest possible notifications of DOE Headquarters and others. Those notifications may best be initiated by declaring an OE classified as a General Emergency. However, it is neither necessary nor useful to attempt

a quantitative analysis of the hazardous material consequences of such catastrophic events in the EPHA to provide a consequence estimate as the basis for the emergency classification. General criteria for the classification of catastrophic events can be included in site EAL procedures or higher-level management directives based on a ***qualitative*** assessment of the type and magnitude of events and expected consequences.

2.5.2 Selection of a Spectrum of Scenarios

A process consisting of the following sequence of steps is an acceptable method for selecting a spectrum of scenarios related to the hazardous materials in the facility: identify MAR(s) in the facility; identify primary barrier(s); select failure mode(s); identify initiating event(s); and identify release condition(s). This selection process is described in detail below.

A. Identify MAR(s) in Facility

The selection process begins by identifying the hazardous substances at each location within the facility. Each quantity or unit of a hazardous substance is the Material-at-Risk (**MAR),** as that term is used in DOE-HDBK-3010-94 (and discussed in Section 2.6, below), for one or more possible release scenarios. Examples of **MAR**s include:

- *Nitric acid* in an outdoor storage tank
- *Radioactive liquid* in a waste processing system
- *Chlorine* in a cylinder attached to a gas manifold
- *Solid radioactive waste* in a waste accumulation area

A facility can contain one or multiple **MAR**s. In some instances, the **MAR** for an event affecting the entire facility (e.g., earthquake, fire) might include all the material located in the facility. This will be addressed in the discussion of the source terms in Section 2.6.

B. Identify Primary Barrier(s)

The physical or administrative features that maintain the hazardous substance in a safe condition should be identified for each MAR. The *primary barrier* is generally the one physically nearest 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, that form or structure can be regarded as the primary barrier.

C. Select Failure Mode(s)

Failure modes are the ways in which the primary barrier might lose its integrity or its ability to perform the function of controlling or confining the hazardous material. Failure modes should be selected that are applicable to the primary barrier for the particular **MAR** being addressed. The following are examples of failure modes of the primary

barrier that might apply to the **MAR** examples given above and the types of release that might be produced:

- ***Puncture*** (of the nitric acid tank, causing spill of liquid)
- ***Fatigue crack*** (in the pipe carrying pressurized radioactive liquid, causing spray leak)
- ***Impact fracture*** (of the chlorine cylinder stop valve, venting a pressurized gas)
- ***Combustion*** (of solid radioactive waste material, releasing contaminants)

For radioactive materials, identification of the failure modes is necessary to make use of the source term information from DOE-HDBK-3010-94. It also helps align the EPHA consequence calculations with authorization basis safety analyses, a key element in the integration of facility hazards analyses. See DOE-HDBK-1163-2003, *Integration of Multiple Hazard Analysis Requirements and Activities* for guidance on this subject. Selecting failure modes and their size/degree is also an initial step in modeling chemical releases using calculation methods such as those described in EPA 550-B-99-009, *Risk Management Program Guidance for Offsite Consequence Analysis.*

The first and most important failure mode to be identified for each **MAR** is the one that produces the bounding (largest possible) source term, either in terms of total amount of material released or the rate of release to the environment. For facilities covered by authorization basis safety analyses, this case is likely to correspond to an analyzed bounding event (DBE or Beyond-DBE). Using the earlier **MAR** and failure mode examples, reasonable bounding source terms might correspond to the following cases:

- Spill of the entire contents of the nitric acid on a flat surface at the highest average daily temperature, producing the largest expected evaporative (airborne vapor) source;
- Spray from a pipe crack of the size that will produce the maximum mass release rate of respirable-size aerosol droplets, continuing for a time corresponding to the expected duration of the liquid transfer operation;
- Release of the entire contents of a chlorine cylinder over a period of 15 minutes (the averaging time used for comparison with the applicable exposure criterion); and
- Burning of the entire contents of a waste accumulation area, with release of the bounding fraction (from DOE-HDBK-3010-94) of the largest amount of radioactive material expected to be in the waste material.

Once the bounding release is identified, one or more additional cases may be needed to adequately represent the range of possibilities. If the consequences of the bounding case are below the threshold for classification at the Alert level, there is little reason to analyze additional cases because any smaller releases will also fall below the threshold for

classification. However, this may only become evident when final consequence calculations are performed.

The following represents a set of failure modes that might apply to a nitric acid tank:

- Puncture (or crack) low on the tank, which would produce an evaporative source limited by the area of the confinement curb/berm
- Puncture/crack at a higher level, which would produce splash/spray source of aerosols, in addition to the evaporative source
- Overturning/toppling, such that all or most of the tank contents end up outside the curb, producing a larger evaporation surface and source

The choice of the spectrum of sizes or degrees of failure (modes) that will apply to the **MAR** under consideration is the ***key*** to the selection approach. If this initial selection of the "spectrum" of failure modes is done carefully and methodically, based on a clear understanding of the features/characteristics of the primary barrier and the **MAR**, then the spectrum of selected scenarios that is the final product of the process will provide a solid foundation/basis for emergency planning.

The results of this step include combinations of MAR and *failure mode* for each MAR and its associated failure modes identified in the facility.

D. Identify Initiating Event(s)

The next step in the process is to identify initiating events/conditions that could apply to each failure mode (i.e., cause the failure). The analyst should postulate a range of initiators applicable to the specific facility/site or activity, starting with the guidance presented in Section 2.5.1 and identifying those that could produce the failure mode under consideration. (Malevolent event initiators should not be considered at this time, but will be addressed in accordance with the guidance in Appendix E.) In addition, the analysis should indicate whether a specific failure mode would be exclusively or most likely associated with a particular initiating event or condition, OR, conversely, if that particular release could **NOT** result from a certain event/condition.

Examples of initiating events that might be considered include: fire, explosion, loss of electrical power, material/manufacturing defect, operator error, and natural phenomena impacts. (Cf. Section 2.5.1) For example, a "puncture" failure of the nitric acid tank might result from impact by a truck or forklift, which, in turn, might be attributed to human error. The puncture might also be caused by a natural phenomenon (wind-driven missile) or an external event (gas explosion in a nearby facility). This step associates one or more initiating events or conditions with the failure mode under consideration.

This step results in a set of failure modes (for a particular **MAR**), each associated with one or more initiating event(s) or condition(s), that is, combinations of MAR, *failure mode*, and *initiating event.* The next step identifies the last parameter(s), which

represents factors that influence the release of the material to the environment (i.e., outside the facility/building).

E. Identify Release Condition(s)

Events or conditions that could influence the progression of the scenarios identified above, or alter the magnitude or nature of the associated consequences, should be identified in this step. These events or conditions, referred to as ***release conditions***, represent the status or functional condition of structures and mitigation systems consistent with the impact/influence of the chosen initiating event. These release conditions can affect the magnitude, rate or location (elevated vs. ground level) of the release to the environment. 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 release conditions might affect the degree of damage to the facility or quantity of hazardous material released.

In the nitric acid tank example, an installed curb or berm may limit the size of the spill and hence the evaporative source. The release rate will depend on whether, for the particular initiating event under consideration, the curb/berm can be expected to limit the pool surface area. Whereas puncture of the tank by one event (missile) might reasonably be expected to spill the contents within the curb/berm, thereby limiting the pool surface area and evaporative source, a seismic event might overturn (topple) the tank, causing all or part of the liquid to spill outside the curb where it could spread out and evaporate from a larger surface area.

If the operation of an engineered feature can be determined at the time of an event, then the performance of the mitigation feature (and the resulting source term mitigation) is known. If the ultimate release to the environment accounting for the mitigation is sufficiently different from any other analyzed case, then separate analysis cases should be identified that represent the performance and the non-performance of the mitigation function. For bounding events that correspond to a safety basis DBE, the performance of the design features that were credited in that analysis can often be determined from the SAR/SAD/DSA, and additional analysis cases can be constructed that take into account different degrees of mitigation.

For example, a filtered ventilation exhaust via an elevated release point will reduce consequences from a release inside a building by removing part of the airborne aerosol and allowing greater dispersion of the plume before it encounters a ground level receptor. If the spray leak discussed above occurs inside a building and the ventilation exhaust function is maintained, one source term (and release point) would apply. If the exhaust system does not operate and the structure is damaged, a second case would have to be identified in which the release occurs at ground level and is unfiltered. If the exhaust system does not operate but the structure remains intact, a third case may even be needed to represent attenuation of the source term by static confinement.

The identification of release conditions is the final step in the selection of a spectrum of scenarios for analysis. The set of release scenarios (or cases) selected for detailed analysis will consist of combinations of MAR, *failure mode(s),* identified *initiating event(s),* and, finally, identified *release condition(s)* that may influence the location or magnitude of the release. The next step (Step 4) involves the analysis of each release scenario/case [i.e., MAR-*failure mode-initiating event-release condition(s)* combination] to characterize the release to the environment by producing an estimate of the source term, calculating the consequences, and identifying recognition factors (if available) for each scenario.

2.6 Analyze Scenarios (Step 4)

Once the full range of possible releases has been identified and representative cases selected in accordance with the preceding sections, each case should be analyzed and the potential consequences should be calculated to determine the areas potentially affected and the need for personnel protective actions. In addition, the analysis includes the identification of recognition factors for each scenario and the development of a final set of technical planning basis scenarios using the previous analyses of consequences and recognition factors.

This step in the hazards assessment process consists of the following analysis components:

- Estimate source term
- Calculate consequences
- Identify recognition factors
- Finalize technical planning basis scenarios

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

2.6.1 Estimates of Source Terms

The source term (i.e., release to the environment) associated with MAR primary barrier failure mode(s), initiating event(s), and release condition(s) should be calculated. For each possible failure mode of the primary barrier (for example, puncture, corrosion/ oxidation, explosive shattering), the release fraction or release rate values from the DOE source term handbook, DOE-HDBK-3010-94. can be used to estimate the amount of radioactive material that would become airborne. Selection of failure mode and size are implicit in the modeling choices that need to be made to calculate chemical releases using

methods such as those described in EPA 550-B-99-009, *Risk Management Program Guidance for Offsite Consequence Analysis.*

Radiological Source Terms. After failure modes have been identified for the primary barrier or containment system associated with each hazardous material, a quantitative estimate of the source term, the amount ultimately released (or rate of release) to the environment, can be developed using the method described in DOE-HDBK-3010-94. The source term is defined as follows:

$$ST = MAR \times DR \times ARF \times RF \times LPF$$

Or

$$ST = MAR \times DR \times (ARR \times t) \times RF \times LPF$$

Where:

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

Material-at-Risk (MAR). For each initiating event, develop a quantitative estimate of the Material-at-Risk (MAR), the amount of material available to be acted on by a given physical stress. The maximum inventory that may be affected by the initiating event is typically used to represent the MAR. For a given analysis, the MAR will be based on factors such as the type and magnitude of the initiating event, the spatial distribution (separation) of the inventory, and administrative controls. For example, consider a facility with a process line producing items that are placed in shipping containers and then transferred to a shipping/receiving area. The MAR for an event affecting the entire facility (for example, a catastrophic earthquake) might include all the material in the process line, all the product in shipping containers still within the process area, and all the product material stored in the shipping/receiving area. The MAR for an explosion in the process line might be the maximum quantity allowed by administrative controls for that process. The MAR for a handling mishap involving a single shipping container might be either the physical capacity or the licensed maximum contents for that type of container.

Damage Ratio (DR). The Damage Ratio is the fraction of the MAR impacted by the actual conditions under evaluation. The DR is usually estimated based on engineering

analysis of the response of the materials involved to stresses of the type and level generated by the event. The DR value will depend on the specific initiating event and the definition of MAR for that event/condition. In the example above, if the MAR for a handling mishap involving a single shipping container were defined as the contents of one container, the DR for a puncture of that single container would be one (1). On the other hand, if the MAR is defined to include all the material in "n" shipping containers subject to handling mishaps, the DR for an event that punctures a single container is 1/n. DOE-HDBK-3010-94 provides information on DRs for various phenomena.

Airborne Release Fraction (ARF). The ARF is the fraction of material suspended in air following physical stress from a specific event. For events of short duration, the ARF is a fraction of the material affected (i.e., of the MAR times DR). For processes that act continuously over a period of time to suspend aerosols (such as aerodynamic entrainment or resuspension) a release rate is required to estimate the consequences. ***Airborne Release Rates (ARRs)*** are based on measurements over an extended period of time from a particular mechanism. Recommended ARF and ARR values are published in DOE-HDBK-3010-94 for a variety of release phenomena.

Respirable Fraction (RF). The Respirable Fraction is the fraction of the airborne material that can be inhaled and thereby contribute to the radiation dose to an exposed person. The RF is commonly defined as the mass fraction of the airborne material that is in the form of particles of 10 micron Aerodynamic Equivalent Diameter (AED) and smaller. 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 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.

Leak Path Factor (LPF). The Leak Path Factor quantifies the combined effects of any secondary barriers and other 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.

Realistic values should be used in developing the LPF for the particular event. To determine the overall LPF, the effectiveness of individual barriers and mitigating features should be estimated. 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, while other scenarios may involve damage to the walls, resulting in part of the release being unfiltered. The methods described in EPA 550-B-99-009, *Risk Management Program Guidance for Offsite Consequence Analysis,* Appendix D, may be used to represent the effect of building confinement.

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, RF and ARR values derived in other safety documents can also be used in the hazards assessment. If no specifically applicable values can be found, the final release fraction values for Hazard Category 2 cited in DOE-STD-1027, Attachment 1, may be used to represent the ARFxRF.

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 and it will be necessary to derive values for these parameters from material properties using basic physical and chemical principles. EPA 550-B-99-009, *Risk Management Program Guidance for Offsite Consequence Analysis,* contains useful information on modeling a number of different toxic gas and liquid release phenomena. Alternatively, any of several computer codes can be used to determine chemical source terms and to model their transport and dispersion. Many of the available models are described in *Directory of Atmospheric Transport and Diffusion Consequence Assessment Models,* FCM-I3-1999, Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCMSSR), March 1999, available at: http://www.ofcm.gov/atd_dir/pdf/frontpage.htm.

Chemical source terms for reaction product formation (e.g., two chemicals spilling and mixing) are normally determined by manual calculation using conservative assumptions regarding the rate and completeness of the reaction. Models or analysis techniques used to develop chemical source terms should be documented and the justification for their use provided.

2.6.2 Consequence Calculations

After all identified combinations of MAR, failure mode(s), initiator(s), and release condition(s) have been considered and the associated source terms recorded, the consequences of each release scenario/case, for which a source term has been estimated, should then be calculated and recorded.

Methods and Models for Consequence Calculations. The consequences of hazardous material releases should be estimated using models and calculation 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 at the facility should be used to conduct this hazards assessment. The selection of dispersion and consequence models should be justified in the EPHA 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 model capabilities with regard to factors such as plume buoyancy, dense gas effects, building wake, surface roughness, gravitational settling, and dry deposition should be described.

As previously indicated, a listing of available codes is provided in *Directory of Atmospheric Transport and Diffusion Consequence Assessment Models*. 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.

- Dose Conversion Factors (DCFs) and exposure parameters embedded in radiological computer codes should be verified to ensure that they are consistent with the desired results [e.g., total effective dose equivalent (TEDE) or committed effective dose equivalent (CEDE)]. DCFs from current International Commission on Radiological Protection (ICRP) publications should be used for consequence calculations. The same DCFs should be used to calculate onsite (worker) and offsite (public) doses for the EPHA (see Appendix F).

- If computer codes are used to calculate chemical consequences, inputs and model choices representing the release (source term) should be selected to ensure that the output (predicted concentration) values are consistent with the criteria against which they will be compared (15 minute time-weighted average concentration). See Appendix F for additional guidance on selecting consequence criteria and computing time-weighted average concentrations.

- For chemical mixtures and ***concurrent releases*** of different substances, the consequences should be assessed using the SCAPA default methodology for analysis of airborne exposures to mixtures (see Appendix F). ***Concurrent releases*** should only be analyzed <u>if a plausible scenario exists by which quantities of different substances, each exceeding a laboratory scale threshold discussed in Appendix A, could be released from the same location at the same time</u>. ***Concurrent releases*** of dissimilar substances that, because of separation by distance or physical barriers, could result only from *extreme* malevolent acts or *catastrophic* events (such as major fires, airplane crashes, severe natural phenomena impacts, and building collapse) ***need not be analyzed***.

- 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.

<u>Dispersion Conditions For EPHA Calculations</u>. At least two sets of dispersion conditions should be considered in computing consequence versus distance for each source term:

- <u>Conservative Conditions</u>. The first case of an assumed ground level release should correspond to the 95 percent *worst-case* relative concentration (X/Q) based on an appropriate wind speed and stability combination for the particular site. If such a determination has not been made for the site, default to a wind speed of 1 m/sec (measured at a height of 10 meters) and Stability Class F to approximate the 95^{th} percentile X/Q.

For an elevated release, the conservative condition may need to be determined by trial. In general, the conservative condition should be the combination of stability class and wind speed that results in the ground level consequence exceeding the Protective Action Criterion (PAC) at the greatest distance from the source. However, if the PAC is not exceeded at ground level, the conservative condition should be that which produces the highest consequence to a ground level receptor. If the dispersion condition meeting the above criterion occurs significantly less than 5 percent of the time at the source location, a less severe combination of wind speed and stability that might be expected approximately 5 percent of the hours in a year may be selected for the conservative case.

- Average Conditions. 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 the selected conservative dispersion condition should be used to develop EALs and default (i.e., pre-planned) initial protective actions and to determine the size of the EPZ. Use of direction-specific atmospheric dispersion factors for these purposes is strongly discouraged. Consequences calculated using average dispersion conditions are for general reference and response planning purposes only. The "typical" or "average" results are used in conjunction with the "conservative" case results to 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.

In general, the use of real-time meteorological conditions as a factor in determining event classification and initial protective actions is not encouraged. Doing so requires a sophisticated understanding of the local atmospheric transport/dispersion environment, as well as accurate information on current meteorological conditions and a high degree of confidence in the forecast. It also complicates, and potentially lengthens, the decision processes. The need for reliable real-time weather information and on-call meteorological expertise, together with the added complexity of the decision process, make such an approach unsuitable for reaching timely, conservative and anticipatory classification and protective action decisions as required by DOE emergency management policy.

Consequence Calculations for EPHAs. Consequences of each radiological and chemical release should be calculated and summarized in the form of a graph or table that gives the dose (TEDE) or concentration (the highest 15-minute time-weighted average concentration) versus distance, extending out to a distance beyond which PACs [i.e., (Protective Action Guides (PAGs) for radioactive materials; and AEGLs, ERPGs, or TEELs for chemicals] are exceeded (Cf. Appendix F). These summarized results can then be used to estimate consequences at receptor locations relevant to each facility, including the facility boundary and nearest site boundary. This data can be used during a response to estimate (interpolate) consequence values at other locations rapidly.

Consequences at the facility boundary and nearest site boundary are used for determining the emergency classification and developing EALs corresponding to each analyzed event. In addition to calculating consequences at specific receptors, the maximum distances at which consequences exceed the applicable PAC are used to develop default (i.e., pre-planned) initial protective actions. Maximum distances at which consequences exceed the PACs and Thresholds for Early (acute) Lethality (TELs) (Cf. Appendix F) are both considered in developing EPZs. The distances at which PACs and TELs might be exceeded under the most severe credible accident conditions are important considerations in defining the EPZ.

Consequences at Receptors of Interest. Calculation of consequences at key receptors provides the emergency planner with essential parameters that impact classification decisions and protective action determinations.

Facility Boundary. Conceptually, the facility boundary is the line of demarcation between the facility, together with its immediate vicinity, and the remainder of the site. The consequences at the facility boundary distance are used to distinguish 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. For purposes of determining the appropriate emergency class for postulated hazardous material releases, a distance of 100 m should be used to represent the facility boundary. Other considerations in defining the facility boundary are discussed in Appendix C.

For determining which release scenarios warrant declaration of an Alert, the analyses should estimate the doses and concentrations at the facility boundary or within the facility boundary at about 30 m from the point of release, depending on the specific criteria selected for defining the Alert for all facilities at the site (Cf. DOE O 151.1C).

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, such as roads, visitor centers, parking lots; commercial (non-DOE/NNSA) facilities and operating areas on the site; and
- Emergency response facilities, such as Emergency Operations Centers (EOCs), evacuation staging areas, medical aid stations, or fire stations.

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 PAC at or beyond the site boundary is to be classified as General Emergency because of the need for full involvement of 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 C.

Other Offsite Receptors. These include locations or facilities that represent specific emergency planning/response problems or issues, such as schools, hospitals, nursing homes, prisons, industrial complexes, evacuation routes, major transportation facilities, EOCs, and concentrations of population. Offsite receptors relevant to the ingestion exposure pathway should include dairy farms, orchards, truck farms, and public water supply intakes.

2.6.3 Identify Recognition Factors

While identifying and analyzing potential release scenarios and their consequences, any means or *recognition factors* (i.e., *observable indicators*) by which an analyzed scenario or a distinct variation of it might be detected and recognized should be recorded. These recognition factors may include such things as direct human observation of the initiating event or the barrier failure, effluent monitoring instrument readings, physiological effects experienced by persons exposed to the hazardous material, or building (structure) damage expected to cause failure of the barrier (such as roof collapse on a building with contaminated ventilation ducts and filters). To the degree possible, the analyst should record the *level* or *value* for each indication that would be associated with the analyzed scenario (such as the specific reading on a pressure gage or observed liquid level in a tank). Many hazardous material releases will be first identified and recognized by outward indications of the "initiating event."

Although the analysis and documentation of recognition factors is completed only after the source term estimate and consequence calculations are done for the final set of scenarios, the validity of the observables (as indicators for specific scenarios) will have been examined to some degree during the process of scenario selection. Recording the results of that examination as it is being done can eliminate the need to repeat the effort during the final phase of the scenario analysis.

For each analyzed scenario (i.e., for each combination of MAR, failure mode, initiating event, and release condition), recognition factors should be identified, if available. DOE G 151.1-4, Chapter 4, provides further guidance on the nature of the recognition factors and how they are used in developing EALs.

2.6.4 Finalize Technical Planning Basis Scenarios

The final step in the analysis involves the exclusion of scenarios that represent nearly duplicate consequences or no unique observable indicators that allow them to be distinguished from another case. This review process causes each possible combination of **MAR**, barrier failure mode, initiating event and release condition(s), including the consequences and recognition factors, to be actively considered and then either retained as part of the technical planning basis or discounted. In general, a case would be retained if:

1. The consequences are sufficiently different from other case(s) that it would be classified at a different level,

AND

2. The recognition factors are sufficiently different that the case could be reliably classified at a level different from other case(s) (i.e., the case could be distinguished from other analyzed cases within a short time after occurrence).

In other words, all of the scenarios might not be unique in terms of the key emergency management characteristics, namely, the consequences and the recognition factors. If two scenarios were not distinguishable using observable indicators, then the one with the most severe consequences would be selected. On the other hand, if two cases have nearly the same consequences, then only one need be included in the planning basis. The general or specific reasons for discounting cases (or groups of cases) should be recorded for future reference.

If the selection of analysis cases is done by applying the above tests to each possible combination of MAR, failure mode, initiator, and release condition(s) at the time the case is conceived in the logical sequence of steps of the methodology, then it may not be necessary to describe and tabulate the entire set of combinations. Many combinations could conceivably be eliminated as the step-by-step process is accomplished using the criteria described above. The approach described in this section lends itself to this modification for the experienced analyst or as the analyst becomes more experienced with the process and analysis results. Using either approach, however, the analyst should arrive at the same final set of analyzed scenarios.

2.7 Document the Results of the Analysis (Step 5)

In documenting EPHA results, it is necessary to consider the different uses of the information developed by the hazards assessment process. The emergency planning and preparedness staff will use the information to create emergency plans and response procedures that are commensurate with the analyzed hazards. As the facilities and hazards evolve over time, future planners (and future hazards assessment analysts) will need to maintain and update the EPHA, plans, and preparedness elements. The emergency management staff may be called upon to explain and defend the hazards assessment process and results to their own management or to evaluators, both internal and external. The documented EPHA should provide solid and convincing evidence that the emergency management program is based on a thorough understanding of the facility-specific hazards.

2.7.1 General Scenario Documentation Guidelines

Each analyzed scenario should be documented in enough detail that, if necessary, the consequence calculations can be modified or recreated later by someone who does not have access to the original analyst or the supporting non-report documentation

(e.g., notes, printouts). Scenario information needed to explain, reconstruct, and revise the analysis should include:

- A brief narrative containing key facts that define each scenario, such as the location, the hazardous material, initiating event (including size or magnitude) and any contributing or mitigating factors. If applicable, the origin of the scenario (SAR/SAD/DSA section, hazards analysis, etc.) should be identified.

- Any assumptions (explicit or implicit) that enable or support the analyses.

- The source terms, including the SAR/SAD/DSA scenarios (if any) to which they correspond. If applicable, values for the MAR, DR, LPF, ARF/ARR, and RF should be recorded, along with the bases for their selection.

- Release characteristics (such as effective height, duration, building wake effects, stack exit velocity, plume buoyancy) and reasons for making the necessary modeling choices.

- Atmospheric transport and exposure model inputs (such as wind speed measurement height, surface roughness, sampling time, exposure pathways, dose conversion factors) and the bases for their selection.

- The consequences of the release at distances and locations of interest.

2.7.2 Documented Basis for Emergency Action Levels (EALs)

Background. Frequently, the emergency planning staffs develop facility EALs, in concert with facility personnel. Because the analyst(s) responsible for producing the EPHA may not be available to contribute to EAL development, the documented hazards assessment should include all the information needed by the planning staff to construct an integrated set (system) of EALs covering the full range of possible facility emergencies. In addition to factual information and descriptions (from the facility description and hazard characterization sections) and the calculated consequences of postulated events, analysts should document their reasoning and insights. Of particular importance to EAL development are analyst insights and conclusions regarding similarities and differences between the analyzed scenarios, the features or elements that comprise each scenario, the outward indications and the consequences associated with those scenarios. For example, the analyst might note that the same event occurring in two different locations (and thus, involving different MAR or different degrees of mitigation) will have very different consequences. If the analyst further determines that there are indications by which one variation of the scenario might be promptly distinguished from the other at the time of occurrence, the two events can be placed in different emergency classes for planning purposes. However, if the analyst determines that there would be no timely, reliable means of distinguishing between the two scenario variations, that conclusion should be documented as part of a rationale for conservatively applying the higher classification to both events.

All relevant facts and analysis results, including the analysts' insights, interpretations, and conclusions should be summarized in an "EAL logic" section that provides essential information needed by the planning staff to develop and maintain facility EALs. The EAL logic should be a concise presentation of the rationale by which the results of the representative analysis cases can be used to create EALs to classify the full range of possible emergency conditions. The EAL logic is the documented link (or "bridge") between the EPHA results and the EAL statements.

Information Requirements. Much of the information needed to support development of EALs is not directly utilized or produced in the process of selecting scenarios and calculating consequences. Therefore, it will not necessarily be completely captured and documented during those steps of the hazards assessment effort. In order for analysts to recognize and preserve key information, they should understand how the products of their efforts would ultimately be used to develop EALs and other elements of the emergency management program. Following are specific types of information that analysts should recognize and preserve for later use in constructing the EAL logic.

- Any means (indications) by which an analyzed scenario or a distinct variation of it might be detected and recognized. Examples include noise, direct visual observation, instrument readings, alarms, and physiological effects on exposed people. To the degree possible, the analyst should record the *level* or *value* for each indication that would be associated with the analyzed scenario (such as the specific reading on a pressure gage or observed liquid level in a tank).

- The timeliness and certainty with which each indication would/could be recognized at the time of, or shortly following, onset of the scenario. The analyst should record whether a particular indication would or might (and under what conditions) be associated with the analyzed scenario. Indications that would not be available within minutes of an occurrence (such as results of laboratory analysis of samples) should be noted. The analyst should understand that while ***any*** indications of the analyzed event/condition may be useful to the planners developing EALs, indications that are prompt, unambiguous, and reliably associated with the event/condition will be most useful.

- Any other events or conditions that would have the same consequences, or for which the consequences can be inferred or extrapolated from the results of an analyzed scenario. Consider, for example, an earthquake-induced building collapse scenario, the source term for which is largely attributable to the crushing of contaminated ventilation ducts and filters. The analyst should recognize that any other event causing major damage to the structure would affect the same MAR (material in ducts and filters), produce the same failure mode (shaking/crushing) and the same status/functional condition of mitigative features (direct release to atmosphere). The analyst might reasonably conclude that ***any*** event involving building collapse or major structure damage would be modeled using about the same parameter values and assumptions used for the earthquake case, thereby yielding the same consequences. Accordingly, the analyst should conclude that the consequences of building/roof

collapse due to high wind or snow/ice buildup would be about the same as for the earthquake, and that the earthquake consequence calculation adequately "represents" that type of initiator and portion of the severity spectrum. By identifying different events/conditions expected to produce source terms that are similar or proportional to those from an analyzed scenario, a small number of carefully chosen representative analyses can provide suitable bases for classifying events across the full spectrum of possible initiating events and severity.

Documentation Approach. The EAL logic should be arranged according to event types sometimes termed "recognition categories" that are used to organize EALs in the facility classification procedure. The event type/recognition category is a short descriptive title or name (such as "fire/explosion," "process upsets" or "natural phenomena") that leads the user of the classification procedure directly to the most applicable EALs, based on the most obvious characteristics of the event/condition. See DOE G 151.1-4, Chapter 4, for suggested EAL groupings.

For each event type the analyst should briefly describe the kinds of events and conditions that make up the event type/recognition category. For example, the "process upsets" event type is usually defined to include events caused by equipment failures, material defect, personnel error, control system failure and loss of power, and so forth. The analyst should then list the scenarios of that type that were analyzed in the hazards assessment and the classification that is indicated by the calculated consequences.

Beginning with the highest classification indicated for any analyzed scenario, the analyst should discuss briefly each of the analyzed scenarios that yielded that classification. Compare and contrast the scenarios with respect to factors such as:

- MAR
- Type and magnitude of the initiating event(s)
- Values of the other parameters that comprise the source term (DR, ARF/ARR, RF, LPF)
- Release pathway and mitigation features
- Time progression of events leading to a release
- Indications by which the event, as well as similar events with higher or lower consequences, could be detected and recognized, including any limitations on the usefulness of those indications as EALs.

Because this discussion is the heart of the documented EAL logic, it should describe the features of each analyzed scenario and what portion of the event spectrum it represents. Events of higher or lower classification involving the same material (MAR) or type of initiating event should be noted. After the EAL "basis" statement is developed (as described below), the discussion should be reviewed and modified as necessary to make

sure that the "basis" statement follows logically from information presented in the discussion.

The analyst should describe the events/conditions of each particular type that require declaration of this emergency class. These descriptions may take several different forms. They may be very specific to a particular analyzed event (such as, "*spill of more than about X gallons of acid*"), they may broadly specify an entire group of events that should be classified at the same level ("*any fire in X Building that is not declared controlled within 10 minutes of initial recognition*") or they may be expressed in terms of an indication that warrants the emergency declaration without reference to the cause ("*release to the environment equal to or greater than X Becquerels per second*").

For each such description, the analyst should provide a succinct "basis" statement that summarizes the information, insights and inferences that support the recommended classification. The basis statement should refer to the facts and insights presented in the "discussion." The basis statements and "discussion" should provide the planning staff with a clear and logical argument for selecting EALs to classify emergencies at each level.

2.7.3 Basis for Planned Protective Actions

As detailed in DOE G 151.1-4, Chapter 7, planned (or "default") initial onsite Protective Actions (PAs) and offsite Protective Action Recommendations (PARs) associated with each EAL should be based on several factors, including:

1. The type of hazardous material involved (radioactive, chemical)

2. The affected area and population characteristics (onsite, offsite, time needed for warning and evacuation)

3. Available options for protective actions (practicality of evacuation, suitability of structures for sheltering, effectiveness of ad hoc measures)

4. The nature of the release implied by the EAL (in progress or imminent, short or long duration, ground level or elevated)

Beyond the documentation suggested earlier in this chapter, little additional information from the hazards assessment process is needed to specifically support development of planned protective actions. The type of hazardous material that would be involved in a particular event should be obvious from the facility description, hazard characterization, and event scenarios. The affected area and population characteristics will come from the results of the consequence calculations, specifically, the distance at which the PAC will be exceeded under adverse dispersion conditions. The available options for protective actions will be determined by the planning staff based on their knowledge of the affected area and population and the locations and types of structures available for sheltering.

In item 4 above, much of the information implied will also be obvious to the planners based on facility descriptions and hazards assessment scenarios. However, the hazards assessment analyst should take care to document any scenario-specific information that will help correlate potential EALs (i.e., the indications by which an actual or potential release would be recognized) with scenario factors that should be considered when selecting planned protective actions. The use of scenario information to develop optimum EAL-specific pre-planned protective actions is discussed in the DOE G 151.1-4, Chapter 7, *Protective Actions and Reentry.*

2.7.4 EPHA Document as a Response Reference

In the early phases of response to a real event, emergency personnel will often utilize the EPHA document in an attempt to understand the event and possible consequences. With scenario information and consequences summarized, the document should serve as a useful tool for initial consequence assessment efforts. Features and information that are particularly useful in this regard include:

- The analyzed scenarios identified using short, descriptive names
- Tabulated consequences of each scenario at key receptor locations
- Graphic or other similar presentations of scenario consequences vs. distance under conservative (adverse) and average (typical) dispersion conditions, including the distances at which the PAC and TELs would be exceeded

2.7.5 EPHA Document Format

The EPHA document should either stand alone as the technical planning basis or incorporate by reference other documented analyses, descriptions, explanations, or justifications. If the latter format is used, the EPHA document should contain all results necessary for directly meeting the emergency management program planning requirements, as would be presented in a standalone version.

If the results of a facility EPHA are included in a site-wide EPHA document, the same documentation of the facility EPHA should be totally included in the site-wide version or fully referenced. A site-wide EPHA document should contain all results necessary for directly meeting the emergency management program planning requirements for each facility covered.

2.8 Special Topics

2.8.1 Smoke from Ordinary Structure Fires

Any structure fires will produce toxic products of incomplete combustion or by-products from the burning of structural materials, preservatives, refrigerants, paint, and so forth. Although fires in office buildings or industrial facilities that do not contain large inventories of hazardous materials may be categorized as OEs, if they result in significant

structural damage with suspected personnel injuries or death, they should not be classified on the basis of the "incidental" hazardous material release.

To determine if a hazards assessment is needed to analyze the release of toxic materials from fires, the results of any formal FHA conducted to meet the requirements of DOE O 420.1B, or the professional judgment of fire protection staff (as may be documented in a building fire pre-plan or run plan) should be considered. If the FHA results or the fire protection staff's assessment suggests that protective actions beyond those normally applied to structure fire response will be needed, the toxic material release should be addressed in an EPHA. (Cf. Appendix H)

2.8.2 Explosives

In general, the blast, missile and burn hazards posed by conventional explosives (and certain other materials like natural gas and propane) are outside the scope of the Hazardous Material emergency management program specified in DOE O 151.1C. Any analysis of hazards from conventional explosives should focus on blast, missile and burn hazards, not the potential airborne release of toxic chemicals. Analysis and planning for those hazards should be done in the context of the facility/site Fire Protection program or other safety programs. Fires involving or threatening conventional explosives should be regarded as imminent blast/missile hazards.

Results of research by the National Institutes of Standards and Technology (NIST) and the U.S. military, as well as Department of Defense (DoD) standards and DOT emergency response guidance clearly indicate that the toxicity hazards from burning explosives are no greater than for many common materials used in structures and furniture and that hazards associated with blast and fragments should dominate the emergency planning concerns for explosives. (Cf. Appendix H)

Based on the above information, conventional (chemical) explosives should be addressed in the following manner:

1. In general, safety/emergency planning for any conventional explosives should be based on the blast and missile hazards and <u>not</u> on the potential for airborne release of toxic chemicals. Any fire involving an explosive should be treated as an imminent blast/missile hazard and the necessary safety measures for the blast/missile hazard implemented.

2. An explosive should be analyzed as a dispersible toxic chemical hazard <u>in an EPHA</u> only if it is used or stored in a form (such as a powder or liquid) that represents a plausible air-dispersible source of the substance.

If an explosion has occurred and there is no potential for another, the most significant safety impacts (blast, shock, missiles) will already have ended and therefore will not be mitigated by the same kinds of protective actions and response measures that are usually applied to hazardous material emergencies (evacuation, sheltering).

2.8.3 Aggregations of Small Quantities of Hazardous Materials

The release of inventories of multiple small quantities of like or unlike hazardous materials (all below the "laboratory scale" threshold) poses an analysis problem in hazards assessments for some DOE/NNSA facilities. A simultaneous release of these quantities of hazardous materials from the same facility or location requires a destructive or energetic event (e.g., fire, explosion, earthquake, structure collapse.) Although such destructive events have the potential to breach multiple containers, the assessment of the impacts resulting from a simultaneous release producing additive effects beyond the local event scene is particularly difficult to quantify because of spatial and temporal separation of individual unit releases, inhibition of the release by structure or rubble, reduction through various release conditions (e.g., scrubbing by fire sprinklers), and other factors.

The uncertainties associated with consequence estimates for these events will be very large and analyses using conventional models and assumptions add little to understanding the hazard. In addition, quantitative analyses are not needed for development of event recognition criteria (EALs) because destructive events necessary to release multiple small quantities are readily recognized by persons most likely to be affected by those releases (i.e., workers in the immediate area and first responders). Conservative, worst-case analyses for simultaneous releases of multiple small quantities cause expenditure of resources on hazards and scenarios of minimal significance and provide little or no useful information to improve planning or response.

The following steps represent a reasonable approach for addressing aggregations of small quantities of like or unlike hazardous materials, each of which is below the "laboratory scale" threshold, in DOE/NNSA emergency management programs. The approach may also be applied to fires that are judged by local fire protection establishment to have the potential for "extraordinary" emissions of toxic combustion products (see Section 2.8.1).

1. In the Hazards Survey, recognize and document the "***HAZMAT***" aspect of possible destructive events involving multiple small quantities of hazardous materials. Building emergency plans and pre-fire plans are the appropriate vehicles for identifying and planning responses to destructive events that would have major, direct human health and safety impacts (blast, burns, entrapment, etc.) and for which hazardous materials in modest quantities would be of secondary concern. Throughout the non-DOE emergency management community such events are routinely managed using standard fire and HAZMAT response methods.

2. ***Define*** certain destructive events (large fire, structure collapse, etc.) to be OEs if it appears that the condition would meet all aspects of the OE definition. The potential "***HAZMAT***" aspect of a destructive event may be used as a **qualitative** factor (i.e., without resorting to quantitative calculations of impact) in defining certain events as OEs.

Quantitative analyses of concurrent releases of small quantities (all below the "laboratory scale" threshold) are typically not warranted because the cost and effort involved in ***accurately*** modeling accident phenomenology on a small scale and the limited

geographic area that could be affected do not add value to the planning and response process.

2.9 Using Safety Analysis Results in EPHAs

To the extent practicable and available, the hazards and accident analysis results from current facility SARs/SADs/DSAs should be used to ensure consistency of the emergency technical planning basis with the facility authorization basis. Careful consideration to use of safety analysis information can both enhance the quality of the EPHA and greatly reduce the effort required for its preparation.

Facility/Process Description. The written description of the facility, processes, hazardous materials and controls can generally be incorporated, in full or in abbreviated form, to provide the most credible and technically sound basis for the EPHA. Properties of hazardous materials (such as concentration, vapor pressure, or unit dose) used for the safety analysis may be adopted for the EPHA without further justification.

Hazards Identification and Analysis. The Hazards Analysis that forms the basis for SAR/SAD/DSA accident selection should be a primary reference for facility hazards identification. The rigorous analysis techniques used for facility/process hazards identification, such as Failure Modes and Effects Analysis (FMEA) or Hazards and Operability Studies (HAZOPs), will often yield a lengthy and detailed list of potential hazards and accidents, along with a qualitative assessment of their consequences. From that list, a few (discussed above) are selected for analysis in the SAR/SAD/DSA to provide the technical justification for engineered and/or administrative controls to prevent or mitigate the hazard. Many of the hazards and accidents identified in the Hazards Analysis will therefore not be addressed in the SAR/SAD/DSA accident analysis section. Events having only non-radiological consequences, those that do not have significant consequences outside the facility, and events that are similar to but with lower consequences than the bounding event of a given type are among those unlikely to receive detailed analysis in the SAR/SAD/DSA. In order for the EPHA to represent the full spectrum of hazards and event severity, hazards identified by the SAR/SAD/DSA Hazards Analysis process (but not addressed in the accident analysis) should be selected for inclusion in the EPHA as needed to fill out the range of potential hazards, consequence/severity levels, and event types.

Accident Analysis. The scenarios and corresponding source terms analyzed in current facility safety analysis documents should be incorporated into the EPHA if consistent with emergency planning requirements and needs. DCFs and exposure parameters embedded in radiological computer codes should be verified to ensure consistency between emergency management and SAR/SAD/DSA results. The SAR/SAD/DSA scenarios will typically represent the maximum or "bounding" event of a given type. If possible, information from the SAR/SAD/DSA discussion or supporting documents can be used to develop variations of the bounding scenario that have different consequences, indications, or initiating events. 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 adjusting for different source terms).

The following examples demonstrate variations in SAR/SAD/DSA scenarios that can provide additional EPHA scenarios without further extensive analysis.

***Example 1*:** The SAR/SAD/DSA calculates the source term for a release to the environment that is mitigated by an isolation system. A second (unmitigated release) case can be inferred from the credited performance characteristics of the isolation system. The unmitigated case would provide a second point on the severity spectrum. The second case will provide information that is most useful for event recognition and classification if response personnel would be able to determine the isolation status at the time of an event.

***Example 2*:** The SAR/SAD/DSA calculates the design-basis fire source term by using the largest of the MAR values associated with several different process areas that are separated by rated fire barriers. Additional cases representing fires in other process areas holding less MAR may be inferred by scaling the source terms for the different MAR values. A catastrophic fire scenario, such as could be attributed to an aircraft crash or extreme malevolent act, might be represented by a source term based on the MAR total for the structure.

3. EMERGENCY PLANNING ZONES

3.1 Background

The DOE Comprehensive Emergency Management System requires the integration of emergency management programs for both radioactive and non-radioactive hazardous materials. Consistent with this approach, an EPZ concept that integrates protective action planning related to all potential hazardous material releases is endorsed as a planning tool. 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.

DOE facilities are subject to EPA emergency management requirements for non-radioactive hazards. It is DOE policy that emergency management for DOE/NNSA nuclear facilities should be consistent with the requirements of the NRC related to radioactive hazards to the extent practicable. Basic planning and response principles, as well as the NRC and EPA requirements and their bases, are considered as background for the guidance provided in this chapter.

The NRC and FEMA have established EPZ requirements for commercial power reactors. The analysis that led to the establishment of the standard radioactive 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 (16 km) plume exposure (airborne) pathway EPZ was adequate because:

1. Projected doses from the traditional design-basis accidents would not exceed PAG levels outside the EPZ;

2. Projected doses from most core melt sequences would not exceed PAG levels outside the EPZ;

3. For the worst case core melt sequences, “immediate life-threatening doses” would generally not occur outside the EPZ; and

4. Detailed planning within the EPZ would provide a substantial base for expansion of response efforts in the event that this proved necessary.

These criteria were developed using the higher PAG levels then in effect (5-rem [50 mSv] whole body, 25-rem [250 mSv] thyroid dose) and are also satisfied relative to the current lower PAG values (1-rem [10 mSv] whole body, 5-rem [50 mSv] thyroid). 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 (16 km).

The EPA has published guidance that leads to the determination of a *vulnerable zone* for non-radioactive hazards. This zone is described by the EPA as the area that may be subject to concentrations of an airborne, Extremely Hazardous Substance (EHS), following an accidental release, at levels that could cause irreversible acute health effects or death to human populations within the area. The EPA guidance defines the *vulnerable zone* in terms of the distance at which a "level of concern (LOC)" would be exceeded because of a release of the hazardous material under severe (conservative) dispersion conditions. A LOC is defined as the concentration of an EHS in air above which there may be serious irreversible health effects or death because of a single exposure for a relatively short time period. LOCs are identified in the EPA guidance for the EHSs listed in 40 CFR 355, Appendix A. The *vulnerable zone* was developed for use 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 concepts developed for DOE facilities.

In the following sections, an EPZ methodology is recommended for DOE facilities that uses the underlying NRC/FEMA/EPA bases for the *radioactive plume exposure (airborne) pathway EPZ* and incorporates planning for both radioactive and non-radioactive hazardous material releases.

3.2 General EPZ Concepts

The designation of an EPZ and the related detailed planning and preparedness activities 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 *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*, EPA 400-R-92-001, May 1992, 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."

In addition, those responsible for establishing the geographic extent of any facility EPZ should note that a larger EPZ does not necessarily provide better protection of the population than a smaller one:

- 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) is 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.

In some cases, specifically the most severe release conditions, protective 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.

3.3 Developing Facility EPZs

An EPZ associated with a particular DOE facility or site is an area within which government and facility managers determine that special planning and preparedness efforts are warranted as a means of apportioning preparedness resources to the areas where they are most needed. As a matter of practical necessity, the EPZ should be developed in cooperation with the responsible local, State, and Tribal authorities, since each has a statutory responsibility to protect its citizens.

Facility 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 local and State authorities.

For those facilities that do not choose the risk-based approach, the EPZ should include as a minimum 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. Hence, the EPZ for each facility should be based on objective analyses of the spectrum of hazards associated with that facility, ***not*** on arbitrary factors such as historical precedent or distance to the site boundary. The results of the consequence calculations described in Section 2.6, geographical and jurisdictional factors, as well as other factors detailed in this guidance can be used to define the ***facility EPZ***.

Following the underlying rationale for establishing the EPZ for commercial nuclear reactors, the integrated EPZ for DOE facilities, which is based on the spectrum of potential radioactive and chemical hazardous material releases, should be of sufficient size that:

a. Protective actions are ***not likely to be required beyond the EPZ for most analyzed events*** (i.e., consequences from most analyzed events are not likely to exceed PACs outside the EPZ);

b. Measures taken within the EPZ would provide for ***substantial reduction in early lethality for all analyzed events*** (i.e., consequences from all analyzed events would not exceed TELs outside the EPZ); and

c. Planning efforts within the EPZ provide a ***substantial basis for expansion*** of response efforts beyond the EPZ, if necessary.

d. The maximum EPZ for any DOE or NNSA facility/site should not exceed a nominal radius of 10 miles (16 kilometers).

The following steps provide a methodology for developing a candidate, technically defensible plume exposure pathway EPZ for DOE/NNSA facilities that implements the basic characteristics of the integrated EPZ as given above.

1. If the results of consequence calculations, done in accordance with Section 2.6, indicate no OE higher than an Alert classification, then an EPZ need not be defined for the facility.

2. From the results of consequence calculations, done in accordance with Section 2.6, determine the maximum distance at which a ***TEL*** would be exceeded for the most severe analyzed release (excluding those, which result from *extreme* malevolent acts discussed in Appendix E) under severe meteorological conditions. This distance, the smallest EPZ radius that should be considered, is denoted EPZ_{MIN}.

3. Next, determine the maximum distance at which a ***PAC*** would be exceeded for the most severe analyzed potential release (excluding those that are "beyond-design-basis" natural phenomena events or which result from *extreme* malevolent acts discussed in Appendix E) under severe meteorological conditions. This distance, the maximum EPZ radius that should be considered, is denoted EPZ_{MAX}.

4. If EPZ_{MAX} is greater than 10 miles (16 kilometers), then the EPZ_{MAX} is set equal to 10 miles (16 kilometers). The value for the EPZ is within the limits EPZ_{MIN} to EPZ_{MAX}.

5. Within the limits of the largest and smallest EPZ radii, EPZ_{MIN} to $EPZ_{MAX,}$ 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 facility/site risk may be used in a semi-quantitative way to determine whether the EPZ size should be closer to the maximum or minimum values as determined in Steps 1-4, 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 F), and the potential for severe irreversible effects resulting from exposure to concentrations between the protective action and lethality thresholds.

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

  - Identification of responsible onsite and offsite emergency response organizations and the mechanisms for activating their services.

  - Establishment of effective communication networks to notify the public within the EPZ and the responsible authorities promptly.

  - 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, to facilitate onsite protective actions, to 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?

As a last consideration, ensure that the underlying *rationale* for establishing the integrated EPZ for DOE facilities (a. through d., page 3-4 above) is generally satisfied for the EPZ determined from Steps 1-5. Document the consideration of each of the tests and any adjustments made to the EPZ. The resulting EPZ and its bases provide the beginning point for discussions with Tribal, State, and local 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. Also, 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.

Finally, the planning process should recognize and provide for the need to refine the initial default protective actions and 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 assist offsite authorities by providing a finer planning and response structure.

4. MAINTAINING HAZARDS SURVEYS AND HAZARDS ASSESSMENTS

Hazards Surveys and EPHAs 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 EPHAs should be reviewed and, as necessary, updated at least every 3 years, and prior to significant changes to the facility/site or to hazardous material inventories. For example, significant changes are those changes which would result in an unreviewed safety question for nuclear facilities, as defined in 10 CFR 830, or in an unreviewed safety issue for accelerator facilities, as defined in DOE O 420.2B. If the change reduces hazards with no adverse effect on safety or emergency preparedness and response, the modifications may be performed at the next scheduled review and update.

- Maintenance of the Hazards Surveys and EPHAs should be monitored through existing administrative processes and commitment tracking systems. A reliable, efficient, and timely method for tracking changes in facility/site or activity operations or processes that involve hazardous materials (e.g., introduction of new materials, new uses, changes in inventories, modification of material environments) should be established and maintained for each facility/activity.

- The method for tracking changes in facility/site or activity operations or processes that involve hazardous materials should allow sufficient transition time for emergency management personnel to review the EPHA and modify plans or procedures, as necessary, to account for changes in the hazardous material situation.

- Methods for tracking changes in facility/site or activity operations may include regular access to current *site-wide inventory records*, special notification procedures for operation or process changes, and/or active involvement of emergency management personnel in the facility/site or activity ISMS. The method can also be linked to the USQ process, which identifies changes in the safety basis of the facility/site or activity.

- Changes in the facility/site or activity safety analysis reports, probabilistic risk assessments, vulnerability assessments, fire hazard analyses, environmental impact statements, and other documents that address facility/site or activity hazards or potential consequences should be integrated with maintenance of the EPHA.

- 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 10 CFR 830.202 and 830.204, and reviews required by 40 CFR 122, National Pollutant Discharge Elimination System (NPDES) or other permit processes. Reviews should be done whenever significant changes to facility, process, or materials inventory occur. For example, significant changes are those changes that would result in an USQ for nuclear facilities, as defined in 10 CFR 830.3(a), or in an unreviewed safety issue for accelerator facilities, as defined in DOE O 420.2B.

- *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 an EPHA exists for the facility, the EPHA 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 calculations, and EALs.

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

- The hazardous material emergency potential associated with facilities undergoing *decommissioning* or *remediation* will decline and become static as the process nears completion. The review and maintenance effort may then be substantially reduced without detriment to the emergency management program by creating a single documented hazards assessment covering a number of facilities of the same general hazard profile and inactive (non-operational) status.

- 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.

5. USING HAZARD SURVEYS AND HAZARDS ASSESSMENTS

5.1 Hazards Survey

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. The Hazards Surveys identify the generic types of emergencies applicable to the facility. From these emergencies, potential OEs can be identified and categorization criteria developed to ensure that the prompt notification requirement for OEs is met. DOE G 151.1-4, Chapter 4, provides guidance on categorization of OEs that do not require classification. Existing site-specific Occurrence Reporting and EAL procedures provide a framework within which the 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 OEs *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 OEs *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 and Recovery Act (RCRA), CERCLA, NPDES, and OSHA requirements. However, the Hazards Survey and its periodic updates, as a minimum, should serve as an internal quality assurance check on compliance with those regulations. Facility/site 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.

5.2 Emergency Planning Hazards Assessment (EPHA)

Since 1991, DOE emergency management orders have incorporated the concept of ***tailoring*** requirements to specific hazards through the "commensurate with hazards" approach. The approach begins with a complete understanding of the emergency situations that could impact DOE facilities/sites or activities, followed by analyses of the resultant hazards to workers, the public, and the environment. Based on completed EPHAs, the requirements in the current Order (i.e., DOE O 151.1C) are tailored to

develop an emergency management program (e.g., plans, tools, training, response, resources) that addresses the unique hazards and operating environment of each facility or activity and consists of the following program elements: program administration, training and drills, exercises, readiness assurance, emergency response organization, offsite response interfaces, emergency facilities and equipment, emergency categorization and classification, notifications and communications, consequence assessment, protective actions and reentry, emergency medical support, emergency public information, and termination and recovery.

Examples of the use of the EPHA output to develop selected program elements are provided below.

- **Training and Drills**. The Training and Drills program, ranging from "general employee training" to Emergency Response Organization (ERO) Manager training should be customized around the EPHA and the Hazardous Waste Operations and Emergency Response (HAZWOPER) programs and their associated program elements.

- **Exercises.** The EPHA provides a ready source of scenarios and source terms for use in developing facility-specific drills and exercises.

- **Emergency Response Organization (ERO)**. The nature and severity of the events analyzed in the EPHA should provide the basis for both on-shift and on-call ERO staffing. Required staffing levels and expertise for functions such as consequence assessment and emergency medical support are directly determined by the hazards present at the facility/site.

- **Offsite Response Interfaces**. In addition to identifying the offsite parties to whom prompt emergency notifications should be made, the EPHA 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.

- **Emergency Facilities and Equipment**. The nature and potential for release of the hazards analyzed in the EPHA 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 models, HAZMAT response vehicles and supplies, and facility data acquisition systems.

- **Classification**. The EPHA provides the quantitative relationships between hazardous material airborne release events and their consequences, as well as the event descriptions and indications that serve as event classification criteria, the EALs.

- **Notification and Communications**. For facilities subject to hazardous material OEs *requiring classification*, the potentially affected areas, the impacts of hazardous

material releases, and the time available to respond will determine the functional requirements for notification systems, procedures, and staff. The need for rapid warnings, notifications, and requests for assistance will determine the required level of sophistication and reliability in communications systems.

- **Consequence Assessment**. The source terms and consequence calculations required for the EPHA will establish the performance requirements for emergency response consequence assessment models and/or methods. Specifically, the response models and methods need to be suitable for the specific hazardous materials addressed by the EPHA over the range of possible release and transport conditions. The EPHA document, or a summary of scenario data and consequences, should be available to responders as a ready source of data on each facility's hazardous material inventory and potential release scenarios.

- **Protective Actions and Reentry**. The EPHA consequence calculation results should be used directly to determine initial, pre-planned (default) onsite PAs and offsite PARs that are specific to each analyzed condition and EAL.

- **Emergency Medical Support**. The hazards analyzed in the EPHA will define the emergency medical support needs, including special preparations such as decontamination supplies; chelating, neutralizing and blocking agents; and medical staff training in treatment of victims exposed to specific hazardous substances.

- **Emergency Public Information (EPI)**. The hazards analyzed in the EPHA and the extent of their impacts will determine the content and geographic coverage of the EPI program. Information will be required on topics such as the nature of the potential hazards, the notifications and communications systems, and protective action plans (e.g., evacuation routes, guidelines for sheltering in place).

Other uses of the EPHA results include:

- Verification and monitoring of facility hazardous material inventories.

- Confirmation of or input to the authorization basis safety analysis.

- Recommendations for minimizing or segmenting hazardous materials inventories.

- Identification and ranking of hazardous material targets to reduce risk and consequences associated with potential malevolent events.

- Inputs to the fire pre-planning and hazardous material spill prevention/cleanup plans.

- Assessing the capability of instruments and effluent monitors to quantify emergency releases.

- Identification of facility and/or procedures changes that would help prevent or mitigate the events analyzed.

APPENDIX C. Facility and Site Boundary Guidelines

C.1 Introduction

The Order defines the OE ***Alert*** classification in terms of releases of hazardous materials to the environment for which it is expected that the radiation dose or concentration in air (of other hazardous materials) is expected to exceed either "10 percent of the applicable PAC … at or beyond the facility boundary" ***or*** "the applicable PAC … at or beyond 30 meters from the point of release to the environment." The terms "releases" and "environment" clearly indicate that the Order intends the consequence criteria to apply only to exposures outside structures or enclosures.

For purposes of emergency planning and classification, the maximum consequences to a hypothetical individual at ground level outside a structure are to be calculated. The hypothetical individual will be standing at a distance of 30 m from the point of any ground-level release to the environment or at the point of maximum ground-level impact (in terms of radiation dose or concentration) for any elevated release.

As used in the Order, the term "facility boundary" denotes a line of separation between the facility (and its immediate environs) and the remainder of the site. The "facility boundary" discussed in this guidance is intended only 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.

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*.

C.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.

To promote consistency of event classification, a standard "analysis radius" of 100 m should be used to represent the facility boundary receptor for all facilities. Using the same facility boundary analysis radius for all facilities ensures that the relationship

between emergency class and consequences is consistent throughout the DOE/NNSA complex.

In a few cases, it may be useful to define a "facility" to include the entire fenced security area that surrounds the structures or activities of interest. If the facility boundary is defined in this way, the minimum distance to the facility boundary from the likely release point(s) should be used as the analysis radius for all consequence calculations. This approach is reasonable if it leads to selection of an analysis radius of at least 100 m, but less than about 200 m, and 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).

C.3 Definition of Site Boundaries

In general, the perimeter enclosing the area where DOE has the responsibility for implementing protective actions 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.

APPENDIX D. Onsite Transportation Analysis

D.1 Introduction

Planning and preparedness for transportation-related hazardous material emergencies on DOE or NNSA sites should be an integral part of the site comprehensive emergency management program. Successful integration requires that the approach to hazard identification, analysis, and the application of the results be consistent with the process used for fixed-facility EPHAs. The purpose of this appendix is to provide specific guidance on the analysis of hazardous material transportation activities on DOE/NNSA sites and the use of the analysis results in emergency management programs.

This appendix is applicable only to onsite transportation activities involving between-facility transfers of hazardous materials. Non-DOE (commercial) shipments of hazardous materials to, from, or across the site are governed by DOT regulations and specifications for commercial hazardous materials transport and do not require a Hazard Survey or Hazards Assessment. Also *exempt* from the Hazards Survey/Hazards Assessment requirements is inter-facility transport of hazardous materials that complies with all *DOT regulations and specifications applicable to the movement of those same materials over public transportation arteries*. Protective actions (i.e., applicable "Initial Isolation" and "Protective Action" distances) for emergencies involving these shipments on DOE/NNSA sites should be determined by information in the DOT ERG, using the substance ID number and Guide number. Analysis requirements for DOE or NNSA shipments moving on or off the site will also depend on the governing DOT regulations and specifications. However, these DOE/NNSA shipments are not covered by this appendix.

The onsite transportation of hazardous materials not exempted by the above criteria may be addressed either in the EPHAs for fixed-facilities with which the materials are associated or in a stand-alone site transportation hazards assessment. In either case, a Hazards Survey of transportation activities is required. The screening process conducted as part of the Hazards Survey effort identifies those hazardous materials involved in onsite transportation activities that require quantitative assessment. If the quantitative analysis of site transportation hazards is documented in one or more of a site's fixed-facility EPHA **or** in the site's Transportation Safety Document**,** the transportation Hazards Survey should identify and reference the specific EPHA documents or Transportation Safety Document section in which specific transportation hazards are addressed.

D.2 Hazards Survey

The Hazards Survey for onsite transportation activities should follow the general steps outlined in Section 1.2, with the following clarifications:

Identify and briefly describe each facility (Step 1).

Instead of "facilities," it is the onsite hazardous material "transportation activities" that should be identified and *briefly* described. The description of each identified transportation activity need only include a brief characterization of the hazardous substance(s) involved, the origin, destination, and mode/method of transport.

Screen hazardous materials to determine need for a quantitative EPHA (Step 2).

In general, hazardous materials in transport are vulnerable to the same types of release and dispersal events/conditions considered in fixed-facility hazards assessments (e.g., fire, spill, breach of containers). Therefore, screening of transportation hazards should follow the process outlined in Appendix A.

Any onsite shipment of hazardous material in a quantity exceeding the applicable screening quantity needs to be quantitatively analyzed in an EPHA to provide the technical planning basis for response.

Identify the generic types of emergency events and conditions that apply (Step 3).

The only type of emergency event that need be identified is "release/loss of control over hazardous materials."

Identify the types of potential impacts of the applicable emergencies (Step 4).

The only potential impacts of the identified types of emergencies that need be identified are "exposure of people to radioactive or other hazardous substances" and "environmental damage/degradation."

Identify and document the applicable Base Program planning and preparedness requirements (Step 5).

List any Federal, State or local planning/preparedness requirements that apply specifically to the transportation of hazardous materials on the site. Such requirements may include:

- Driver certification/training on emergency notification and response;
- Vehicle specifications for certain cargos;
- Means for notifying site authorities in the event of an accident;
- Notification of site authorities prior to specific shipments entering the site;
- Safety/security escorts or route control;
- Emergency management oversight of specific shipments; and

- DOT standards for placards, labels and manifests.

D.3 Hazards Assessment

Repetition should be avoided by consolidating material that applies to all site transportation activities (site description, methodology, etc.) in a single document section, then devoting a separate Chapter or annex to the quantitative analyses of each particular transportation activity. The quantitative hazards assessment for onsite transportation activities should follow the general steps outlined in Section 2.2, with the following clarifications:

Define and describe the facility and operations (Step 1).

The definition and description should be specific to each particular transportation operation involving hazardous material quantities in excess of the applicable screening threshold quantity. The "definition" statement should give the scope of the particular analysis in unambiguous terms. For example: "This analysis addresses the transport of solid radioactive waste generated by the decommissioning activities in the ____ Area to the _____solid waste burial ground."

At a minimum, the "description" of the activity should include:

- The hazardous substance(s) being transported (Examples: sulfur dioxide gas, low-level radioactive waste from laboratory operations);

- General packaging type or container information (Examples: 55 gallon drums, DOT spec 3AL2015 gas cylinders);

- Mode of transport or type of vehicle used (Examples: 2000 gallon tanker truck, enclosed van)

- Onsite route(s) used, including any restrictions (Example: Building 340 to Central Waste Management, via Hazel Street and Route 4. Daylight only)

- Any other controls or restrictions applicable to this shipment type (Example: Driver to notify Security 60 minutes before departure. Speed limit of 35 mph to be observed)

Characterize the hazardous materials (Step 2).

As in fixed-facility analyses, the hazardous material characterization should include those facts and information necessary to support the quantitative assessment of release consequences. Specifically:

- The common name, CAS number, and concentration of hazardous chemicals;

- Radionuclide(s) and concentration, specific activity or unit dose (i.e., dose-per-unit-intake);
- Properties related to release potential and dispersibility (e.g., vapor pressure, boiling point, particle size);
- Typical and maximum (if known) quantities in each package and shipment; and
- Packaging or container information that will help define DR and LPF for different accident types (e.g., cardboard cases of glass bottles, 55 gallon drums, special shipping containers).

Select and analyze emergency events and conditions (Step 3).

The events and conditions that could lead to the release of hazardous materials in transport may be different from those selected for fixed-facility analyses. The following release events should be considered, as applicable:

- Puncture of one or more individual packages/containers during handling;
- Energetic impact of container(s) during collision (crush, rupture);
- Involvement of the entire shipment in fire;
- Detonation/deflagration of materials (if applicable);
- Spill of dry materials; and
- Spill/venting of tanker contents (liquids and pressurized gases).

One or more releases of each applicable type should be analyzed. For a given type of event, only the bounding event need be analyzed if it is determined that there would be no way to distinguish between different release magnitudes at the time of the event (for example, the number of packages breached in a crash followed by fire).

Estimate the consequences (Step 4).

In general, the calculation models and approaches used for fixed-facility analyses are appropriate for transportation analyses. However, because transportation accidents may occur anywhere on the travel route, distances from the point of release to key receptors are not fixed. Consequences of each postulated release should therefore be calculated at 30 m, 100 m, and several other distances extending out to the maximum distance at which the PAC would be exceeded under the “conservative” dispersion conditions.

Transportation event releases to the atmosphere should be modeled using a “standard” or “open country” terrain factor unless the transportation route is entirely within a built-up

area of the site where the "urban" terrain factor better represents the local dispersion environment.

Document the results of the analyses (Step 5).

The results of the consequence calculations should be documented in a manner that makes them useful for interpolating the consequences of actual events at specific locations. Tabular or graphic representations of the data can be very useful to responders for determining the area potentially affected by a release and for executing protective actions. The distance at which the PAC will be exceeded for each scenario should be clearly identified. If an event occurs and the distance to the site boundary or other "public" receptor location) is within the distance at which the PAC will be exceeded, classification as a General Emergency is indicated.

APPENDIX E. Malevolent Events

E.1 Introduction

Malevolent events (e.g., vandalism, sabotage, terrorism), including the use of explosives or flammable material, are potential initiators of hazardous material releases within the scope of emergency planning. In contrast to the randomness of initiators associated with accidents, natural phenomena and other external events, a malevolent, ***intelligent*** initiator can determine where to place explosives or start fires and/or how to use site systems and equipment to deliberately initiate or exacerbate emergency events or conditions. Such premeditated, even suicidal, malevolent events can maximize the impact of a release of hazardous material ranging from use-denial by contamination to serious harm to workers or the public.

The objective of this appendix is to provide guidance for selecting the set of malevolent events to be included in the technical planning basis to ensure that a range of potential releases from malevolent events are reflected in the emergency management program. Not all inventories of hazardous materials have to be evaluated with malevolent event initiators and not all potential malevolent events in a facility have to be analyzed and included in the planning basis or in the set of EALs. In many cases, malevolent event scenarios will produce releases and consequences similar to those that could be caused by accidental, natural phenomena, or other external initiating events. Identifying a malevolent event 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 nearly the same level of damage and resulting source term might also be caused by an act of sabotage involving an explosion and fire in the same location, the malevolent event might simply be considered a second initiator for the same basic fire/explosion condition. In that case, there need be no explicit component in the EAL that reflects the cause of the initiator, because the recognition indicator is the explosion/fire itself, not whether the initiator is an accident or malevolent event.

The selection and analysis of malevolent events, which represents the final step in the development of the technical planning basis, can benefit from the cooperative involvement of facility and site experts representing a broad scope of interested functions, including Operations, programs, S&S, and safety, in addition to emergency management analysts. Of particular importance is the cooperation and active assistance of S&S personnel, who provide essential expertise for interpreting the current Departmental ***Design Basis Threat (DBT)*** policy as it is applied to the specific facility.

An additional benefit of the hazards assessment process is the possibility of revealing opportunities to decrease the likelihood or magnitude of potential malevolent events by implementing active or passive security measures or modifying facility features or procedures. The responsible S&S staff should be made aware of this potentially valuable

byproduct and the hazards assessment analysts should be encouraged to identify such opportunities for improvements.

A general approach is presented in the next section for selecting malevolent events to incorporate in the planning basis for an emergency management program. This selection of malevolent event scenarios is intended to follow the *completed* selection and analyses of scenarios that represent the technical planning basis for the emergency management program based on events from Groups 1, 2 and 3 [Cf. DOE G 151.1-2, Sections 2.5 – 2.6].

E.2 Scenario Selection

The first step in the selection of malevolent events involves the identification of potential threats to each facility involving the dispersal of hazardous materials. Emergency planning analysts should consider any facility with significant quantities of hazardous materials as a potential target of malevolent action. The current Departmental ***DBT*** should be consulted for the characterization/description, capabilities, resources, and intent of potential threats that might be applicable to each facility and its associated hazards. Based on these potential threats, candidate malevolent event scenarios ranging from minor to extreme severity should be developed. Associated with this range of scenarios should be estimates of event initiator capabilities (e.g., explosive capability, flammable material availability, intrusion/disruption capabilities, etc.) that will provide necessary failure modes and source term estimates associated with potential hazardous material releases. If a facility VA is available, analyzed release scenarios should be considered candidates for inclusion in the spectrum events for emergency planning purposes, either as separate analysis cases or by comparison with other cases already analyzed.

The next step in the malevolent event selection process involves applying the malevolent event scenarios to the respective hazardous material facilities and determining the resulting source terms. The estimated malevolent event source terms are then compared with source terms for identified accidental, natural phenomena, or other external initiator scenarios. Where the source term and subsequent dispersal of a potential malevolent event compare closely to other analyzed scenarios, additional quantitative analysis of the malevolent event is not necessary. Any observable indicators uniquely associated with these malevolent event scenarios, however, should be documented for use in EAL development. Malevolent event scenarios with consequences close to other types of scenarios, but having no unique observable indicators, will not appear separately in the EAL set. For example, if a release can be attributed to an accident (e.g., corrosion, human error) or to a malevolent event scenario (e.g., deliberate tampering with controls), and detection of the release itself is the only observable indicator, then a unique malevolent event EAL will not be added to the set of EALs.

Malevolent event scenarios, whose resulting consequences differ significantly from other types of scenarios analyzed, should be analyzed quantitatively, documented, and included in the technical planning basis. [Note that ***extreme*** malevolent events (i.e., events within the ***DBT*** that result in consequences that exceed the largest release from other initiators) are treated separately in Section E.3, below.] Unique indicators for those malevolent

events should be documented and will become the basis for stand-alone EAL statements. Denoting the *malevolent* cause of the initiator (e.g., *malevolent event* involving an explosion) is usually not necessary, since the initiator (e.g., explosion) will become the recognition indicator for the associated EAL. For all malevolent events added to the technical planning basis and EAL set, initial onsite PAs and, as required, offsite PARs should be developed.

E.3 Extreme Malevolent Events

Special consideration should be given to extreme malevolent event scenarios, which are within the constraints of the DBT and result in consequences that exceed the largest release from other scenarios. Facility VAs may provide a representative *extreme* malevolent event scenario(s), with the associated calculation of potential release consequences. This scenario will also represent an *extreme* malevolent event for emergency planning purposes. However, the analyst should ensure that the source term and the transport/dispersion parameters and meteorological assumptions used in the VA analysis are consistent with those used in calculations for emergency planning. If the parameters used in the VA calculations are not consistent, then the consequences should be recalculated using the same MAR but with emergency planning assumptions. [Cf. DOE G 151.1-2, Section 2.6] If a VA is not required for the facility, then consequences from postulated *extreme* malevolent event scenarios within the ***DBT*** (as identified by emergency planners in collaboration with site security professionals) will be analyzed following emergency planning guidance.

Sites and facilities are not expected to include these *extreme* malevolent events in the technical planning basis or in determining the EPZ. However, recognizing that such events may require response measures that exceed site and EPZ planning and could require the involvement of multi-jurisdictional and even State and Federal response authorities, these events should be part of the site-wide EAL set to ensure prompt recognition. In addition, as is the case for all events included in the EAL set, initial onsite PAs and offsite PARs should be developed for these analyzed *extreme* malevolent events. The key to response for scenarios whose consequences extend beyond the EPZ is that planning efforts within the EPZ provide a substantial basis for expansion of response efforts beyond the EPZ, if necessary, as more accurate information on the nature of the event and its potential consequences become available.

APPENDIX F. Consequence Thresholds

F.1 Introduction

The purpose of this Appendix is to provide additional guidance regarding the definition and use of the terms: Protective Action Criteria (PACs), Protective Action Guide (PAG), Acute Exposure Guideline Level (AEGL), Emergency Response Planning Guideline (ERPG), Temporary Emergency Exposure Limit (TEEL), and Threshold for Early Lethality (TEL), as consequence thresholds for hazardous material effects.

The Order specifies the consequences of an actual or potential hazardous material release as a key determinant of the emergency class. The PAGs published by the Environmental Protection Agency (EPA) are specified as the applicable consequence thresholds for radiological exposures. The AEGL-2 published by the EPA, the ERPG-2 published by the American Industrial Hygiene Association (AIHA), and the TEEL-2 developed by DOE are identified, in order of preference, as the corresponding consequence thresholds for chemical 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 assessments and emergency planning.

Section 2.6, DOE G 151.1-2, directs the user to calculate the consequences of hazardous material releases at several locations and compare the results with the applicable threshold in order to determine the appropriate emergency class. The user is also directed to calculate the maximum distance at which PACs and TELs would be expected and to use those distances in determination of Emergency Planning Zones (EPZs).

F.2 Protective Action Criteria (PACs)

PAC is the general term for the level of hazardous material impact that, if observed or predicted, indicates action is needed to prevent or limit exposure of people to the hazard. "PAC" is used for both radiological and non-radiological consequence criteria in DOE facility emergency planning and response.

F.2.1 Radiological PAC

DOE O 151.1C specifies that the PAGs published by the EPA in its *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* (EPA 400-R-92-001) should be used for comparison with exposures resulting from radiological releases to determine the appropriate emergency classification. 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 the 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.

The projected dose value for initiating protective actions (evacuation or sheltering) specified in Table 2.1 of EPA-400 is 10 to 50 mSv (1 to 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). The PAG values for committed dose equivalent to the thyroid and the skin are 50 to 250 mSv (5 to 25 rem) and 500 to 2500 mSv (50 to 250 rem), respectively.

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

- A projected dose equivalent of 10 mSv (1 rem) TEDE 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; or

- A projected committed dose equivalent (CDE) to the adult thyroid of 50 mSv (5 rem); or

- A projected CDE to the skin of 500 mSv (50 rem).

EPA 400-R-92-001 states that for planning purposes, "... it will usually be convenient to assume that the early phase will last for four days." However, it also states that the assumed time of exposure to deposited materials may depend on "... unique characteristics of some facilities or situations..." and that exposure pathways contributing less than 10 percent of the dose in the early phase need not be considered.

External exposure to deposited materials may be excluded from the early phase dose projection if the exposure for a period equal to the estimated EPZ evacuation time (or a maximum of four days) can be shown to contribute less than 10 percent of the TEDE. If no official prior estimate of EPZ evacuation time exists, an estimate may be developed and documented within the EPHA.

Facilities having substantive and persuasive arguments for using 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 the procedure specified in 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-R-92-001.

For ingestion pathway exposure, the U.S. Food and Drug Administration (FDA) has issued recommended PAGs that correspond to the "intervention levels of dose" consensus values set by international organizations (FDA 1998). Those PAGs are 5 mSv (0.5 rem) for CEDE or 50 mSv (5 rem) committed dose equivalent to an individual tissue or organ, whichever is more limiting. The FDA also recommended Derived Intervention Levels (DILs) corresponding to the PAGs for several groups of radionuclides. DILs corresponding to the ingestion pathway PAGs may be derived locally according to the

FDA recommendations for specific radionuclides, foodstuffs, and animal feeds of interest.

F.2.2 Non-radiological PAC

DOE O 151.1C specifies that AEGL-2, promulgated by the EPA; ERPG-2, published by the American Industrial Hygiene Association (AIHA); and TEEL-2, developed by DOE are to be used, in order of preference, as PACs for non-radioactive hazardous materials.

AEGLs are guideline levels for once-in-a-lifetime, short-term (***not*** repeated chronic) exposures to airborne concentrations of acutely toxic chemicals. These exposure limits are intended to protect most individuals in the general population, including those that might be particularly susceptible to the toxic effects of the chemicals. However, certain individuals could experience effects at concentrations below the corresponding AEGLs. AEGL-1, -2 and –3 values are being developed for each of five exposure periods, ranging from 10 minutes to eight hours.

AEGLs are first published as "proposed" in the Federal Register for a review and comment period. Following resolution of relevant issues raised through public review, the values are classified as "interim." The interim values are available for use, as deemed appropriate, on an interim basis by Federal and state regulatory agencies and the private sector. When concurrence by the National Research Council AEGL Subcommittee is achieved, the AEGL values are published as "final." Final AEGL values may be used on a permanent basis by all Federal, state and local agencies and private organizations.

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 130 chemicals as of 2006, and about 185 interim and final AEGLs have been published. Because there are no approved ERPG or final AEGL values for many hazardous chemicals of particular interest to DOE and its operations, the Chemical Exposures Working Group of the DOE Emergency Management Issues Special Interest Group (EMI SIG), Subcommittee on Consequence

Assessment and Protective Action (SCAPA), developed and published a method for determining alternative planning values. The system of alternative values, termed Temporary Emergency Exposure Limits (TEELs), includes three biological reference values (TEEL-1, -2 and -3) for each substance, each with a definition similar to the corresponding ERPG value. TEEL values and the development methodology are disseminated for use within DOE via the DOE Chemical Safety web site: http://www.eh.doe.gov/chem_safety//teel.html.

DOE facilities/sites or activities in need of PAC values for other substances should request that SCAPA develop and publish the TEELs. TEEL requests are submitted via the SCAPA website http://www.orau.gov/emi/scapa/index.htm. Future requests for TEELs should be for chemicals that are used in sufficient quantities that **could** result in an Operational Emergency.

In the event that PAC values cannot be obtained using the TEEL methodology, users may select from one of the sets of chemical exposure guidelines issued by other agencies that are sometimes used as emergency planning criteria. These include the short-term public emergency guidance levels (SPEGLs) and emergency exposure guidance levels (EEGLs) developed by the National Research Council, and the LOCs published jointly by the EPA, FEMA, and DOT.

To determine whether a chemical consequence exceeds PAC, the highest time-weighted average (TWA) concentration predicted or measured for any 15-minute period (i.e., the maximum or peak 15-minute TWA concentration) should be compared to the PAC. 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.

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

Where:

C = **Concentration (ppm or mg/m^3)**, and

T = **Time period of exposure (min)**

It is not recommended that individual time intervals 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.

For purposes of applying the Order emergency class definitions, the term PAC should be interpreted to mean the following:

A 15-minute TWA concentration of the substance in air that equals (in order of preference) the Final or Interim AEGL-2 (60-minute), the ERPG-2, or TEEL-2 value for that substance; if none of these values is available, an alternative concentration criterion may be selected in accordance with this guidance.

F.3 Threshold for Early Lethality (TEL)

Chapter 3, DOE G 151.1-2, specifies use of the maximum distance at which facility emergency consequences could exceed a TEL 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.

For purposes of conducting facility hazards assessments, the term "TEL" should be interpreted as follows.

For radioactive releases, the TEL is:

A projected dose (TEDE) of about 100 rem (1 Sv) 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 using 100 rem (1 Sv) TEDE as an approximation of the TEL is conservative. Radiation effects studies have estimated a 5 percent risk of early fatality following a 140 rem (1.4 Sv) acute dose, with a smaller, indeterminate risk expected for lower doses. Little if any risk of early fatality would be associated with a TEDE equal to 100 rem (1 Sv), if the dose were received over a period of time from radioactive material taken into the body.

For chemical releases, the TEL is

A projected 15-minute average concentration of the substance in air that equals (in order of preference) the Final or Interim AEGL-3 (60 minute), the ERPG-3, or TEEL-3 value for that substance. If none of these values is available, an alternative concentration criterion may be selected in accordance with this guidance.

F.4 Chemical Mixtures

For chemical mixtures and ***concurrent releases*** of different substances, consequences should be assessed using the Mixture Methodology "Hazard Index" approach recommended by the SCAPA Chemical Mixtures Working Group (Craig, et al., 1999). A brief explanation of this approach and the published journal article are available on the SCAPA website, http://www.orau.gov/emi/scapa/index.htm, under Health Code Numbers (HCNs). An EXCEL workbook that automates the implementation of the approach is also available on the SCAPA website.

Concurrent releases should be analyzed if a plausible scenario exists by which quantities of different substances, each exceeding a laboratory scale threshold discussed in Appendix A, could be released from the same location at the same time. ***Concurrent releases*** of dissimilar substances that, because of separation by distance or physical barriers, could result only from *extreme* malevolent acts or *catastrophic* events (such as major fires, airplane crashes, severe natural phenomena impacts, and building collapse) ***need not be analyzed***.

APPENDIX G. Combustion Products and Toxicity in Hazards Assessments

G.1 Introduction

The DOE Emergency Management system provides for analysis of hazards and hazard-specific planning to prevent or reduce negative impacts on people and the environment. Of paramount concern is the prevention of death, injury and serious near-term health effects in populations that may be exposed to hazardous material releases originating from DOE facilities/sites or activities. To ensure that DOE/NNSA hazardous material identification and screening approaches remain consistent with the historical and policy bases of the DOE Orders and with current Federal, State and local emergency management requirements and practices, this appendix clarifies how certain toxic hazards should be assessed and the results used in emergency planning and response.

G.2 Background

DOE hazardous material emergency planning and response requirements were originally specific to the radiological hazards posed by weapons materials production and research activities. In the early 1980's, the requirements were modified to bring them generally into alignment with NRC emergency preparedness regulations that applied to commercial nuclear power reactors and radioactive material facilities. The DOE Orders were further revised in 1991 to place toxic chemicals on a par with radioactive materials for purposes of analysis, planning and response. As with the earlier modifications, the 1991 changes helped align DOE requirements with regulations being implemented by other Federal agencies, including the EPA, DOT, and Department of Labor (DOL). Throughout their evolution to the present date, the DOE Order requirements were (and continue to be) primarily intended to apply to toxic substances that, if released to the atmosphere, could pose an imminent health hazard to persons beyond the immediate vicinity of the release.

The process of determining whether a substance should be considered a "hazardous material" for DOE emergency management purposes is complicated somewhat by the fact that many very ordinary and ubiquitous substances are, in fact, toxic to humans or have other hazardous properties under specific conditions of exposure or misuse. In addition, other substances that are generally regarded as hazardous for one specific reason may have several different hazardous properties. [Note: Gasoline is a classic example. It is acutely toxic by ingestion and inhalation, environmentally destructive, highly flammable, explosive (when vaporized), and contains a known human carcinogen (benzene). Flammability dominates the safety/handling concerns and it is generally excluded from the domain of hazardous material emergency planning under DOE O 151.1C.]

Finally, burning almost anything will produce combustion products that meet the basic definition of "hazardous material" as that term is used in the context of emergency planning. In recent years, it has become apparent that by taking certain passages from

DOE Orders and guidance documents in isolation and interpreting them narrowly, many commonplace substances can be deemed "hazardous materials" and almost any fire can be considered a "hazardous material emergency." However, that kind of narrow and selective interpretation is not consistent with DOE emergency management policy and the intent of the Order.

G.3 Chemical Explosives

As part of their weapons development and research missions, several DOE facilities and activities store, process or dispose of chemical explosives in substantial quantities. Beyond the obvious danger from inadvertent explosions, some chemical explosives are also acutely toxic if inhaled or taken into the body by other routes. Most chemical explosives are solids with low vapor pressures at ambient temperatures and therefore do not conform to the general definition of a "dispersible" toxic substance upon which the DOE emergency management requirements are based. Historically, the toxic effects have been observed only in persons involved in directly handling or fabricating the materials without adequate workplace environmental controls or personal protective equipment. Accordingly, chemical explosives are not normally considered "dispersible" toxic substances requiring analysis and hazardous material emergency planning.

Another aspect of the hazard associated with chemical explosives is the production of toxic combustion products when they burn. Many explosives burn readily in air and open burning is, in fact, a common disposal method for surplus explosives. Several DOE activities have recognized the potential hazard posed by the combustion products and attempted to quantify it as a basis for emergency planning. Using combustion yield data derived from theoretical studies and field experiments, the amount of nitrogen oxides and other toxics produced by burning of explosives can be calculated. Taken as a potential airborne source, the toxics associated with combustion of a few pounds of TNT, RDX or any of several other commonly used explosives can exceed applicable PAC at significant distances, implying that categorization and classification as OEs may be required. However, it is established fact that many other materials used in building construction, furniture and fabrics produce copious amounts of toxics if burned. Therefore, the question: Is there any rational basis for applying the "hazardous material emergency" definition to fires involving explosives and not to other "ordinary" fires that represent equal or greater toxic sources? In an attempt to answer this question, the following section examines the toxic hazard from "ordinary" fires and compares it with that produced by burning explosives.

G.4 Toxic Release Comparison

Any structure fire will produce toxic products of combustion from the burning of structural materials, preservatives, refrigerants, paint, plastics, and so forth. Dangerous concentrations of carbon monoxide, hydrogen cyanide, hydrogen chloride, oxides of nitrogen, and various organics can be expected in the vicinity of even the most "ordinary" structure fire and profound respect for the toxic properties of all smoke is a guiding principle of modern firefighting and Incident Command practice. The position of the fire protection community is made perfectly clear in the NFPA Fire Protection Handbook,