EMPO-558
Rev. 3

OAK RIDGE Y-12 PLANT EMERGENCY MANAGEMENT HAZARDS ASSESSMENT (EMHA) PROCESS

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August 2000

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LOCKHEED MARTIN ENERGY SYSTEMS, INC.

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ACRONYMS

AB	Authorization Basis
AFTOX	Air Force Toxic Chemical Dispersion Model
AIHA	American Industrial Hygiene Association
ALOHA	Area Locations of Hazardous Atmospheres
ARAC	Atmospheric Release Advisory Capability
ARF	Airborne Release Fractions
ARR	Airborne Release Rates
BEW	Building Emergency Warden
B/FEP	Building/Facility Emergency Plan
BIO	Basis for Interim Operation
BLEVE	Boiling Liquid Expanding Vapor Explosions
CFR	Code of Federal Regulations
COR	Contracting Officer's Representative
CHARM	Complex Hazardous Air Release Model
DOE	Department of Energy
DR	Damage Ratio
DYMCAS	Dynamic Special Nuclear Material Control and Accountability System.
EAL	Emergency Action Level
EFPC	East Fork Poplar Creek
EMHA	Emergency Management Hazards Assessment
EMPO	Emergency Management Program Organization
EMO	Emergency Management Organization
EPA	Environmental Protection Agency
EPIcode	Emergency Prediction Information Code
EPZ	Emergency planning zone
ERPGs	Emergency Response Planning Guides
ESHE	Early Severe Health Effects
FEMA	Federal Emergency Management Agency
GE	General Emergency
HARM	Hazardous Atmospheric Release Model II
HASCAL	Hazard Assessment System for Consequence Analysis
HER	Hazard Evaluation Report
HF	Hydrogen Fluoride
HMIS	Hazardous Materials Information System
HPAC	Hazard Prediction and Assessment Capability
HPIMS	Health Physics Information Management System
LES	Local Emergency Supervisor
LMES	Lockheed Martin Energy Systems, Inc., referred to as Energy Systems
LPF	Leak Path Factor
LPG	liquid propane gas
MAR	Material at risk
MAQ	Maximum Anticipated Quantity
MMI	Modified Mercalli Intensity
MPF	Maximum Probable Flood
NBC	Nuclear, Biological, & Chemical Materials

ACRONYMS (continued)

NOAA	National Oceanic and Atmospheric Administration
NFPA	National Fire Protection Association
NRC	U.S. Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Guide
ORO	DOE-Oak Ridge Operations Office
ORR	Oak Ridge Reservation
PAC	Protective Action Criteria
PHR	preliminary hazards review
PSM	process safety management
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RASCAL	Radiological Assessment System for Consequence Analysis
RF	Respirable Fraction
RMP	Risk Management Plan
RQs	Reportable Quantities
SAE	Site Area Emergency
SAR	Safety Analysis Report
SME	Subject-Matter Expert
SNM	Special Nuclear Material
ST	source term
TEELs	Temporary Emergency Exposure Limits
TLE	Threshold for Lethal Effects
TOMES	Toxicology, Occupational Medicine and Environmental Series
TPQ	Threshold Planning Quantity
TQ	Threshold Quantity
TSR	Technical Safety Requirements
VA	vulnerability assessment
WITS	Waste Information Tracking System

1. PURPOSE

This document establishes requirements and standard methods for the development and maintenance of the Emergency Management Hazards Assessment (EMHA) process used by the lead and all event contractors at the Y-12 Plant for emergency planning and preparedness. The EMHA process provides the technical basis for the Y-12 emergency management program.

2. SCOPE

The instructions provided in this document include methods and requirements for performing the following emergency management activities at Y-12:

1. Hazards Identification,
2. Hazards Survey, and
3. Hazards Assessment.

3. PROCESS

This document is divided into the following ten subsections:

1. Identify Facility Hazards,
2. Hazards Survey,
3. Hazards Assessment,
4. Emergency Action Level (EAL) Indicators,
5. Configuration Management
6. Hazards Assessment Format,
7. Temporary/Transitory Facility Hazards,
8. Quality Assurance,
9. Hazards Assessment Control, and
10. Records.

A simplified overview of the EMHA process is provided in Fig. 1, Y-12 Emergency Management Hazards Assessment Process.

Terms and definitions are located in Appendix A of this document.

3.1 IDENTIFY FACILITY HAZARDS

The facility-specific, preliminary hazards-screening process qualitatively identifies the hazards at the facility level. The facility/operations manager is responsible for identifying and quantifying the facility hazards by utilizing subject-matter experts (SMEs), Basis for Interim Operation (BIO), Safety Analysis Report (SAR), Vulnerability Assessment (VA), Building/Facility Emergency Plan records, databases, etc. For Lockheed Martin Energy Systems, Inc. (LMES), or referred to as Energy Systems, operated facilities at Y-12, the facility manager/operations manager provides a written report to the Emergency Management Program Organization (EMPO) that enumerates the facility-specific hazards, in accordance with LMES command media, Y40-137, "Y-12 Emergency Management Hazards Assessment Process." All other event contractors at Y-12 are required to complete hazards identification in accordance with this document, EMPO-558.

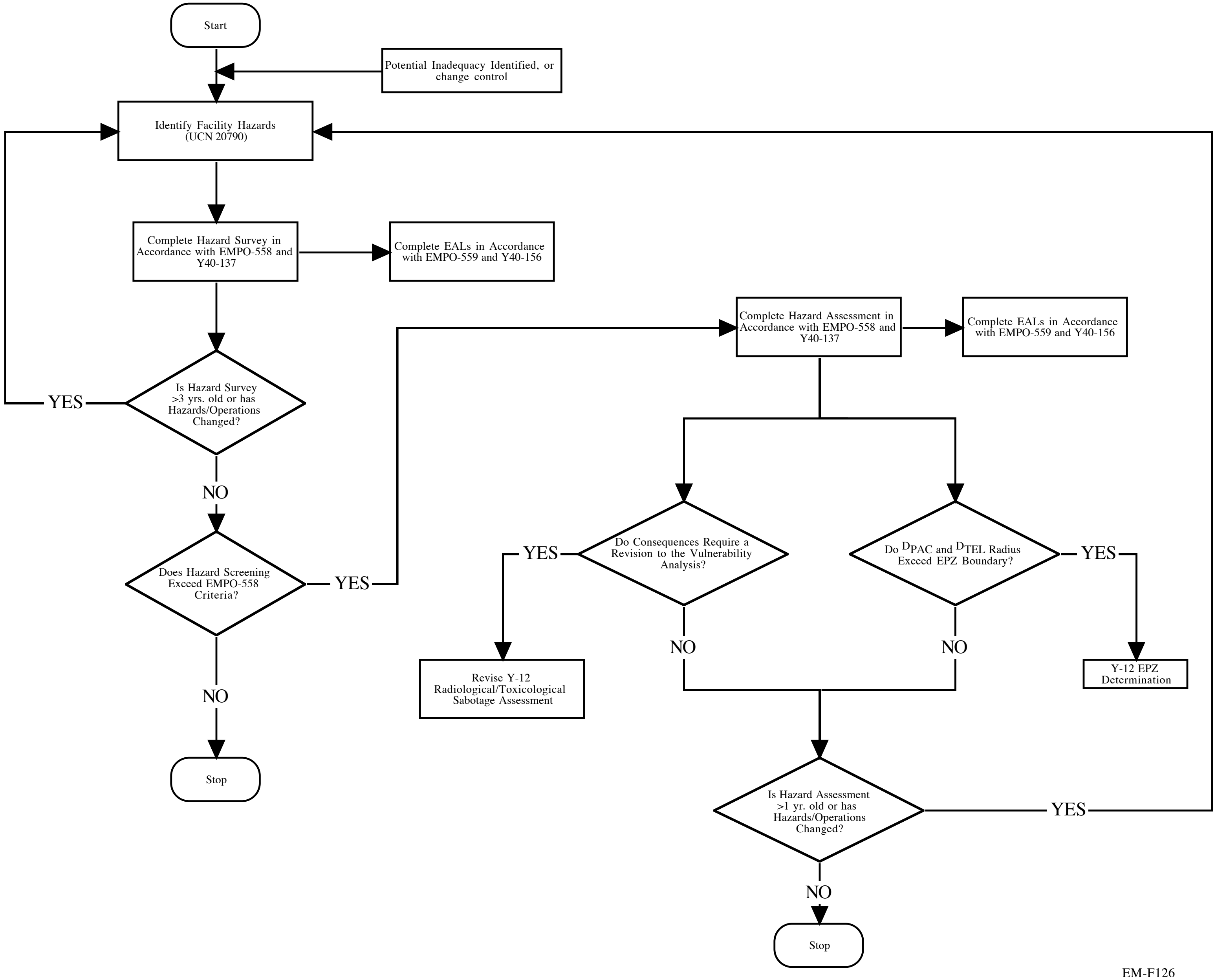

Figure 1. Y-12 Emergency Management Hazards Assessment Process

Hazards are screened against the lowest quantity listed as a Threshold Quantity (TQ) in 29 Code of Federal Regulations (CFR) 1910.119 or 40 CFR 68.130 and the Threshold Planning Quantity (TPQ) listed in 40 CFR 355. For chemicals not listed, the Reportable Quantities (RQs) for hazardous substances listed in 40 CFR 302.4 are considered.

Those chemicals for which RQs are listed in 40 CFR 302.4 and those which exceed established National Fire Protection Association (NFPA) screening criteria will be identified in the facility-specific Hazards Survey. Determining criteria for eliminating those facility-specific chemicals from further analysis in the quantitative hazards assessments is based on the potential for a chemical hazard to represent an Emergency Response Planning Guide (ERPG)-2 (or equivalent) value at 30-meters from the point of release under a conservative meteorological set, while applying the appropriate transport and dispersion criteria (e.g., release fraction, release height, etc.).

For radioactive materials, the quantities listed in 10 CFR 30.72, Schedule C, are used as screening thresholds for the radionuclides listed. Generic thresholds for hazardous materials (radiological or nonradiological) not listed in those references may be used if approved by EMPO following appropriate development and documentation of screening quantities based on the properties of the material and conservative consequence modeling.

The hazards-screening process is summarized in documentation maintained by EMPO with input from each event contractor. The objective of this activity is to identify, at the facility level, hazardous material(s) that is significant enough to warrant consideration in the Y-12 operational emergency hazardous materials program. Each Y-12 facility will be covered by a qualitative Hazards Survey that briefly describes the potential impacts of emergency events or conditions and summarizes the planning and preparedness requirements that apply. The Y-12 facility-specific hazards-screening and Hazards Survey documentation identifies the scope of the Y-12 base program that is required and provides the framework for response to serious events or conditions that involve health and safety, the environment, and safeguards and security. If the hazards screening and/or the Hazards Survey process identifies hazardous materials at a facility in excess of predetermined thresholds, a prioritized schedule (based on a graded approach) for completing facility-specific Hazards Assessments is required. The prioritized schedule is maintained by each event contractor and will include review/revision frequencies.

3.1.1 Compliance Schedule

Existing facilities are required to prepare and submit Hazard Identification documents as agreed to by their respective Contracting Officer's Representative (COR) in accordance with Sections 3.1.2 and through Step 3.1.3.

New facilities shall complete Hazard Identification documents as necessary to support design/construction/start-up activities.

*** * * * * ATTENTION * * * * ***

An increase in the inventory of hazardous materials not evaluated prior to implementation, including the introduction of materials not previously evaluated, may result in a violation of federal laws (10 CFR 830, 29 CFR 1910.119, and/or 40 CFR 68).

* * * * * * * * * * * * * * * * * * *

Hazardous materials shall not be introduced into a facility until appropriately addressed in Authorization Basis (AB) documents and EMHA documents (hazards surveys/assessments) that have been prepared, when required, pursuant to the applicable requirements. The Hazard Identification document should be updated to reflect operational changes in a timely manner in accordance with this document.

3.1.2 Hazard Identification and Documentation

Y74-801INS, *Hazard Identification*, provides instructions for implementing hazard identification at the Y-12 Plant. This Instruction delineates requirements for preparing, approving, and revising Hazard Identification Documents. The Hazard Identification Document provides information supporting Facility Classification and the development of Authorization Basis Documents (AB Documents), Emergency Management Hazards Assessments and Emergency Planning, and Fire Hazards Analyses. These latter documents provide the basis for safe operations and emergency response and may establish limits which should be reflected back into the Hazard Identification Document. The Maximum Anticipated Quantities (MAQs) established through application of Instruction Y74-801INS are limits that shall not be exceeded until appropriately addressed pursuant to Facility Safety and Emergency Management requirements identified in Y74-801INS.

Note: An overview of the hazard identification and reporting process found in Y74-801INS is provided in Figure 2.

3.1.2.1 At the facility level, identify hazardous materials which will be stored, processed, or created in the facility as well as materials which pass through the facility.

1. Identify and quantify the facility hazards by utilizing SMEs, BIO, SAR, VA, B/FEP, records, databases, etc.

   Note: A hazardous material is any solid, liquid, or gaseous material that is toxic, flammable, radioactive, corrosive, chemically reactive, or unstable upon prolonged storage in quantities that could pose a threat to life and health, property, or the environment.

2. Provide a written report to EMPO that specifically quantifies the facility-specific hazardous materials, using Form UCN-20790.

3. Verify the hazardous materials (chemical and radiological) identified are consistent with existing hazardous material inventories, including the Waste Information Tracking System (WITS), the Dynamic Special Material Control Accountability System (DYMCAS), the Hazardous Material Inventory System (HMIS), and the Health Physics Information Management System (HPIMS).

4. Eliminate the need to identify insignificant hazards utilizing the following methodology:

   Nonradiological materials are evaluated from the perspective of industrial health, fire, and reactivity. Energy Systems uses the rating scheme of 0 to 4, where 4 represents the highest level of health, fire, or reactivity hazard. The criteria for the hazard ratings are provided in Y-12 Plant procedure, Y70-208, *Hazard Communication Written Program*. These ratings, along with past experience and knowledge of the storage form of the materials, are used to identify which materials should be considered for inclusion in the Hazards Assessment. To eliminate insignificant hazards, **only those nonradioactive materials identified as having a health or fire rating of 3 or greater, or a reactivity (also referred to as instability) rating of 2 or greater are retained for screening.** A health rating of 2 or less indicates the potential for only minor acute or chronic health effects. A fire rating of 2 or less indicates the material is not highly flammable. Materials with a reactivity rating of less than 2 are considered stable. EMHA will only document those hazardous materials that exceed screening quantities and/or thresholds, and those nonradioactive materials identified as having a health or fire rating of $\geq$ 3, or an instability rating of $\geq$ 2.

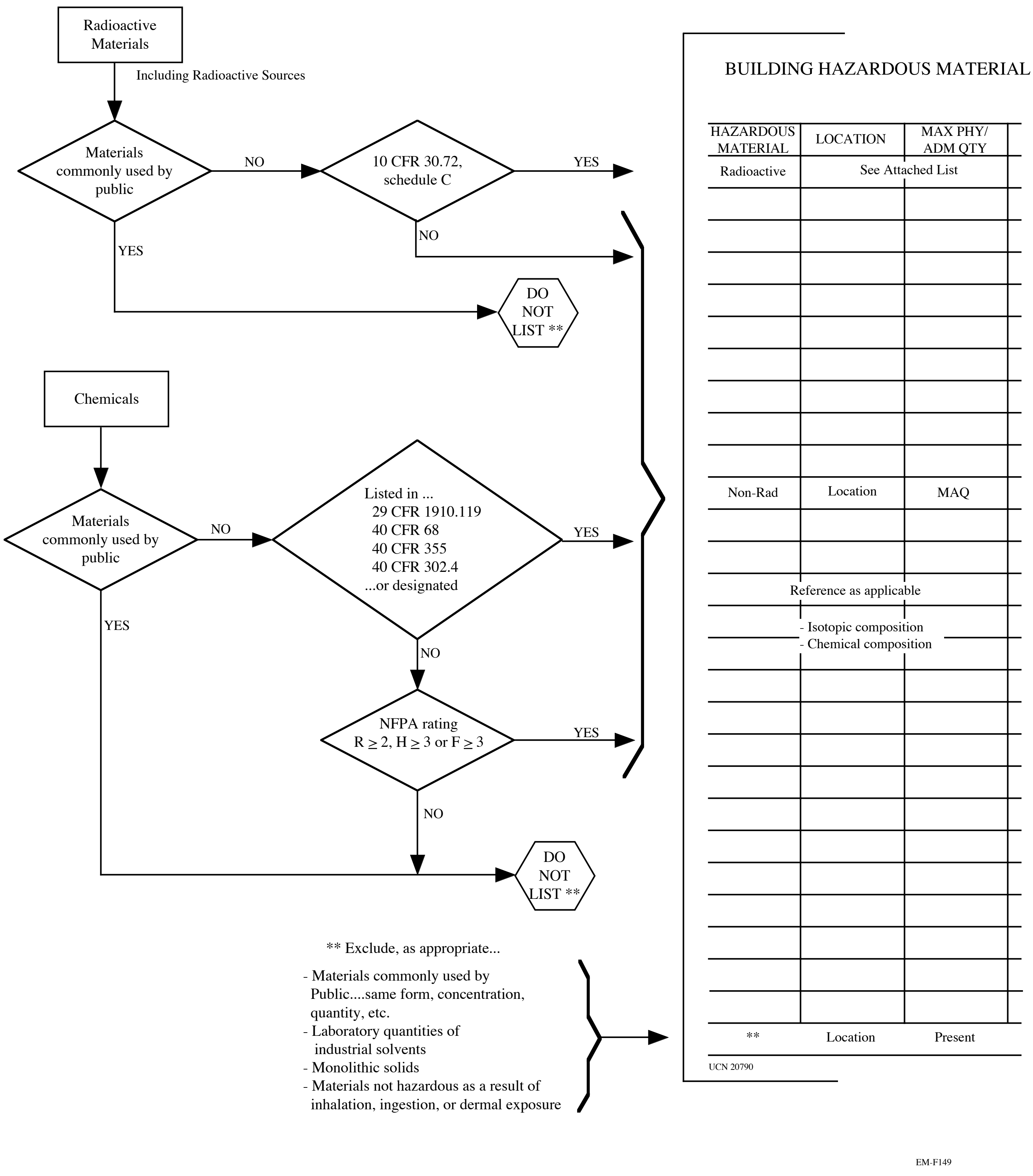

Figure 2. Overview of hazard identification and reporting (C)

3.1.2.2 Determine the maximum anticipated quantity of each material identified in Step 3.1.2.1.

1. The maximum quantity identified may determine facility classification. If there is sufficient flexibility in operations, maximums may be set at or below thresholds to avoid increased rigor in operational requirements (e.g., staying below Category 3 thresholds to avoid nuclear facility requirements).

2. For the purpose of this document, the maximum anticipated quantity for an intermediate reaction product is the maximum quantity expected during normal operations unless available accident analyses document significant generation of intermediate products under accident conditions. If subsequent analyses show significant production of intermediate products under accident conditions, a revised Hazard Identification document should be prepared.

3.1.2.3 List radioactive and hazardous materials, their location(s), and the maximum anticipated quantities on Form UCN-20790.

1. Use page 1 of Form UCN-20790 and continue on page 2, as necessary, to list identified materials. List radioactive materials first, then nonradiological hazardous materials. Radioactive materials may be listed by isotope or by chemical name with isotopic composition provided. Mixtures containing hazardous materials may be listed with an appropriate descriptor, total quantity of material, and a description of its composition. Descriptions of composition must be included. Radioactive materials will be listed twice if they contribute to meeting toxic hazardous material thresholds, appearing both as a radioactive material with a maximum anticipated quantity in Curies and as a hazardous material with a maximum anticipated quantity in pounds or kilograms.

2. Locations may be specific (e.g., specific "control areas" utilized in an appropriate inventory system), but the degree of specificity limits operations involving materials to the location(s) specified. If a facility is divided into subareas, radioactive, followed by nonradiological hazardous materials for each subarea may be listed together. If materials are listed by subarea, it is recommended that a spreadsheet listing all materials identified on Form UCN-20790, the maximum anticipated quantity in each area and the total maximum anticipated quantity for the facility, be included as supporting information in the Hazard Identification document.

3.1.2.4 Complete the third page of Form UCN-20790 except for the Signature and Date blocks.

Note that the form allows a one-line "Building/Facility Description." It is recommended that a brief "Facility Description" (at most a few pages) be appended to describe the facility, its mission, its location, and its layout. For a facility having an authorization basis, the summary should reference the appropriate document [i.e., SAR, BIO, or Hazard Evaluation Report (HER)]. The brief description is utilized for subsequent preparation of the emergency management B/FEP.

3.1.2.5 Assemble the Hazard Identification document, which consists of the following:

* Form UCN-20790, page 1, List radioactive materials first, then nonradioactive hazardous materials.

* Form UCN-20790, page 2, Repeat, as necessary, to complete the hazardous materials list.

* Form UCN-20790, page 3.

* Supporting material, e.g., a brief facility description, isotopic contents of radioactive materials, descriptions of mixtures of nonradiological hazardous materials, spreadsheet summarizing total

maximum anticipated quantities of radioactive and nonradiological materials for a facility when materials are listed by subareas within a facility.

Note that Form UCN-20790 or its equivalent may be used, provided the equivalent contains at a minimum the information requested by Form UCN-20790.

3.1.3 Approval of Hazard Identification Documents

If the facility/operations manager developed the Hazard Identification document, it is recommended that the managers have at least one other person familiar with the facility review and concur with the document prior to the managers approval.

3.1.3.1 Hazard Identification Form (UCN-20790)

The facility/operations manager, or if applicable the Operational Safety Board, will review and concur with the content of the Hazard Identification document. Issues to address include the completeness and accuracy of the document as well as the appropriateness of the maximum anticipated quantities in relation to the operations anticipated for the facility. After concurrence, the facility/operations manager will approve the Hazard Identification document by signing and dating page 3 of Form UCN-20790.

Copies of the approved Hazard Identification document will be sent to:
Emergency Management Program Organization (EMPO)
Building 9766, MS 8114

3.1.3.2 Hazardous Materials Inventory System

Where applicable, update the Hazardous Materials Inventory System (HMIS) and other inventory systems to reflect the approved maximum anticipated quantities.

The maximum inventories identified in HMIS shall be consistent with the maximum anticipated quantities identified in approved Hazard Identification documents. If the Hazard Identification document and HMIS do not agree, HMIS shall be updated expeditiously on approval of the Hazard Identification document. The HMIS coordinator can be contacted for assistance in updating HMIS.

If other systems are used to track inventories (e.g., WITS, DYMCAS, HPIMS), these systems shall also be updated on approval of the Hazard Identification document.

3.1.4 Review and Revision of Hazard Identification Documents

Significant changes in maximum anticipated quantities of radioactive and hazardous materials should be reported to EMPO before being implemented. Notification may be by e-mail or other convenient written format.

At least quarterly (e.g., following completion of the quarterly HMIS update), notify EMPO of increases in reported maximum anticipated quantities and/or the addition of new materials subject to this process. This notification may be by e-mail or other convenient written format.

When the defined scope of work for a facility changes, or at least annually, review the Hazard Identification document to determine if changes are required. When changes are required, prepare changes in accordance with Section 3.1.1.

3.1.5 Hazard Screening

1. Using Form UCN-20790, EMPO or the appropriate event contractor organization will screen the identified hazards and indicate which materials meet the following criteria:

    - Radioactive materials whose maximum anticipated quantity exceeds quantity listed in 10 CFR 30.72, Schedule C.

    - Nonradiological hazardous materials whose maximum anticipated quantity exceeds any TQ, TPQ, or RQ listed in 29 CFR 1910.119, 40 CFR 68, 40 CFR 302.4, or 40 CFR 355.

    - Nonradiological hazardous materials not meeting the criteria above but which are expected to exceed a protective action criteria (PAC) at or beyond 30-m under worst-case analyzed conditions.

2. Hazardous materials, for the purpose of this activity, are those materials listed in, or otherwise subject to, any of the following regulations:

    - 29 CFR 1910.119 *Process Safety Management of Highly Hazardous Chemicals*

    - 40 CFR 68 *Chemical Accident Prevention Provisions*

    - 40 CFR 302.4 *Designation of Hazardous Substances*

    - 40 CFR 355 *Emergency Planning and Notification*

    - 10 CFR 30.72 Schedule C, *Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release*

3. Materials "created" in the facility include not only intermediate or final products or wastes which may be present in "significant" quantities but also intermediate reaction products which may normally be present in very small quantities. Such intermediate reaction products may become a significant hazard if there is a pipe break or vessel failure at a critical point in a process. Excessive effort should not be expended pursuant to this document in identifying intermediate reaction products; however, the Hazard Identification should be updated if subsequent analyses identify the potential for quantities in excess of minimum thresholds identified herein under normal operating or accident conditions.

4. The following hazardous materials do not need to be addressed pursuant to this process. However, such excluded materials, if they could cause or significantly exacerbate the release of radioactive materials or more hazardous materials, may need to be addressed in subsequent analyses.

    - Materials commonly used by the general public. This exclusion includes any substance to the extent it is used for personal, family, or household purposes or is present in the same form and concentration as a product packaged for distribution and use by the general public.

3.2 HAZARDS SURVEY

This section outlines the process for conducting and documenting Hazards Surveys. It is expected that much of the material necessary to generate a Hazards Survey will already have been developed in the course of meeting other Department of Energy (DOE) and federal agency requirements relating to facility safety, occupational safety, environmental and effluent controls, and hazardous materials management. However, the intent of DOE Order 151.1, *Comprehensive Emergency Management System*, is not likely to be met by simply defining existing documents or analyses as the Hazards Survey document. Hazardous material inventory information need only be documented to the extent necessary to determine whether further assessment and planning are required. The Hazards Survey Document is a distinct document and contains or incorporates all the information specified in Section 3.2 of EMPO-558.

In order to promote efficiency, DOE Order 151.1 requires that each Hazards Survey incorporate as many facilities as possible that are subject to the same type of hazards. To facilitate incorporation of multiple facilities, that information is compiled and presented in tabular or matrix format.

For Energy Systems operated facilities at Y-12, Hazards Surveys are completed in accordance with procedure Y40-137, "Y-12 Emergency Management Hazards Assessment Process." All other event contractors at Y-12 are required to complete Hazards Surveys in accordance with this document, EMPO-558

The steps in the Hazards Survey include

- Identify and briefly describe each facility;
- Identify the generic emergency conditions that apply to each facility;
- Qualitatively describe the potential health, safety, or environmental impacts of the applicable emergencies; and
- Identify the applicable planning and preparedness requirements.

3.2.1 Identify and Describe the Facility

Each facility or activity is covered by a Hazards Survey that identifies and briefly describes its operations. Highly specific and detailed information is not necessary and may be included by reference. At a minimum, sufficient information to provide a general understanding of the facility(ies) covered should be included. Areas to be addressed include

- A general characterization of the facility and its operations (e.g., office building, laboratory, warehouse);
- The normal occupancy, including the number of people not based in administrative offices;
- Whether classified material is used or stored in the facility;
- Any special designations, such as nuclear facility, radiological facility, hazardous waste site, Treatment, Storage or Disposal facility, etc.; and
- Whether hazardous materials (other than standard office products and cleaning supplies) are used or stored in the facility.

If hazardous material is identified qualitative, screening is performed to determine the need for a quantitative Hazards Assessment. The screening is based on the guidelines in Section 3.3.5; however, the methodology is not applied or documented as rigorously as during the Hazards Assessment. For materials with no screening threshold, a qualitative evaluation is performed to determine if the materials would be expected to exceed a PAC at or beyond 30-m under worst-case release conditions.

DOE offsite transportation activities identified during the Hazards Survey process as involving hazardous materials in excess of the screening thresholds are also subject to the requirements for EMHA.

Facility engineering changes and/or modifications shall be reported to EMPO. This will ensure that changes affecting emergency planning and response are incorporated and documented into the EMHA process.

3.2.2 Identify Generic Emergency Conditions

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

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

Some emergency conditions apply to nearly every facility (e.g., fires), while others apply only to facilities that exceed a threshold inventory [e.g., hydrogen fluoride (HF)] or are located near other hazards. Site-specific potential hazards, such as flooding, are included in the list of potential emergencies to identify the facilities that are potentially threatened.

3.2.3 Qualitatively Describe Potential Impacts

Qualitatively describe the potential impacts of the emergency conditions identified in the previous step. These descriptions relate the potential impacts to the different types of operational emergencies. A Y-12 facility-specific application is shown in Table 1.

3.2.4 Identify Applicable Planning and Preparedness Requirements

From the results of 3.2.1 - 3.2.3, group facilities according to the following types of emergencies.

- **Facilities requiring a quantitative Hazards Assessment.** Those facilities that have hazardous materials equal to or in excess of predetermined thresholds require a quantitative EMHA.
- **All other facilities.** Facilities not having significant quantities of hazardous materials are not required to develop a quantitative Hazards Assessment. Those facilities are subject to the base program (i.e., Hazards Survey) planning, preparedness, and response requirements.

Note: All Y-12 facilities are subject to the base program and Hazards Surveys will contain a brief description of that program as part of the document.

Table 1. 9212 Complex Hazards Survey summary

Building or facility ID	Type/use	Occupancy	Classified materials	Special conditions	Hazardous materials	Applicable requirements	Potential impacts
9212	Chemical processes, Offices, Maintenance	Occupancy during dayshift includes ~300 employees Occupancy during offshift includes ~15 employees, as needed	Yes	Fixed contamination areas Material Access Areas High contamination areas RCRA-regulated hazardous waste area Fissile control area Radiation area TSCA-regulated materials storage area - PCBs	Greater than screening values: Radiological materials: Enriched and depleted uranium Uranyl nitrate Plutonium (PuBe sources) Nonradiological materials: Anhydrous hydrogen fluoride Nirtric acid 30% & 50% Mercury Polychlorinated biphenyls Other materials considered for analysis: None identified Aluminum nitrate Aluminum nitrate nonahydrate Acidified aluminum nitrate	10 CFR 30.72 29 CFR 1910.119 40 CFR 68.130 40 CFR 355 40 CFR 302.4 NFPA704	1-13. Worker injury/death. 1-13. Pollution of air and/or water. 1-13. Compromise of classified material.
9416-12	Utilities/Water treatment	Occupancy as necessary	No	None identified	Greater than screening values: Radiological materials: None identified Nonradiological materials: None identified Other materials considered for analysis: None identified None identified	10 CFR 30.72 29 CFR 1910.119 40 CFR 68.130 40 CFR 355 40 CFR 302.4 NFPA704	

Table. 1. 9212 Complex Hazards Survey summary (continued)

Building or facility ID	Type/use	Occupancy	Classified materials	Special conditions	Hazardous materials	Applicable requirements	Potential impacts
9811-9	**Tanker loading area**	**Occupied as necessary**	**No**	**Fixed contamination areas High contamination area RCR-regulated hazardous waste area**	**Greater than screening values: Radiological materials: None identified Nonradiological materials: None identified Other materials considered for analysis: None identified None identified**	** 10 CFR 30.72 29 CFR 1910.119 40 CFR 68.130 40 CFR 355 40 CFR 302.4 NFPA704**	**2-6,10. Worker injury/death. 2-7,10,13. Pollution of water.**
9818	**Water processing-chemical operations support/enriched uranium operations**	**Occupancy during dayshift includes ~10 employees**	**No**	**None identified**	**Greater than screening values: Radiological materials: None identified Nonradiological materials: Nitric acid - 30% and 50% Other materials considered for analysis: None identified Aluminum nitrate Acidified aluminum nitrate**	** 10 CFR 30.72 29 CFR 1910.119 40 CFR 68.130 40 CFR 355 40 CFR 302.4 NFPA704**	**1-7,10-13. Worker injury/death. 1-7,10-13. Pollution of water.**

3.3 HAZARDS ASSESSMENT

Note: Classified information identification and protection controls are not to restrict the scope of the development of EMHA. Classify the facility-specific EMHA accordingly or develop a separate classified section of EMHA.

The facility-specific EMHA identifies and analyzes hazards that are significant enough to warrant consideration in a facility's operational emergency management program. The process includes a screening step whereby insignificant hazards are excluded from detailed consideration. Facility-specific EMHA is the technical basis for EALs.

3.3.1 Integration With Other Safety Documentation

The schedule for other safety documentation (SAR, BIO, process safety management/risk management documentation, etc.) and development is considered and, where possible, EMHA is integrated with this scheduled to increase efficiency and reduce cost. Release parameters and analysis techniques will be standardized where possible to minimize the differences between Hazards Assessments for a given scenario.

3.3.2 Hazards Assessment Team Identification

EMHA team members should be selected based on their experience in Hazards Assessment-type work, facility knowledge, and discipline. Personnel assigned to the Hazards Assessment Team should be assigned for the duration of the schedule to maintain consistency and reduce cost. From team members, the facility manager shall appoint a lead, if there is more than one person representing a facility.

3.3.2.1 Hazards Assessment Team Training

At least one member of the EMHA team will be trained and experienced in the following areas:

- Source term determination,
- Dispersion modeling, and
- Facility mission, systems, and processes.

3.3.2.2. Facility Walkdowns

Facility walkdowns include both physical walkdowns and information (or paper) walkdowns. Physical walkdowns permit the team to familiarize themselves first-hand with actual facility systems, processes, practices, equipment, and inventory. Information or paper walkdowns is the process of EMHA team members reviewing existing safety documentation, design/system drawings, and procedures in the context of hazard identification. The team should perform physical and/or information walkdowns to identify hazardous materials and energy sources for each facility.

An inventory document listing all known radiological and chemical hazards should be completed prior to conducting the walkdown. These results are a key input to the process of hazard identification. This effort should not be duplicated by the EMHA team. However, additional hazards may be identified as a result of chemical interactions. Chemical mixing should be considered as part of hazard identification. For purposes of EMHA chemical mixing is limited to a maximum of two chemicals.

The physical walkdown should be coordinated through the Hazard Assessment Team's facility representative. The facility representative should ensure that team members participating in the facility walkdown have proper clearance and any required facility-specific training.

The paper walkdown should include a review of the following:

- Facility description;
- Inventory;
- Existing safety documentation [preliminary hazards review (PHRs), SARs, BIOs, Operational Safety Report, technical standards, project design documents, fire hazards analysis, etc.]; and
- Consultations with facility system and/or process experts.

Similar to the physical walkdown, consultation with facility experts should be coordinated through the facility representative.

3.3.3 Facility Description/Boundaries

The EMHA project coordinator should perform the remaining steps in this process with assistance and concurrence of facility representatives on the EMHA team.

3.3.3.1 Facility Description Summary

Summarize a clear, accurate, and unambiguous written and schematic description of the facility and its operations that are to be the subject of EMHA. Provide sufficient detail to support the identification and characterization of all hazards and a determination of their potential consequences.

For facilities with current SARs, environmental reports, and BIO, the descriptions from those reports may be sufficient. In this case, write a brief summary description of the facility with a reference to other applicable documents for further detailed descriptions or copy the description into EMHA.

The principal considerations are the material processing operations and corresponding physical (structural or geographical) boundaries. A facility includes all buildings, structures, support equipment, and auxiliary systems that support a common mission.

Several structures or component units with a common or related purpose may constitute a single facility. For example, the waste tank farms are defined as one facility because they are composed of a number of units of approximately the same nature and purpose and under common management and operational control.

Consider as a single facility a complex of dissimilar buildings, operations, and equipment if they are physically adjacent under common management and have a common programmatic mission. For example, separation facilities and associated outside facilities, ventilation buildings, and filters.

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

3.3.3.2 Define the Facility Boundary

A 100 m analysis radius will be used as the standard "facility boundary" for facilities that are in close proximity to one another, unless a specific reason for applying a physical boundary exists. In this case the rationale for defining the physical boundary will be included in the EMHA

For hazards associated with transportation incidents, 100 m will be the default facility boundary. EMHA will clearly identify what constitutes the subject facility. See Appendix B, "Facility/Site Boundary Guidelines" of this document, for further guidance on defining a facility boundary.

3.3.3.3 Determine Common Distance

In order to negate the need to calculate a distance from the release point to the nearest facility boundary for each scenario, determine one common distance to the nearest facility boundary as follows:

1. Using the applicable Y-12 site maps, estimate the geometric center of the facility or the primary release point (e.g., main building stack).

2. Determine the distance from this center to the nearest facility boundary.

3. Document this distance in EMHA.

3.3.3.4 Define the Nearest Site Boundary

See Appendix B, "Facility/Site Boundary Guidelines" of this document, for further guidance on the Y-12 site boundary. For EMHA, calculate the distance to the nearest site boundary, using the site boundary definition and the same methodology outlined in Step 3.3.3.3. Document this distance in EMHA.

3.3.3.5 Identify Independent Segments

Segments are independent if barrier failure and human errors in one segment do not propagate into another segment. Segmentation is helpful during accident analysis in properly estimating inventories released when barriers fail. As an example, the 9212 building consists of a headhouse and several wings. The EMHA will logically consider these physical structures during the source term and consequence assessment determinations.

Segmentation of the facility is also necessary to document EMHA in the proper format and is used as a work control tool during the development of the Hazards Assessment. For facilities where segmentation is needed more from a work control standpoint rather than accident analysis, it is not necessary to prove independence. The accident analysis section of EMHA must specifically take into account segments that are not independent during source term estimation calculations.

3.3.4 Identification of Hazards

3.3.4.1 Identify Nonradioactive Hazardous Materials Inventories

Identify the maximum anticipated inventories of nonradioactive hazardous materials. Include, as applicable, both physical limits (e.g., tank capacity) and associated administrative limits (e.g., maintain tank level $\leq$ 75%). Expected or historical quantities are normally used where physical and administrative limits do not exist. The inventory includes purchased, process, and waste stream nonradioactive hazardous materials.

HMIS is the basic source of information for all purchased chemicals at Y-12. The method to download the facility-purchased chemical inventory from the HMIS database is in the latest revision of the HMIS User's Guide. However, if another database is used by an event contractor, that database should be used and noted in the hazardous materials identification process implementation.

SARs, BIOs, Technical Safety Requirements (TSRs), and subordinate facility procedures are a source of inventory information for nonpurchased process-related and waste stream nonradioactive hazardous materials along with system descriptions, process flow sheets, SMEs, and facility walkdowns.

3.3.4.2 Identify Radioactive Hazardous Materials Inventories

Identity the maximum anticipated inventories of radioactive hazardous materials. Include, as applicable, both physical limits (e.g., tank capacity) and associated administrative limits (e.g., maintain tank level ≤ 75%). Expected or historical quantities are normally used where physical and administrative limits do not exist. The inventory includes purchased, process, and waste stream radioactive hazardous materials.

SARs, BIOs, TSRs, and subordinate facility procedures are a source of inventory information. Material Control and Accountability records are the primary source of information on current holdings and authorized limits for special nuclear material (SNM). Test plans, process safety assessments, or other controlling documentation for hazards of a transient or intermittent nature also contain relevant hazardous material inventory information.

For facilities having a documented vulnerability analysis (according to DOE Order 470.1), note the identified targets that are also hazardous materials [e.g., radioactive material at risk (MAR) from theft diversion or sabotage] in the list of facility hazards. Normally, the target list is classified. Consider pertinent information from these vulnerability analyses in the Hazards Assessment and classify EMHA the accordingly.

3.3.4.3 Identify Hazards Associated with Transportation Activities

This identification will include both radiological and nonradiological hazardous materials. List, screen, and analyze transportation hazardous materials separately to facilitate EAL development. The transportation list of hazardous materials includes both those generated from within the facility (receiving and outgoing shipments) and those generated from other facilities but passing within the boundary of the facility being analyzed. Onsite transportation activities will be analyzed in conjunction with those facilities with which the transported material is associated (e.g., delivery of HF will be included in the Building 9212 EMHA).

3.3.4.4 Identify Any External Hazards

The Energy Systems EMPO is responsible for consulting with the Local Emergency Planning Committee to identify nearby facilities having hazardous material inventories that could affect the Y-12 site. This activity will consider railroads, highways, and other transportation arteries near the site as possible locations of hazardous material transportation accidents. Estimates on the effects on the site following a hazardous material event originating offsite will be used as the basis for determining whether specific arrangements should be made with offsite authorities for notification and joint response. Any applicable findings will be included in EMHA.

3.3.5 Screening and Characterization of Hazards

3.3.5.1 Chemical Hazardous Materials

Screen chemical hazards as per the lowest quantity listed as a TQ or TPQ in 29 CFR 1910.119, 40 CFR 68.130, or 40 CFR 355. For chemicals not listed, RQs for hazardous substances listed in 40 CFR 302.4 are considered in determining the need to develop facility-specific Hazards Assessments. The general criteria used and the order of their use are as follows:

1. Eliminate a chemical if it is not present in quantities greater than TQ, TPQ, RQ, or applied NFPA criteria and does not exceed PAC at 30-m.

2. If a container or storage vessel holds a mixture or solution of a chemical of concern, multiply the concentration of the chemical of concern, in weight percent, by the mass in the vessel to determine actual quantity. Eliminate those chemicals that do not equal or exceed screening criteria.

3. Eliminate a chemical if it has already been identified as a common hazardous material and there is nothing to indicate that a more detailed evaluation is required (e.g., the material is present in greater than end-user quantities).

4. Consider eliminating the chemical as a common hazardous material if it satisfies one or more of the following criteria:

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

   - The material is not hazardous to humans by inhalation, ingestion, or dermal exposure. C

   - The material has a vapor pressure of $\leq$0.5 mmHg @ 25ºC and an ERPG-2 or equivalent of $\geq$ 1 ppm.

5. Eliminate the chemical if one or more of the following is valid:

   - It is verified that the use of a chemical has been discontinued by the facility,
   - The material is identified as a sample,
   - The material is identified as part of the radionuclide inventory, or

     Note: Some radioactive materials (e.g., uranium) exceed toxicological hazard criteria without exceeding a radiological limit. Do not chemically screen these types of materials as part of the radionuclide inventory.

   - The material is used in a laboratory setting and in laboratory-scale quantities.

6. Evaluate materials (e.g., sodium hydroxide) that do not fit the conventional definition of "hazards" for airborne human health or safety impacts that could cause a significant environmental impact (e.g., barrier failure allows direct spillage of material into a public water supply). Consider the effects on the environment, the necessary response actions, and the time within which actions need to be taken when determining whether to include such materials within the scope of EMHA for a given facility.

7. Evaluate the incompatibility of materials (e.g., sodium hydroxide) that do not fit the conventional definition of "hazards" for airborne human health or safety impacts that could cause a significant hazard when mixed with other nearby chemicals. Check chemicals not eliminated in the screening process for adverse interactions with other chemicals located nearby. Document this evaluation in the EMHA process.

8. Evaluate for chemical reactivity by use of references such as the National Fire Protection Association publication "Fire Protection Guide to Hazardous Materials," Toxicology, Occupational Medicine and Environmental Series (TOMES) database, Material Safety Data Sheets, etc.

9. Eliminate materials, such as vehicle fuel and laboratory quantities of common industrial solvents, unless they are potential event initiators for hazardous materials in close proximity. Document any materials to be considered as event initiators.

10. Document the PAC for each chemical not eliminated in the screening process.

3.3.5.2 Radioactive Materials Screening Process

1. For radioactive materials, the quantities listed in 10 CFR 30.72, Schedule C, are used as screening quantities by determining the ratio of the amount of a radionuclide present to its allowed amount. The radionuclides are not screened out if the summation of the ratios is $\geq$ 1. It is not necessary to calculate and sum all ratios if a simple calculation shows that one or a few radionuclides ratio(s) equals or exceeds 1. This screening methodology is detailed in the DOE-STD-1027-92, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Report."

2. If the summation ratio is $\geq$1, reduce the number of radionuclides (normally performed by process stream or segment) carried through EMHA by calculating their dose contribution as follows:

   - Determine the source term by multiplying each isotope's Curie content by the appropriate release fraction described in the DOE-STD-1027-92. If comparing streams or materials at risk directly, the release fraction is set to one for all isotopes.

   - Multiply the source term by the most restrictive (based on clearance class) inhalation Dose Conversion Factor stated in DOE/EH-0071 to obtain the potential dose in rem.

   - Determine the percent contribution of each isotope to the total dose in rem.

   - Retain the isotopes contributing the greatest percentage so that $\geq$95% of the total dose is included. The smaller contributions of radionuclide not necessary to reach 95% will be eliminated. Guidelines for the dose estimates are located in Appendix C of this document.

   - Tabulate the results and include these data in the screening section of EMHA.

   - Document in EMHA those materials that represent a significant risk or hazard and the facilities whose maximum inventories are greater than the screening quantity. On completion of the radiological material screening process, some facilities may have no identified radionuclides requiring further characterization and analysis. In this case, document the results of the screening process and the basis for the conclusion that no further analysis is needed.

3. Sealed sources, "special form" material or radioactive material stored in DOE-approved shipping containers may usually be excluded from the isotope totals that are compared with the 10 CFR 30.72 screening quantities.

3.3.5.3 Barrier Identification

Assemble and document information that describes and quantifies the remaining hazards to support the development of accident analysis of possible releases.

1. Document the following for both radioactive and nonradioactive hazardous materials.

   - The material storage and/or process location(s).

   - A description of the conditions under which the material is stored or used. Include process systems or containers that hold the material and barriers/mitigative features that may affect its release or dispersion (e.g., shipping containers, buildings, berms, sumps, or catch basins). Identify, where applicable, security and access controls for the storage and use locations.

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

- A description of administrative controls that would prevent or mitigate the initiation of a hazardous material release. This includes such things 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.

2. For facilities where criticality accidents are credible, the inventory of interest is the total yield of gaseous and volatile fission products from the postulated criticality event.

3. Where the material consists of irradiated fuel containing mixed fission products, analyze the relevant factors that define the radiotoxicity of the mixture (e.g., enrichment, burnup, age). Select a limiting case, such as one that produces the largest impact.

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

5. Include other materials and hazard sources, such as flammable or explosive materials and energy sources, in the characterization. Consider their potential for initiating releases of radioactive or chemically toxic materials, contributing to dispersal of those materials, or degrading the effectiveness of safety systems.

6. Assess available information concerning the reactive properties of the hazardous materials.

3.3.6 Accident Analysis

If available, utilize Barrier Challenge/Failure analysis to determine the scenarios (i.e., combinations of events and conditions) that could cause releases of each hazardous material characterized and the magnitudes of those possible releases. Facilities with a compliant SAR will have a barrier analysis performed in accordance with Attachment 1 of DOE Order 5480.23. These analyses can be used in the accident analysis section of EMHA by reference.

DOE Order 5480.23 SARs typically include analysis results for a limited number of accident scenarios chosen from the relatively narrow range of severity that defines the limit of credible (in the probabilistic sense) accidents. Facilities with compliant SARs will have Beyond Design Basis Accidents analyzed as per Attachment 1 of 5480.23. These analyses can also be used in the accident analysis section of EMHA by reference.

Table 2 shows the half-life and quantities of the total nuclide inventory suggested in Reg. Guide 3.34 using 100% release fraction for noble gases and 25% release fraction for the radiodines (instead of the smaller values allowed by DOE-HDBK-3010-94 or DOE-STD-1027-92). These quantities, used in Y/TS-1272, represent total production for each nuclide by fission and by ingrowth from the decay of fission-produced parents and do not account for decay. Y/DD-384 used the ORIGEN code to provide a more realistic source term (as allowed by the regulatory guidance) which accounts for both production and removal of decay products. These values will be used to calculate consequences from criticality event scenarios’ in the EMHAs.

Table 2. Radionuclides assumed to be released in a criticality accident

Nuclide	Half-life	Quantity available for release (Ci)
Kr-83m	1.8 h	1.6 (10^2)
Kr-85m	4.5 h	1.5 (10^2)
Kr-85	10.7 y	1.6 (10^{-3})
Kr-87	76.3 m	9.9 (10^2)
Kr-88	2.8 h	6.5 (10^2)
Kr-89	3.2 m	4.2 (10^4)
Xe-131m	11.9 d	8.2 (10^{-2})
Xe-133m	2.0 d	1.8
Xe-133	5.2 d	2.7 (10^1)
Xe-135m	15.6 m	2.2 (10^3)
Xe-135	9.1 h	3.6 (10^2)
Xe-137	3.8 m	4.9 (10^4)
Xe-138	14.2 m	1.3(10^4)
I-131	8.0 d	2.2
I-132	2.3 h	2.8 (10^2)
I-133	20.8 h	4.0 (10^1)
I-134	52.6 m	1.1 (10^3)
I-135	6.6 h	1.2 (10^2)

DOE Order 5480.23 SAR analyses are nearly always an incomplete representation of the Operational Emergencies for which emergency planning is required by DOE Order 151.1. Normally, a SAR does not perform analysis of higher probability, lower consequence events and severe events that from a facility-design standpoint, would be beyond credible. DOE Order 151.1 states that EMHA will consider emergency events that result from operation of the facility, accidents, sabotage or malevolent acts, or earthquakes or other natural phenomena. The probabilistic risk analysis performed for a SAR to determine credibility of an accident does not include several of the initiators (terrorism, sabotage, malevolent acts, etc.) that 151.1 requires. Therefore, the use of a $>10^{-6}$ frequency for beyond credible accidents, as calculated for SAR analysis, as exclusion criteria in EMHA is not appropriate. Use SAR analyses as input to EMHA. Characterize and consider the rest of the accident severity spectrum.

3.3.6.1 Identify Primary Barriers

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

3.3.6.2 Identify Failure Modes of Primary Barriers

The initial step in this analysis is to postulate failure modes of the primary barrier. The second step is to identify possible causes of each primary barrier failure mode. In the example of a tank or container that contains a gaseous or liquid material, possible causes of failure might include corrosion, design or manufacturing flaw, overpressure, external impact (missile, forklift, crane load), operator error, excessive temperature, or water hammer.

While performing this analysis, compile a list of the indications of barrier failure or challenge. This list will include instrumentation that gives indication of barrier failure along with the instrument's associated ranges of indication. Note where instrumentation does not exist.

3.3.6.3 Estimate the Magnitude of Release from Primary Barrier

For each cause of failure develop a quantitative estimate of MAR. Consider the physical properties of the material, such as volatility, viscosity, melting point, vapor pressure, temperature and pressure conditions under which the material is stored, and the postulated mode of failure.

Estimate the radiological source term by multiplying MAR by the appropriate Airborne Release Fraction (ARF).

DOE-HDBK-3010-94 contains ARFs. The bounding ARFs listed in the DOE-HDBK-3010-94 are the appropriate ARFs for Hazards Assessment analysis. Accident-specific ARFs derived in other safety documents or by experimental/analytical methods can be used in the Hazards Assessment. If no applicable ARF can be found, use ARFs contained in DOE-STD-1027.

For accident events involving multiple release mechanisms [e.g., an instantaneous release followed by a longer term release(s)], use the dominating release mechanism to establish the source term.

For airborne radioactive releases, assume the receptor is at the plume centerline throughout the plume passage and is also exposed for two hrs. to any ground deposition and resuspended material.

A range of possible releases needs to be analyzed, not just the maximum. For some failure modes (for example, detonation of explosives next to a pressurized gas system) the maximum release might be the only plausible release. For other modes (e.g., puncture) it is recommended to analyze several different leak sizes that correspond to different release events.

Use the maximum physical inventory (e.g., tank capacity) when estimating the release from a barrier. If administrative controls limit the amount of material in a tank, or a concentration in a process, perform another analysis with the administrative control amount as the maximum inventory, unless the maximum physical inventory analysis does not present a problem. Document both results in EMHA, as applicable.

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

Two sets of dispersion conditions will be utilized in computing the consequence versus distance data for source terms identified in EMHAs. The results will then be used in evaluating the consequences at each receptor location identified.

The first case will represent a “conservative” estimate of consequences. For atmospheric release of hazardous materials, a wind speed of 1 m per second with stability class of F, and a ground level release is utilized, with the exception of spills and subsequent evaporation of hazardous materials. For spill scenarios’, a more conservative approach, as indicated by consequence results from modeling, will utilize a typical meteorological set of D stability and a wind speed of 3 m per second. Consequences calculated using these conditions will be used to develop EALs and to determine the size of EPZ. In addition, wind direction is not utilized in developing EALs or EPZs, rather the closest distance to a receptor (e.g., facility/site boundary) will be the determining factor.

The second case will approximate a “typical” set of conditions, as identified above for a spill scenario, D stability and 3 m per second wind speed. Consequences calculated using these conditions are for general reference and response planning purposes, which are useful in offsite planning with local authorities and as a resource for emergency response personnel.

3.3.6.4 Assess the Effects of Secondary Barriers and Mitigating Features

Assess and document the effects of secondary barriers and mitigating features on the maximum amount of material released from the primary barrier. Depending on the hazardous material in question and the storage mode or process, additional barriers or mitigating features may or may not have to be defeated if a release to the atmosphere is to occur.

For example, in the case of an outdoor, freestanding acid tank, there are no secondary barriers to consider. A breach of the tank wall discharges the acid directly to the environment. In the case of radioactive materials within a glovebox, inside a building, the glovebox exhaust filters, the glovebox itself, the room ventilation system, and the building walls may be barriers and mitigating features of interest.

Characterize the effectiveness of secondary barriers and mitigating features. For example, an exhaust filter may have a rated or tested efficiency for particles of a given size that will apply to all release conditions in which the ventilation system is operating and is the release pathway (e.g., High Efficiency Particulate Air Filters assume a 99.9% efficiency for the first stage and 99.8% efficiency for subsequent stages where sand filters assume a 99.5% efficiency). However, building walls may be characterized as either intact, in which case one set of release scenarios applies, or not intact, which lead to a completely different set of release possibilities.

The type of event postulated determines how much mitigation the secondary barriers provide. The barrier analysis process may point out the need to modify or enhance facility mitigating features or instrumentation used to monitor barrier states.

3.3.6.5 Identify Initiating Events

Evaluate possible initiating events and accident scenarios that could lead to the release of hazardous materials. For each set of barrier failures that could lead to the release of hazardous material, identify possible initiating events, accident mechanisms and/or equipment failures that could initiate a release (e.g., spontaneous failure of a barrier(s), failure of administrative controls, impact of external events, etc.).

Malevolent acts are considered as possible release initiators. The process for evaluating sabotage vulnerabilities is shown in Appendix D of this document.

Table 3 provides an overview of consequence assessment values used in the Y-12 Plant vulnerability analysis C
process.

Table 3. Consequence Values for Radiological and Toxicological Sabotage

Consequence Value	Effects on the public, employees, and environment from acts of radiological or toxicological sabotage*
1.0 – Catastrophic	On- and off-site fatalities and injury, long-term denial (greater than two years) of facility due to damage or radiation contamination, and off-site denial of food, water or habitat due to contamination for more than one year.
0.8 – High	Off-site injury and on-site fatalities and injury, on-site facility denial one to two years, and off-site denial of food, water, or habitat due to contamination for less than one year.
0.5 – Moderate	On-site injury (no off-site injury), on-site facility denial six months to one year, and denial of food, water, or habitat due to contamination less than six months.
0.2 – Low	On-site injury, on-site facility denial less than one month and no impact on food, water supply or habitat.

*Note: These effects are after mitigation measures have been employed.
**Note: Fatalities – Persons killed by prompt doses which cause death out to 60 days post-exposure.
***Note: Injuries – Persons injured and unable to return to work, or requiring hospitalization.

Incorporate any contributing events or conditions that could influence the progression of the scenario or alter the magnitude or nature of the consequences. For example, failure of fire suppression systems to activate following initiation of a fire would change the accident progression. Likewise, different levels of combustible loading in a given area might increase or decrease the magnitude of the fire. Either or both events might affect the possible level of damage to the facility or quantity of hazardous material released.

For events that take a finite amount of time between the initiator and the barrier failure (e.g., a loss of purge flow resulting in a buildup of a flammable mixture), calculate that time.

For each combination of hazard and release type identified, select initiating events and accident scenarios ranging from minor to severe.

3.3.6.6 Y-12 Plant Emergency Management Hazards Assessment Event Scenarios

The EMHA process should postulate events covering the full range of possible initiators and resulting event severity levels. Initiating events and mechanisms considered in the Y-12 EMHA process include the traditionally defined operational "accidents" as well as natural phenomena events, external events and malevolent acts. (Refer to Appendix H.)

Typically design basis events, herein referred to as operational accident events, are assessed during the facility safety analysis process and documented in the Y-12 Authorization Basis. Both “severe” events (natural phenomena and external) and malevolent acts, considered as beyond design basis events, are included in the facility-specific EMHA because they represent the upper end of the consequence spectrum, for which prompt recognition and response may be essential to mitigation of both the event and its health and safety consequences.

Section 6 of a typical Y-12 facility-specific EMHA (EMPO/HA-514-xxx) includes the spectrum of event scenarios postulated and analyzed to cover the full range of possible initiators and severity levels. In descending order of severity, Section 6 will include all (as applicable) of the initiating event scenarios found in Appendix H of this document.

3.3.7 Estimate Source Term

3.3.7.1 Radiological Source Terms

The source term (ST) information, which may result from a mass of material escaping the confines of a primary containment, may be determined. The airborne source term is typically calculated by the following linear equation. During the release of various sources of airborne material generated from an accident, some or all of these factors may need to be determined for particular releases.

The final ST is calculated as follows:

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

or

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

where

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

DOE-HDBK-3010-94 provides 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 EMHA. Accident-specific ARF-RFs and ARRs derived in other safety documents may also be used in EMHA.

3.3.7.2 Chemical Source Terms

Interactive computer codes for calculating the source term for chemical releases have been developed and are included as a front-end preprocessor to some dispersion models, e.g., Complex Hazardous Air Release Model (CHARM) and Area Locations of Hazardous Atmospheric (ALOHA), described in Appendix E of this document, and in the broader suite of models listed in *Atmospheric Dispersion Modeling Resources.*

Calculation capabilities include evaporation rates and leak rates from holes in tanks and from broken pipes. Specialized codes such as LEAK have also been developed and are retained for use as needed for chemicals like fluorine and uranium hexafluoride which may exhibit unique discharge properties. In many cases, a conservative manual estimate of the chemical source term may be appropriately applied, based on the stored quantity and a reasonable estimate of release time. Source term units reported in EMHA will be mass-per-unit time.

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

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

Hazardous reaction and/or combustion products may be released during an emergency event and must be considered in the EMHA process. Spilled materials, either compatible or incompatible, may mix and react to produce toxic vapors or heat that could result in a fire. Toxic combustion products may result from incomplete or uncontrolled burning of materials.

3.3.8 Estimate Potential Event Consequences

DOE modified the Nuclear Regulatory Commission's (NRC's) proposed release fractions [Nuclear Regulatory Guide (NUREG)-1140] for source term determination based on experimental and historical observations. The following set of release fractions will be utilized for hazardous material (radiological and nonradiological) release source term determinations unless an event-specific ARF is determined:

DOE Proposed Release Fractions

3. Noble gases	1E-0	1
4. Highly volatile/combustible	5E-1	0.5
5. Carbon	1E-2	0.01
6. Semivolatile	1E-2	0.01
7. Unknown form	1E-2	0.01
8. Nonvolatile solid/powder/liquid (explosion)	1E-1	0.1
9. Nonvolatile solid/powder/liquid (fire)	1E-3	0.001
10. Uranium/plutonium/thorium metal (explosion)	1E-1	0.1
11. Uranium/plutonium/thorium metal (fire)	1E-3	0.001

Estimate potential consequences of the hazardous material scenarios developed in the preceding section to determine the area(s) potentially affected.

Document in EMHA the methods and calculation models used in estimating consequences in such a manner that the analyses and their results can be critically reviewed, understood and, if necessary, reconstructed by independent experts.

The release calculations yield a quantitative estimate of the consequences (e.g., radiation dose, or peak concentration of a toxic chemical) of each release at each receptor of interest. The consequences at these locations form the bases for emergency planning and preparedness. Analyze the following receptor locations for each facility and/or transportation incident utilizing two meteorological sets: (1) a "conservative meteorological set (i.e., wind speed at 1 m/s and an atmospheric stability of F) and (2) a "typical meteorological" set (i.e., wind speed at 3 m/s and an atmospheric stability of D).

1. Thirty m from the release point or edge of the spill. The consequence (e.g., radiation dose or peak concentration of a toxic chemical) at this receptor location provides the demarcation between an accident that would require emergency response organization involvement (e.g., ALERT) and one that would not.

2. Distance from the release point or edge of the spill to the nearest facility boundary. The facility boundary is the demarcation between the facility and its immediate vicinity and the remainder of the site. The consequence (e.g., radiation dose or peak concentration of a toxic chemical) at this receptor location provides the demarcation between an ALERT and SITE AREA EMERGENCY (SAE) declaration.

3. Distance from the release point or edge of the spill to the closest site boundary. The consequence (e.g., radiation dose or peak concentration of a toxic chemical) at this receptor location is the demarcation for a GENERAL EMERGENCY (GE) declaration.

Note: See Appendix F of this document, "Isodose Concept," for graphic representation of relationship between the receptor points and emergency classification.

4. The maximum distance for which a consequence threshold is exceeded for a given event.

5. Determine other onsite receptor locations of interest for the facility being analyzed. Give consideration to adjacent facilities with significant occupancy, protected area boundaries where outdoor assembly points are normally located, and emergency response facilities (e.g., emergency control center, technical support center, personnel decontamination center, fire hall, security command center, etc.).

6. At a minimum, EMHA will include tables with the following specified information provided for the key receptor locations under the specified meteorological conditions:

   - identification of receptor
   - Distance to receptor from release point
   - Consequence (dose or concentration, im ppm) at receptor
   - Plume travel time in minutes

7. At a minimum, key Y-12 receptors are defined as follows:
   (Additional receptor locations, specified by EMPO, will be identified and added as appropriate.)

   <u>ONSITE:</u>
   - 30 m from release point
   - Facility boundary
   - Assembly point(s) for the facility
   - Emergency Control Center/Technical Support Center (9706-2)

- Y-12 Technical Support Center
- Medical Staging Depot (9723-28)
- Security Command Center (9710-3)
- Fire Command Center (9710-2)
- Nearest Site boundary

OFFSITE
- Nearest resident
- Nearest business
- Oak Ridge Mall
- Oak Ridge Hospital
- Woodland Elementary School
- Oak Ridge High School

8 Analyze, using the following receptor points, hazardous material releases related to transportation accidents.

- Thirty m from the release point or edge of the spill.
- One hundred m from the release point or edge of the spill. This receptor point is analogous with the facility boundary for a transportation accident occurring outside a fixed facility.
- The maximum distance for which a consequence threshold is exceeded for a given event.

9. Compare the results at the 30 m, facility boundary, and site boundary receptor locations to the applicable consequence thresholds. Appendix G of this document, "Consequence Thresholds for use in Facility Hazards Assessment," provides an explanation of the consequence thresholds.

10. Calculate the consequences of the hazardous material releases at the selected receptor locations using the following DOE-YSO-approved dispersion models for Y-12.

- Primary radiological model is HOTSPOT
- Secondary radiological model is Atmospheric Release Advisory Capability (ARAC)
- Primary nonradiological model is Complex Hazardous Air Release Model (CHARM)
- Secondary nonradiological model is Hazardous Atmospheric Release Model II (HARM)

11. Models used in the EMHA process are the same as those used in the emergency response phase, and those models are resident in the OREOC Consequence Assessment Team Room.

12. The *Tennessee Multi-Jurisdictional Emergency Response Plan for the United States Department of Energy* specifies that, on activation of OREOC, the consequence assessment team will run computer programs which estimate the transport, dispersion, and deposition of hazardous material(s). Plume modeling consists of providing source term parameter sheets, which provide source term data, conditions pertaining to the release, and meteorology, centerline projections, graphic imagery of the plume over site maps, and standards for units of measure.

3.3.8.1 Technical Basis Summary

EMHA and Safety Analysis processes have much in common and a few prominent differences. This document recognizes this fact and utilizes the safety analysis process to eliminate duplication of analysis effort and documentation.

Both safety analysis and Hazards Assessment documents describe the facility and process, describe the screening of the inventory and analyze release scenarios. There are significant differences between the screening criteria, scope of the release scenarios and, in some cases, the receptor locations used in the two analyses. Different codes are frequently used to calculate the consequences of releases to the environment. Some of the differences are small but others are more fundamental. For example, both processes begin by screening the hazardous material inventory to determine the need for further analysis. The screening criteria are similar for radioactive material but are significantly different for chemicals. There is a fundamental difference in scope of the accident scenarios because both malevolent acts and a broader range of severity levels are analyzed for emergency planning purposes.

To reduce duplication of analysis and documentation effort at Y-12, preparation of the emergency management hazard assessment begins with the identification of safety documentation previously developed for a facility. The facility, site and process descriptions, the hazardous materials inventory and many of the accident source terms are extracted directly from the safety documentation. As necessary, additional scenarios are developed to cover the broader range of events, including malevolent acts needed to fill out the facility emergency planning basis. Separate consequence calculations are performed using the emergency response models. Finally, the consequences of the analyzed events are interpreted to determine the appropriate emergency classifications and the size of the emergency planning zone is determined. Throughout the process, the analyst identifies and records the indications and symptoms that will help ensure the rapid recognition and classification of the analyzed events, should they ever occur.

To ensure that there is a clear understanding of the safety documentation used in the EMHA process, Section 8 of a typical Y-12 facility-specific EMHA (EMPO/HA-514-xxx) will list the documentation utilized by the analyst.

3.3.9 Atmospheric Transport and Dispersion Models

The Y-12 Plant is involved in operations and activities that implicate a broad range of hazards which must be considered in effective emergency planning and preparedness. Due to the complexity of air quality simulation and hydrology involving complex source dynamics and chemistry, Y-12 utilizes the previously identified dispersion models for Hazards Assessment. However, several codes for nonradiological and radiological transport and diffusion modeling are available for comparison and available from EMPO as follows: (1) Phillips Laboratory Directorate of Geophysics developed "Air Force Toxic Chemical Dispersion Model (AFTOX)," (2) NOAA and Environmental Protection Agency (EPA) developed "Area Locations of Hazardous Atmospheres (ALOHA)," (3) "Atmospheric Release Advisory Capability (ARAC)," (4) Radian Corporation developed "Complex Hazardous Air Release Model (CHARM)," (5) Homann Associates Incorporated developed the "Emergency Prediction Information Code (EPIcode)," (6) "Hazardous Atmospheric Release Model (HARM)" developed by the National Oceanic and Atmospheric Administration (NOAA), (7) Defense Special Weapons Agency developed "Hazard Assessment System for Consequence Analysis (HASCAL), (8) Lawrence Livermore National Laboratory developed "HOTSPOT," (9) U.S. NRC developed "Radiological Assessment System for Consequence Analysis (RASCAL), and (10) DuPont Incorporated developed "*SAFER* Emergency Management System." A brief description of these models are shown in Appendix E of this document.

3.3.10 Developing the Y-12 Emergency Planning Zone (EPZ)

3.3.10.1 Facility-Specific EPZ

If a facility-specific EMHA indicates no emergency higher than the Alert class, an emergency planning zone (EPZ) will not be defined. The EPZ shall, as a minimum, include the area where people would be at risk of death or severe injury from severe releases under worst-case (conservative) meteorological conditions. The EPZ shall be based on objective analysis for the hazards associated with a specific facility, and not on arbitrary factors such as historical precedent or distance to the site boundary.

The following steps will be utilized in developing a technically defensible EPZ:

1. From the results of facility consequence calculations, determine the distance at which a threshold for early lethality (i.e., ERPG-3 or equivalent, or 100-rem TEDE) is exceeded for the most severe analyzed release (excluding those which result from extreme malevolent acts) under worst-case meteorological conditions (i.e., wind speed of 1 m/s and stability class of F). This calculated distance represents the smallest EPZ radius.

2. Determine the distance at which a PAC (i.e., ERPG-2 or equivalent, or 1 rem TEDE) would be exceeded for the most severe analyzed release under worst-case meteorological conditions (i.e., wind speed of 1 m/s and stability class of F). Exclude analyses that are "beyond design basis" natural phenomena events or which result from "extreme" malevolent acts. This calculated distance or 16 km, whichever is smaller, is the largest EPZ radius.

3. Within the limits of the largest and smallest EPZ radii, EMPO will adjust the size and shape of the Y-12 EPZ in accordance with the following principles.

    - Consider the full spectrum of emergencies that contribute to facility offsite risk.

        — If the most severe analyzed release results 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 shall 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 is utilized.

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

        — If the hazard is radiological, an EPZ radius closer to the minimum than the maximum value shall be selected. This rationale is based on the wide margin (a factor greater than 100) between the thresholds for protective action and early lethality, 1-rem and 100-rem, respectively.

        — Contrarily, if the hazard is nonradiological, an EPZ radius closer to the maximum than the minimum value shall be selected because of the narrow margin between the concentration thresholds for protective action and lethality (typically a factor of 3 to 10 between ERPG-2 and ERPG-3 or equivalent values), and the potential for severe irreversible effects resulting from exposure to concentrations between the protective action and lethality thresholds.

    - 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 shall be defined to simplify communications and offsite interactions.

    - Onsite transportation accidents involving hazardous materials should be handled as follows:

- Transportation of hazardous materials within the site shall be analyzed in facility-specific Hazards Assessments for fixed facilities with which the materials are associated.

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

- The EPZ for a facility shall not be extended beyond the Y-12 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.

The Y-12 facility EPZ determination logic is shown in Fig. 3. A completed copy of this figure is typically included in the facility's EMHA.

3.3.10.2 Y-12 EPZ

The Y-12 EPZ is derived from the compilation of facility-specific EPZ determinations. The Y-12 EPZ is developed in coordination with the state and local governments utilizing sectors that conform to natural and jurisdictional landmarks. A Y-12 EPZ Technical Basis Document summarizes this activity. Individual sector boundaries that comprise the Y-12 EPZ are included in both the *U.S. Department of Energy Oak Ridge Reservation Emergency Plan* and *The State of Tennessee Multi-Jurisdictional Emergency Response Plan(s) for The United States Department of Energy Oak Ridge Reservation*.

- The primary purpose of defining the Y-12 EPZ is to ensure significant planning, preparedness, and resource measures are applied where the maximum benefits for protection of personnel is realized. Among the planning, preparedness, and response activities that Y-12 is expected to support on behalf of the population within EPZ are the following.

  - Mechanism(s) for identifying and activating onsite and off-site emergency response organizations.

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

  - Development and delivery of public information and education materials to ensure timely and correct response to warnings.

  - Identification or predetermined response actions.

  - Development and testing of response procedures.

- The size of the Y-12 EPZ will be no larger than the resources allocated to protect the people who are at risk. A larger EPZ may actually be less effective at mitigating overall risk to the population than a smaller one.

- Adjust the size and shape of the Y-12 EPZ so that:

  - EPZ conforms to the physical and jurisdictional realities of ORR and the Y-12 Site.

  - EPZ gives confidence that planning and preparedness is sufficiently flexible and detailed to deal with a wide range of types and magnitudes of emergency conditions.

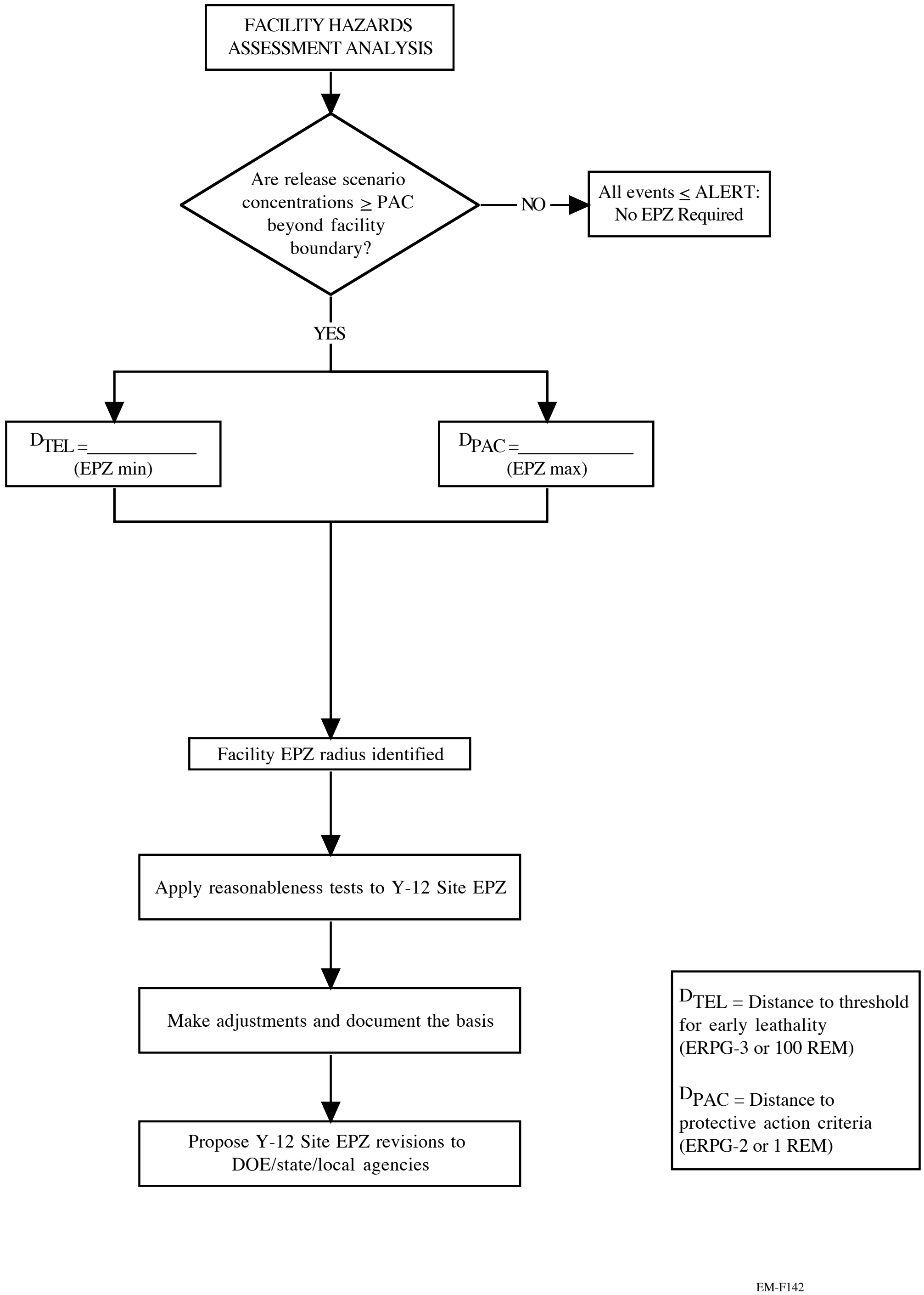

Fig. 3. Y-12 facility EPZ determination logic

- Significant considerations that cannot be readily stated as quantitative guidance are presented next in the form of questions to be used as "tests of reasonableness" for EPZ defined.

  — Are the maximum distances to PAC level impacts for most of the analyzed accident scenarios (e.g., all but the most severe consequence scenario for each hazardous material) equal to or less than the EPZ radius selected?

  If the answer is yes, the selected EPZ radius is reasonable, and should be judged against the remaining criteria. However, if more than just the most severe of the analyzed scenarios or any single-failure event will produce consequences exceeding PAC beyond the chosen EPZ distance, increase the EPZ radius until this criterion is satisfied.

  If the EPZ radius encompasses a vast majority of accidents analyzed, the radius may be decreased until the aforementioned criteria are met. Subject the radius to the remaining reasonableness criteria.

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

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

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

  — What enhancement of the Y-12 preparedness stature would be achieved by increasing the selected EPZ radius?

  The intent of this test is to identify where a larger EPZ might result in a significant increase in preparedness without corresponding large increases in cost or other detriment.

- Document in the Y-12 site EPZ basis consideration of each test of reasonableness and any resulting adjustments to the EPZ size. The resulting value and its bases provide the beginning point for discussions with state and local authorities.

- EPZ calculations will provide for potential releases by aquatic or other nonatmospheric pathways if these analyses were performed in EMHA. The Y-12 emergency plan and implementing procedures will provide for timely communications with those entities, such as health departments or utility companies in downstream communities that draw water from an effected river, regarding any release and its implications.

- The planning process shall recognize and provide for the need to carry out protective actions in limited portions of EPZ for specific events or conditions. This is accomplished by dividing the EPZ into sectors by direction and radial distance and using natural or jurisdictional boundaries are utilized to define protective action zones.

3.4 EMERGENCY CLASSES AND EMERGENCY ACTION LEVELS

Emergency classifications are determined by comparing hazardous material release consequences to the protective action criteria. Criteria used to detect and recognize, classify and/or identify the potential consequences of a specific operational emergency event are referred to as Emergency Action Levels (EALs).

Protective actions will be correlated with emergency classes and EALs to ensure that physical measures, such as evacuation or sheltering, are taken to prevent potential health hazards resulting from the release of hazardous materials to the environment, from adversely affecting employees or the offsite population. This information will be summarized in Section 10 of the typical facility-specific EMHA, EMPO/HA-514-xxx.

3.4.1 Emergency Action Level (EAL) Development

EALs are developed and maintained in accordance with Appendix D, "Y-12 Emergency Action Level Process," EMPO-559, as found in *The Oak Ridge Y-12 Plant Emergency Plan*. The facility-specific Hazards Assessment is the technical basis for that facility and provides the foundation on which to develop EALs and the corresponding event classifications.

For detection and recognition methods that correlate directly with actual or potential consequences, calculate specific values or conditions that correspond to each emergency class. Indications for which specific values or conditions may be calculated are alarms, instrument readings, sample analysis results, and system or equipment status indicators. Specific values or conditions that indicate when a PAC has or will be reached at a facility or site boundary becomes the EAL.

In most cases at Y-12, event indicators or symptoms are not detectable by quantitative methods, or they may be indirectly recognized. If a readily recognizable event has the potential for causing a release of hazardous material, and an actual release would be difficult or impossible to confirm, the recognition or observation of the event becomes the EAL, and the event classification is based upon the maximum consequences determined in the EMHA process.

The Hazards Assessment will summarize the proposed correlation with the EAL(s). The summary will include identifying the event classification, the EAL statement, and the basis for the EAL.

3.4.2 Assess Adequacy of Instrumentation

Assess the adequacy of determining barrier failure/challenge and/or an event occurrence based on the identified instrumentation. Rank the instrumentation identified as to its relative value in determining barrier integrity or event occurrence.

Assess the adequacy of available instruments to estimate the potential source term due to a barrier failure or event occurrence.

3.4.3 Recommend Improvements

As appropriate, summarize recommendations of the types of instruments needed to better define barrier failure/challenge, event occurrence, and source term determination when the barrier fails in EMHA.

3.5 CONFIGURATION MANAGEMENT

3.5.1 Review Frequency

Ensure that Hazards Assessments/Surveys are reviewed and assessed whenever significant modifications to the facility process or material inventory occurs.

3.5.2 Change Control

3.5.2.1 Establishment of Inventory Limits

Instruction Y74-801INS, *Hazard Identification*, requires existing facilities to prepare and submit hazard identification documents which provide information supporting facility classification and development of authorization basis documents, emergency management hazards assessments and emergency planning, and fire hazards analyses. These latter documents provide the basis for safe operations and emergency response. The instruction requires that a hazardous or radioactive material shall not be introduced into a facility until appropriately addressed, when required, in authorization basis documents.

Information contained in the hazard identification document must be kept current to reflect operational changes and to maintain consistency with the authorization basis documents in accordance with Y74-801INS. The operations manager and the Operational Safety Board, where applicable, have responsibility for approval of the hazard identification document.

Responsibility for ensuring that hazard identification inventories and limits are up-to-date are as follows:

1. The Operations Manager establishes limits for the facility in the MAQs identified in the Hazard Identification Document. These limits (i.e., the MAQs) shall not be exceeded.

2. The Operations Manager serves as the approval authority for the introduction of radioactive and/or hazardous materials into the facility in accordance with the approved MAQs. This authority may be delegated. If multiple organizations conduct operations within a facility, the designated individual shall act on behalf of all organizations.

3. The Operations Manager will report to EMPO any planned increase in an MAQ, including the introduction of a new material. Notification may be by e-mail or other convenient written format.

4. The Operations Manager ensures that planned increases in MAQs are appropriately assessed before being implemented.
   A. EMPO will assess planned increases in MAQs for impacts in accordance with Y40-137, incorporate necessary revisions to emergency planning documents, then notify the Operations Manager to proceed with planned increases in MAQs.
   B. The Operations Manager will annotate the working copy of the Hazard Identification Document with increased MAQs and implement the increase after receiving EMPO approval.

5. Upon effective implementation of decreases in MAQs, the Operations Manager will notify EMPO of the of the decrease, and annotate the decrease in the working copy of the Hazard Identification Document. Notification may be by e-mail or other convenient written form.

3.5.2.2 Hazardous Materials Tracking

Instruction Y74-801INS, *Hazard Identification*, requires that the hazardous materials limits identified in the hazard identification document be used to update the Hazardous Material Inventory System (HMIS). Each organization manager appoints hazardous materials custodians in their facilities to execute this responsibility.

Instruction Y73-181INS, *Hazardous Material Management Program*, requires that the hazardous materials custodian manages and maintains accurate information regarding hazardous materials inventory via HMIS for all hazardous materials within his/her control areas. The procedure also requires adherence to the hazardous materials requirements of the facility's authorization basis. The HMIS system does not currently contain a data field that allows a facility to enter the approved maximum quantities for the hazardous materials.

3.5.2.3 Change Control Process

The change control process provided in Y15-187, *Integrated Safety and Change Control Process*, will ensure that changes to applicable Y-12 facilities and/or structures, systems, and components are properly identified, developed, reviewed, approved, implemented, and documented. The change control process provides an Integrated Safety Management approach, as defined in Y10-202, *Integrated Safety Management Program*.

Relative to the EMHA process, the following change control criteria will initiate a review if a positive screen occurs.

<u>Change Control Criteria</u>

1. Does the proposed change increase the maximum anticipated quantity of material identified in the approved Hazards Identification (form UCN-20790)? Include, as applicable, both physical limits (e.g., tank capacity) and associated administrative limits (e.g., maintain tank level <75%). Expected or historical quantities may have been used where physical and administrative limits did not exist.

2. Does the proposed change alter the identified hazardous materials storage and/or process location(s)?

3. Does the proposed change alter the conditions under which the material is stored or used? Include process systems or containers that hold the material and barriers/mitigative features that may affect its release or dispersion (e.g., shipping containers, buildings, berms, sumps, or catch basins). Identify, where applicable, security and access controls for the storage and use locations.

4. Does the proposed change alter the engineered controls, safeguards, or safety systems designed to prevent or mitigate a hazardous material release? This includes both automatic and manually activated mitigating systems (e.g., fire sprinklers, filters, scrubbers, isolation dampers) as well as passive mitigating features and engineered geometry or configuration controls for fissionable materials.

5. Does the proposed change alter the administrative controls that would prevent or mitigate the initiation of a hazardous materials release? This includes such things 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.

3.6 HAZARDS SURVEY AND HAZARDS ASSESSMENT FORMATS

3.6.1 Hazards Survey Format

The Hazards Survey is formatted in accordance with the following sections:

- Title/approval page
- Document change record
- Table of contents
- List of figures
- List of tables

Section 1 Introduction

Section 2 Scope
(1) Description
(2) Facilities covered

Section 3 Qualitative Summary
(1) Facilities Having the Potential for Operational Emergencies Requiring Classification
(2) Facilities Not Having the Potential for Operational Emergencies Requiring Classification
(3) Base Program Requirements

3.6.2 Hazards Assessment Format

The Hazards Assessment is formatted in accordance with the following sections:

- Title/approval page
- Document change record
- Table of contents
- List of figures
- List of tables
- List of acronyms

Section 1 Introduction

Section 2 Facility Description
(1) Facility Mission
(2) Location
(3) Facility Layout

Section 3 Principal Operations and Processes

Section 4 Hazard Identification and Screening
(1) Chemical
(2) Radioactive
(3) Transportation
(4) External Hazards

Section 5 Hazard Characterization
(1) Chemical
(2) Radioactive
(3) Barrier identification

Section 6 Event Scenarios

Section 7 Event Consequence Assessment
(1) Calculational Models
(2) Source Term Determinations
(3) Results

Section 8 Technical Basis Summary

Section 9 EPZ Determination

Section 10 Emergency Classes and EAL

Section 11 Maintenance And Review of Hazards Assessments

Section 12 References

3.7 TEMPORARY/TRANSITORY FACILITY HAZARDS

Temporary and/or transitory hazards, such as short-duration storage of hazardous materials or special process testing within a facility will be covered by specific updates (as an addendum) to EMHA and associated emergency planning documents (e.g., classification procedure, protective action procedure, etc.).

3.8 QUALITY ASSURANCE

The Y-12 EMPO manager is responsible for ensuring that all Quality Assurance requirements are met during the implementation of the EMHA process.

3.9 HAZARDS ASSESSMENT PROCESS CONTROL

3.9.1 Review and Approval of the Facility-Specific Hazards Survey and Assessment

The facility-specific Hazards Survey and Hazards Assessment undergo an internal review by the EMHA team and selected cognizant personnel within the facility prior to being routed for formal review and approval.

As applicable, Hazards Surveys and Hazards Assessments are reviewed by the following personnel/organizations:

- Facility/Operations Manager
- SMEs
- Y-12 EMPO
- Applicable DOE COR (i.e., YSO)

Allow four to six weeks (maximum) for this review cycle. Comments received after the review cycle should not delay the approval of the document but rather be incorporated into the next revision.

The EMHA team leader coordinates the comment review cycle, responds to all comments and dispositions comments as appropriate.

Upon completion of the review cycle, the Hazards Survey and Hazards Assessment are at minimum approved by the following personnel/organizations:

- Facility/Operations Manager or Event Contractor
- Y-12 EMPO Manager
- Applicable DOE COR (i.e., YSO)

3.9.2 Revision Control

Approved EMHAs are reviewed and revised when any proposed change in the facility or its operations results in a determination identified during the implementation of Standing Order SO-Y-12-00-01. EMHA is also reviewed and revised on an annual basis. The annual review allows for a ± 25% window in its performance. Any reviews that will extend ≥ 25% beyond the annual due date requires notification to the Y-12 EMPO manager and/or YSO.

3.10 RECORDS

Maintain all Hazards Identifications, Surveys, and/or Hazards Assessments generated by this document.

As applicable, the record file for the facility will contain the following:

1. A completed hazards identification (Form UCN-20790),
2. A completed hazards screening,
3. A memo to file documenting the facility walkdown,
4. A completed Hazards Survey,
5. A completed Hazards Assessment, and
6. All working files (i.e., source term determinations, consequence assessments, etc.) used in developing the Hazards Assessment.

4. REFERENCES

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

American Industrial Hygiene Association (AIHA) 1999. *The AIHA 1999 Emergency Response Planning guidelines and Workplace Environmental Exposure Level Guides Handbook.*

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

Appendix A
TERMS AND DEFINITIONS

Absorbed Dose. The amount of energy imparted to matter by ionizing radiation expressed in rads.

Accident. A deviation from normal operations or activities associated with a hazard that has the potential to result in an emergency.

Airborne Release Faction. The coefficient used to estimate the amount of a hazardous material (material at risk) suspended in air and made available for airborne transport under a specific set of induced physical stress.

Airborne Release Rate (ARR). The airborne release rate is the rate necessary to estimate the potential airborne release from postulated accident conditions and is based on measurements over some extended period of time.

Alert. The emergency class associated with events predicted, in progress, or having occurred that involve an actual or potential substantial reduction in the level of facility safety and protection. On the Oak Ridge Reservation, an Alert classification is appropriate if unplanned events result in hazardous material being released to the environment in concentrations that will result in exposures that exceed a Protective Action Criterion at or beyond 30 m from the point of release to the environment, but not at or beyond the facility boundary.

Beyond Design Basis Accidents. Those accidents postulated for emergency management purposes which, due either to their low probability/high consequence or high probability/high consequence, exceed the parameters of the Design Basis Accident.

Committed Dose Equivalent (CDE). The predicted total dose equivalent to an organ or tissue over a 50-year period after intake of a radionuclide into the body and is expressed in rems. It does not include contributions due to penetrating radiation from sources external to the body.

Committed Effective Dose Equivalent (CEDE). The sum of the committed dose equivalents to all organs and tissues in the body, each multiplied by an appropriate weighting factor that represents the relative vulnerability of different parts of the body to radiation expressed in rems.

Consequence. The result or effect (usually expressed in exposure to radiological or chemical hazards) of a release of hazardous materials to the environment.

Damage Ratio (DR). The damage ratio is the fraction of the material at risk that is actually impacted by the accident-generated conditions. The DR is an estimated value based on engineering analysis of the response of structural materials for the containment to the type and degree of stress or force generated during the event. Standard engineering approximations are typically employed in order to obtain a realistic understanding of the potential effect of the accident.

Dose Equivalent. The product of the absorbed dose in an organ or tissue and quality factors, which represent the relative damage to the organ or tissue by the different types of radiation involved, and perhaps other modifying factors that represent the distribution of radiation expressed in rems.

Effective Dose Equivalent (EDE). An estimate of the total risk of potential effects from radiation exposure, expressed in rems. It is the sum of total dose equivalents to all organs and tissues in the body, each multiplied by an appropriate risk-based weighting factor. Use of the weighting factors permits addition of dose equivalents from internally deposited radionuclides and from exposures to penetrating radiation from sources external to the body.

Emergency. An emergency is the most serious event in the Occurrence Reporting System (DOE 232-1A, "Occurrence Reporting and Processing of Operations Information"). It consists of any unwanted operational, civil, natural phenomena, or security occurrence that could endanger or adversely affect people, property, or the environment.

Emergency Action Level (EAL). Criteria used to detect, recognize, and determine the emergency class of Operational Emergencies.

Emergency Class. A severity group within the Operational Emergency category. Operational Emergencies involving an actual or potential release of hazardous material are classified as: Alert, Site Area Emergency, or General Emergency depending on the measured or projected consequences.

Emergency Plan. A clear and concise description of the overall emergency organization, designation of responsibilities, and procedures involved in coping with any or all aspects of an Operational Emergency.

Emergency Planning Zone (EPZ). A geographic area surrounding a specific facility for which special planning and preparedness efforts are carried out to ensure that prompt and effective protective actions can be taken to reduce or minimize the impact to onsite personnel, public health and safety, and the environment in the event of an Operational Emergency.

Emergency Response Planning Guidelines (ERPGs). A system of hazardous chemical personnel exposure levels developed for use in emergency planning and response. A committee of the American Industrial Hygiene Association approves ERPGs.

Event. Any real-time occurrence or significant deviation from planned or expected behavior that could endanger or adversely affect people, property, or the environment.

Facility Boundary. The receptor location at which measured or projected hazardous material consequences differentiates between the Alert and Site Area Emergency classifications for a particular event.

General Emergency (GE). The emergency class associated with events that are in progress or have occurred that involve actual or imminent catastrophic failure of facility safety systems with potential for loss of confinement integrity, catastrophic degradation of facility protection systems, or catastrophic failure in safety or protection systems threatening the integrity of a weapon or test device that could lead to substantial offsite impacts. Environmental releases of hazardous materials can reasonably be expected to exceed a Protective Action Criterion at or beyond the site boundary.

Hazards Assessment. The process of identifying and analyzing those hazards significant enough to warrant consideration in a facility's operational emergency hazardous material program. This hazard assessment process provides the technical basis for emergency classification and other response procedures.

Hazardous Material. Any solid, liquid, or gaseous material that is toxic, flammable, radioactive, corrosive, chemically reactive, or unstable upon prolonged storage in quantities that could pose a threat to life, property, or the environment.

Isodose System. A system of classifying Operational Emergencies where the consequence threshold remains constant and the receptor location changes (30 m, facility boundary, site boundary) to determine emergency classification.

Leak Path Factor (LPF). The leak path factor is the fraction of the radionuclides in the aerosol transported through some confinement deposition of filtration mechanism. There can be many LPFs for some accident conditions. Where multiple leak paths are involved, their cumulative effect is often expressed as one value that is the product of all leak path multiples. The LPF is a calculated or standard value based on established relationships between size of the particulate material, airborne transport mechanisms, and losses by deposition mechanisms, or specified filtration efficiencies.

Material At Risk (MAR). The amount of hazardous material that is available to be acted on by a given physical stress. Multiply MAR by the appropriate release fraction to determine the source term.

Maximum Inventory. For a process; the maximum quantity of a hazardous material that a process uses during the process cycle. For storage tanks, the maximum inventory is equivalent to the physical capacity of the tank.

Operational Emergency. Significant accidents, incidents, events, or natural phenomena that seriously degrade the safety or security of a facility and require a time-urgent response from outside a facility.

Protective Action. Physical measures (e.g., evacuation or sheltering) taken to prevent potential health hazards, resulting from a release of hazardous materials to the environment, from adversely affecting employees or the offsite population.

Protective Action Criteria (PAC). Hazardous material exposure or dose values used in emergency planning and response. If consequences exceeding a Protective Action Criterion are observed or predicted, action to prevent or minimize the consequences must be taken.

Release. An airborne effluent to the environment as this pathway typically represents the most time-urgent situation. Spills to aquatic and ground pathways in most instances do not have the same time urgency as airborne releases.

Respirable Fraction. The fraction of airborne hazardous materials as particles that can be transported through air and inhaled into the human respiratory system, generally defined as particles 10-µm Aerodynamic Equivalent Diameter and less in size.

Safety Analysis Report (SAR). A documented process to systematically identify the hazards of a DOE operation; to describe and analyze the adequacy of the measures taken to eliminate, control, or mitigate identified hazards; and to analyze and evaluate potential accidents and their associated risks.

Segment. A demarcation used in Hazards Assessments where the system, section, building, etc., is not affected by the failure of other systems, sections, buildings, etc.

Site Area Emergency (SAE). The emergency class applicable to events that are in progress or have occurred involving actual or likely major failure(s) of facility safety or safeguard systems needed for the protection of onsite personnel, the public health and safety, the environment, or national security. Environmental releases of hazardous materials are expected to exceed a Protective Action Criterion (PAC) at or beyond the facility boundary but not at or beyond the site boundary.

Site Boundary. In general, the perimeter of the DOE-owned and controlled land surrounding the Y-12 Plant is the site boundary. Areas where the general public has uncontrolled access to areas at Y-12 are offsite for purposes of emergency classification unless it can be assured that those areas can be evacuated and access control established within one hour of event declaration.

Source Term (ST). The amount of material released to the environment or the rate at which it is released, expressed in terms that permit calculation of consequences at some distance from the release point.

Special Nuclear Material (SNM). Plutonium, uranium-233, uranium enriched in isotope 233 or 235; any material artificially enriched by any of these elements; or any other material which the U.S. Nuclear Regulatory Commission, pursuant to the provisions of Section 51 of the Atomic Energy Act, determines to be SNM, not including source material.

Target. As in DOE Order 470.1 and the Safeguards and Security Agreement Verification Guide, " . . . that which is threatened or at risk from theft, diversion, or damage." A target such as a quantity of plutonium is also a hazardous material, as defined previously.

Threshold for Early Lethality (TEL). 100 rem Total Effective Dose Equivalent (TEDE) or peak concentration of a hazardous material in air greater than or equal to the ERPG-3 or equivalent.

Total Effective Dose Equivalent (TEDE). The sum of the deep dose equivalent (from external exposure) and the committed effective dose equivalent (from internal exposure).

Uncontrolled Access. Oak Ridge Reservation locations where the general public is allowed unescorted access and it cannot be assured that the area can be evacuated and access control established within one hour of any Operational Emergency declaration.

Appendix B
FACILITY/SITE BOUNDARY GUIDELINES

Discussion

1. For many facilities and activities, there will be little or no question about what constitutes the facility operational and physical boundaries. The guidelines presented herein help to establish boundaries where they have not previously been defined or need revision based on the facility's location relative to other facilities.

2. The boundary definition adopted for a given facility determines whether certain events and conditions are classified as Alert or Site Area Emergency (SAE). In developing facility boundary definitions, keep in mind that the process of determining emergency classes shall always enhance communications and promote common understanding of the general level of severity or magnitude of the event, both within the Department of Energy (DOE) and contractor community, and for the general public and news media.

3. 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 (e.g., Alert), to those that affect the site outside the facility but not offsite areas (e.g., SAE), to those that affect offsite areas (e.g., 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 and site boundary may become one where they are both the same. Adjust emergency declarations accordingly using the most restrictive classification scheme.

Definition of Facility Boundary

1. The definition of a facility boundary considers material processing operation boundaries and physical boundaries (e.g., structural or geographical). 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.

2. The "facility boundary" concept is easy to apply to a facility that consists of a single building or structure. However, many facilities consist of large laboratory or manufacturing complexes that may include several buildings, structures, or installations.

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

4. Facility boundary receptor locations will meet several tests:

   a. Personnel whose normal work location is within the specified facility boundary are directly associated with the operation of the facility in question. Therefore, some offices, shops, and support facilities are part of the facility for Hazards Assessment purposes.

b. No other facility (as defined for Hazards Assessment purposes), and no road or other location routinely accessible to members of the general public will fall within the defined facility boundary.

c. If a physical boundary is not obvious or logical for a particular facility, the Hazards Assessment will utilize a nominal 100-m radius from the perimeter of the structure for analysis purposes to determine the emergency classes for facility events.

d. If the facility boundary (or the 100-m radius) coincides with or crosses a site boundary; encompass a significant number of other site workers; or crosses into areas routinely accessible to the general public; a higher classification for any given event is indicated. A 100 m analysis radius will be used as the standard "facility boundary" for facilities that are in close proximity to one another, unless a specific reason for applying a physical boundary exists. In this case the rationale for defining the physical boundary will be included in the EMHA.

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

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

   (2) Includes less than ten personnel not directly involved with the operations and management of the facility; and

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

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

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

(3) Large geographic areas enclosing multiple structures, operating areas or components.

(4) Distances between individual structures that exceed about 200 m are treated as separate facilities.

Definition of the Y-12 Site Boundary. The Y-12 site boundary is clearly identified for the Hazards Assessment process. If the general public is allowed unescorted access to areas of the Y-12 site (e.g., public highways), those areas are considered as offsite, unless it has been ensured that those areas can be evacuated and access control established within about one hour of any emergency declaration. For example, if Bear Creek Road is controlled and evacuated within one hour, this road is included within the Y-12 site boundary.

Facilities occupied by private business within the site boundary shall reach an agreement with DOE regarding emergency notification and protective action responsibilities and be considered on site for purposes of analysis and event classification.

Based on the previously stated rationale, Fig. 1 identifies the approved Y-12 site boundary. A narrative text of the Y-12 site boundary is as follows:

The boundary starts at a point along the west side of Scarboro Road near the existing guard portal and at the intersection of the patrol road (Midway Turnpike) that runs north of the Y-12 Plant with Scarboro Road;

Thence south with the boundary along the west side of Scarboro Road to Bear Creek Road then crossing Bear Creek Road continuing south to the west side of the railroad property;

Thence continuing south along the west property of the railroad to Second Street;

Thence continuing south, crossing Second Street and then continuing east along the south side of Second Street to the west side of Scarboro Road;

Thence continuing south along the west side of Scarboro Road to the north side of Old Bethel Valley Road;

Thence continuing west along the north side of Old Bethel Valley Road to the west side of Mount Vernon Road;

Thence continuing north and on the west side of Mount Vernon Road to a gravel road south of Sanitary Landfill II and Landfill IV.

Thence leaving Mount Vernon Road in a north westerly direction on the south side of the perimeter gravel road around Sanitary Landfill II and Landfill VI to monitoring well 54;

Thence leaving said gravel road and in a northwest direction 1,960 feet, more or less, to a point on the top of Chestnut Ridge;

Thence continuing in a westerly direction along the north side of a road that runs along the top of Chestnut Ridge to the west side of a gravel road (Diggs Road);

Thence continuing northwesterly and along the west side of Diggs Road to the south side of Bear Creek Road;

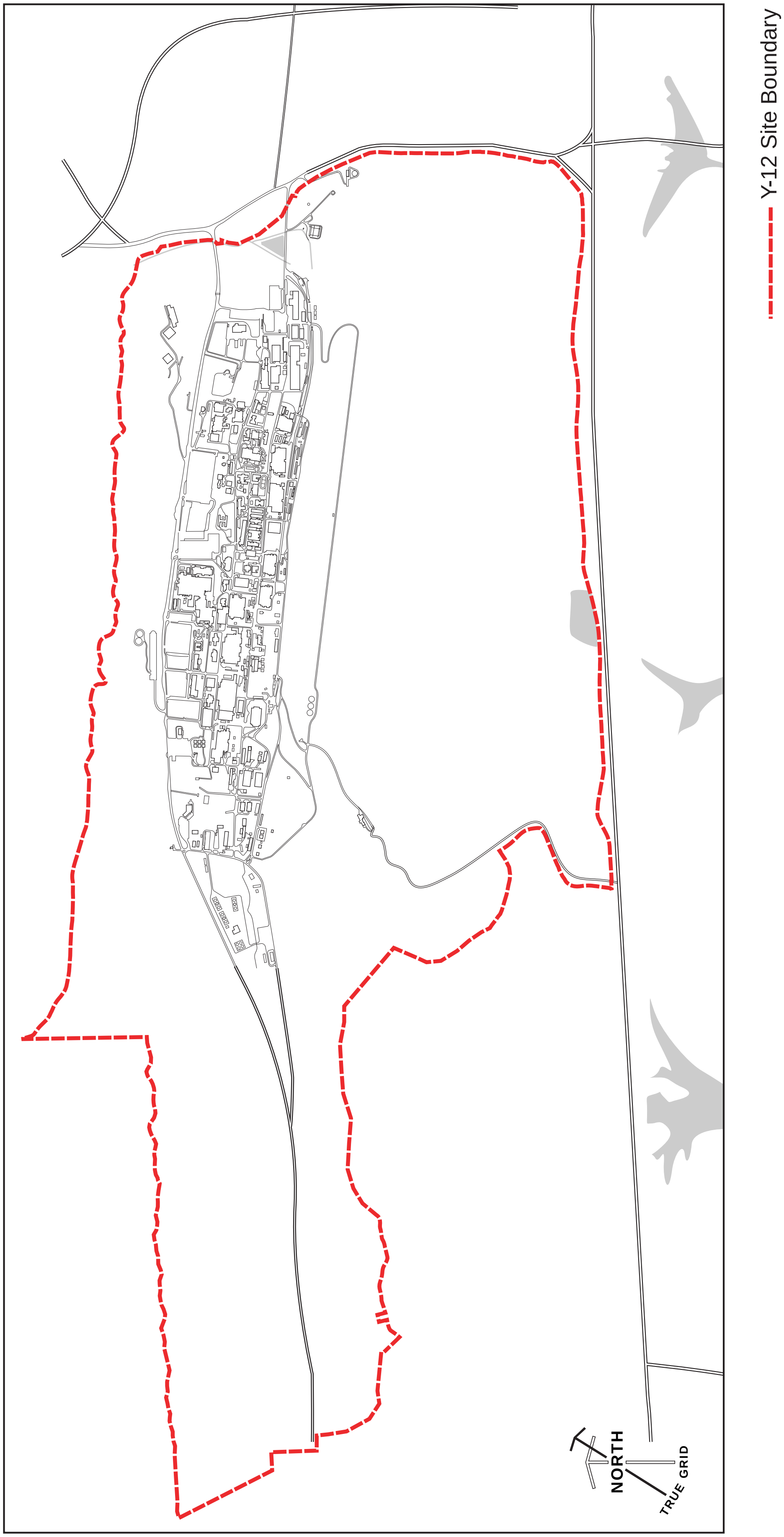


Fig. 1. Y-12 Site Boundary

Thence continuing in a west and northwesterly direction along the 229 Boundary line to a point on the ridge top of Pine Ridge;

Thence continuing in an easterly direction and along the top of the ridge to a point where the top of Pine Ridge intersects a Y-12 grid line designated E 50,000;

Thence north and with the E 50,000 grid line to existing fence along the north side of a gravel patrol road (Midway Turnpike) near the north property line of DOE,

Thence along the fence and in an south easterly direction to a gate on the patrol road which is approximately 200 north of the previous mentioned guard portal;

Thence crossing the patrol road at the gate to the west side of the patrol road;

Thence continuing along the west side of the patrol road to the point of beginning.

Appendix C
GUIDELINES FOR DOSE ESTIMATES

A. Inhalation Dose [(Committed Effective Dose Equivalent (CEDE)]

Reduce the number of radionuclides (normally performed by process stream or segment) carried through the applicable analysis by calculating their contribution to inhalation dose as follows:

1. Determine a source term by multiplying each isotope's Curie content by the appropriate airborne release fraction (ARF) and respirable fraction (RF). If comparing streams or materials at risk (MAR) directly, ARF and RF would be set to one for all isotopes. Hazards Assessment work uses the following ARF from DOE-STD-1027-92 and ARF and RF values from DOE-HDBK-3010-94.

Material state	Airborne release fraction
Gases	1.0E+00
Highly Volatile Combustible	5.0E-01
Semi-Volatile	1.0E-02
Solid, Powder, Liquid	1.0E-03

2. Multiply the resulting source term by the most restrictive inhalation dose conversion factor (DCF) stated in DOE/EH-0071 to obtain the potential dose in rem.

3. Determine the percent contribution of each isotope to the total dose (rem).

4. Retain the total dose from isotopes analyzed in the Hazards Assessment process; however for timely initial assessment one may choose to eliminate analysis of isotopes contributing minimally to the total dose.

5. Tabulate the results and include the results in the appropriate engineering calculation and the facility inventory document, as applicable.

NOTE: Total effective dose equivalent (TEDE) includes effective dose equivalent (EDE) (exposure from external sources) and CEDE (dose from inhalation/ingestion).

6. Isotope calculations are useful for performing dose pathway specific consequence assessment with models that only take a single isotope as input or when it is desired to compare two or more MARs with large amounts of isotopes to see which one contributes more to the dose of interest.

B. Ingestion Dose (CEDE)

The same steps as for the inhalation dose are used to characterize MAR for ingestion dose. The only difference is that ingestion DCFs from DOE/EH-0071 are used.

C. Direct Dose (EDE)

Again, the same basic steps are used to characterize MAR for direct dose. In this case, DCFs are replaced by the average gamma energy per disintegration obtained from the Table of Radioactive Isotopes by Browne and Firestone. Other reference tables of radioactive isotopes may be used to obtain the gamma energy information. As essentially all of EDE is from the gamma component of isotopic decay, the use of the average gamma energy per disintegration normalized MAR to allow the percent contribution to be calculated. The dose-rate conversion factors used to calculate the exposure dosage in rems from external sources are stated in DOE/EH-0070.

D. Isotope Contribution Results

The results of the calculated isotope contribution indicates which isotopes contribute to the major dose through the inhalation (CEDE), the ingestion (CEDE), and the direct dose (EDE).

REFERENCES

1. *Internal Dose Conversion Factors for Calculation of Dose to the Public*. DOE/EH-0071, U.S. Department of Energy, Washington, DC, July 1988.

2. Browne, and Firestone, R. B. *Table of Radioactive Isotopes.* John Wiley and sons, Inc., New York, NY, 1986.

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

4. *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. DOE-HDBK-3010-94, U.S. Department of Energy, Washington, DC, October 1994.

5. *External Dose-Rate Conversion Factors for Calculation of Dose to the Public*. DOE/EH-0070, U.S. Department of Energy, Washington, DC, July 1988.

Appendix D
RADIOLOGICAL AND TOXICOLOGICAL SABOTAGE

NOTE: This process is taken from ORO O 150, Rev. 1, Chg. 1, dated February 28, 1997.

The process to evaluate sabotage vulnerabilities supports the implementation of radiological/toxicological sabotage protection. Sabotage is one event that can disperse hazardous materials and therefore is a component of overall risks assessments of hazardous materials inventories. Radiological/toxicological sabotage is a malevolent act resulting in the release of hazardous materials stored, produced, or used at Y-12 that may adversely impact the health and safety of employees, the public, or the environment.

The sabotage evaluation process includes representation of all interested functions (e.g., operations, programs, safeguards and security, safety, and emergency management). The following is the seven-step process utilized for assessing and addressing sabotage risks at Y-12.

1. Establish the team.
2. Identify and assess quantities of hazardous materials at the facility.
3. Identify and rank hazardous material targets.
4. Perform a vulnerability assessment of credible threat targets.
5. Evaluate sabotage risk reduction options.
6. Select and implement prevention and mitigation options.
7. Validate the program [performed by the Department of Energy (DOE)].

The team shall perform the following radiological/toxicological/sabotage evaluation process:

- Assessment and protection is provided by utilizing the Facility-Specific Hazards Assessment process.

- Upgrades are evaluated and selected for implementation, considering cost compared to the continued acceptance of risk. Protection against radiological and toxicological sabotage at Y-12 is cost-effective and, where appropriate, consistent with protection afforded to similar hazardous materials in the commercial and private sector.

- Safety, safeguards and security, and emergency planning elements are combined to ensure that mutually compatible and effective measures provide defense in-depth prevention, mitigation, and/or response to sabotage events.

- Current guidance and computer-based methodologies used to conduct vulnerability assessments in support of the Y-12 Safeguards and Security Plan (SSSP) should not be required. Hazards Assessments and risk assessments should be primarily used to develop radiological/toxicological sabotage scenarios. Vulnerabilities should be identified by the security professional using a tabletop analysis approach.

- Prioritization of facilities/interests needs to be completed to ensure more obvious concerns are analyzed first.

IMPLEMENTATION PROCESS STEPS

STEP 1 - ESTABLISH TEAM. A team representing all interested parties is established to identify and develop preventative, mitigative, and response options.

1.1 Appoint Team Members

Each facility manager should utilize personnel from the organizations that have a role in the management, protection, and planning for, or responding to, incidents of radiological or toxicological sabotage. At a minimum, representatives of the following disciplines are appointed to the team: (1) Emergency Management; (2) Facility Management and Operations; and (3) Safeguards and Security. This team should closely resemble the Hazards Assessment team with the addition of safeguards and security personnel.

The responsibilities of the team should include

- Identifying, assessing, and ranking hazardous materials and hazardous material targets at the facility. The ranking should include the attractiveness of the hazardous material to a potential adversary and the resultant sabotage risk.

- Conducting an integrated assessment of radiological and toxicological sabotage events that could have an unacceptable level of impact upon employees, the public, or the environment.

- Performing assessments of the potential consequences due to an act of sabotage associated with hazardous materials in storage or in use at the facilities which are above the screening thresholds.

- Evaluating and recommending, for YSO concurrence and cognizant Program Office approval, options to reduce the security risk and/or postulated level of consequences of sabotage events and the priority for implementing each recommended option.

1.2 Establish Milestones

The team establishes realistic and attainable milestones for accomplishing Steps 1 through 6 of this process. The milestones for sabotage assessment include time tables for related safety and emergency preparedness assessment and documentation.

STEP 2 - IDENTIFY AND ASSESS QUANTITIES OF HAZARDOUS MATERIALS AT THE FACILITY. Threshold quantities of hazardous materials are screened in accordance with the "Standard for Development and Maintenance of the Y-12 Emergency Management Hazards Assessment Process."

All applicable regulations are used to determine the screening threshold.

2.1 Identify Types, Quantities, and Locations of Hazardous Materials

2.2 Determine Which Hazardous Materials Are Above Screening Thresholds

Review, as appropriate, safeguards and security vulnerability assessments that have previously identified screening thresholds for nuclear material using 10 CFR Part 100 specification.

STEP 3 - IDENTIFY AND RANK HAZARDOUS MATERIAL TARGETS. If quantities of hazardous materials above threshold limits are present, materials are ranked on a relative quantity/hazard scale and are combined within the same building or location. Therefore, targets are identified in a format that indicates those hazardous materials that may pose larger risks/consequences.

The team or organization develops a rank-ordered listing of those hazardous materials above threshold limits (screening threshold) based on the event scenario consequence assessments.

The event contractor/facility manager evaluates the materials at risk consistent with methodologies utilized for environmental, safety, and health (ES&H) issues. This considers the use of one or more of a variety of risk-based ranking systems which have been utilized within DOE. These systems include (1) Capital Asset Management Process (CAMP) Prioritization (DOE Order 430.1, "Life Cycle Asset Management," dated August 24, 1995); (2) a Safety and Health Risk-Based Priority Model that prioritizes risk through the use of a Priority Planning Grid (PPG); (3) DOE Prioritization for Waste Management Operations; (4) DOE Prioritization for Environmental Restoration; (5) Funding Prioritization of Fire Protection Items; (6) Occupational Safety Model-Risk Assessment Methodology; (7) EH Assessment priorities.

The PPG approach used to rank ES&H issues and planned corrective actions should be used in ranking risks from sabotage. However, information developed from this process should be consistent with CAMP requirements for upgrade projects. The establishment of priorities for evaluation should include consideration of those potential targets where minimal protection exists. For example, the assessment should initially focus on those materials located in areas with the most protection.

The first decision in the process (Fig. 1) addresses whether similar materials are transported, stored and/or used in the commercial/private sector. If the answer is yes, the second decision is whether the protection afforded the material is comparable to similar materials transported, stored, and/or used in the commercial/private sector. If the answer is no, a secondary screening criteria are applied which relates to whether personnel are routinely within the Early Severe Health Effects (ESHE) radius. This decision establishes two categories, high-priority and low-priority, for accomplishing sabotage vulnerability assessments. After the analyses of the high-priority facilities and interests are completed, the low-priority materials should be analyzed.

The number of people within the ESHE radius, and potential cleanup costs associated with a hypothetical sabotage scenario are facility-specific and useful for prioritizing within the high-priority category to ensure the materials that pose the highest risk are analyzed first. After the analyses of the high-priority facilities/interests are completed, the low-priority materials are analyzed.

STEP 4 - PERFORM A VULNERABILITY ASSESSMENT OF CREDIBLE THREAT-TARGET COMBINATION. The vulnerability assessment includes several factors, such as locations, site-specific features, and existing safety and security features. In this process, scenarios that lead to releases of hazardous materials are developed and analyzed. The first action in the assessment is identifying and documenting protective features that reduce the probability of successful completion of a sabotage act and/or mitigate the consequences. The analyses include completed results for accident scenarios, emergency event classification, protective actions and consequence assessments in accordance with the Y-12 Emergency Plan. Performance of the analyses should identify scenarios that create an unacceptable risk in safety, safeguards, security protection systems, and in response planning for release scenarios.

Hazards Assessments and risk assessments are used to develop radiological and toxicological sabotage scenarios. Safeguards and Security personnel review the accident scenarios developed during the Hazards Assessment process to determine if there is a way in which an individual could cause a similar event (malevolent act) to occur. For example, an accident scenario could involve the inadvertent opening of a valve. A malevolent scenario could involve an employee using explosives to disable the valve and potentially change

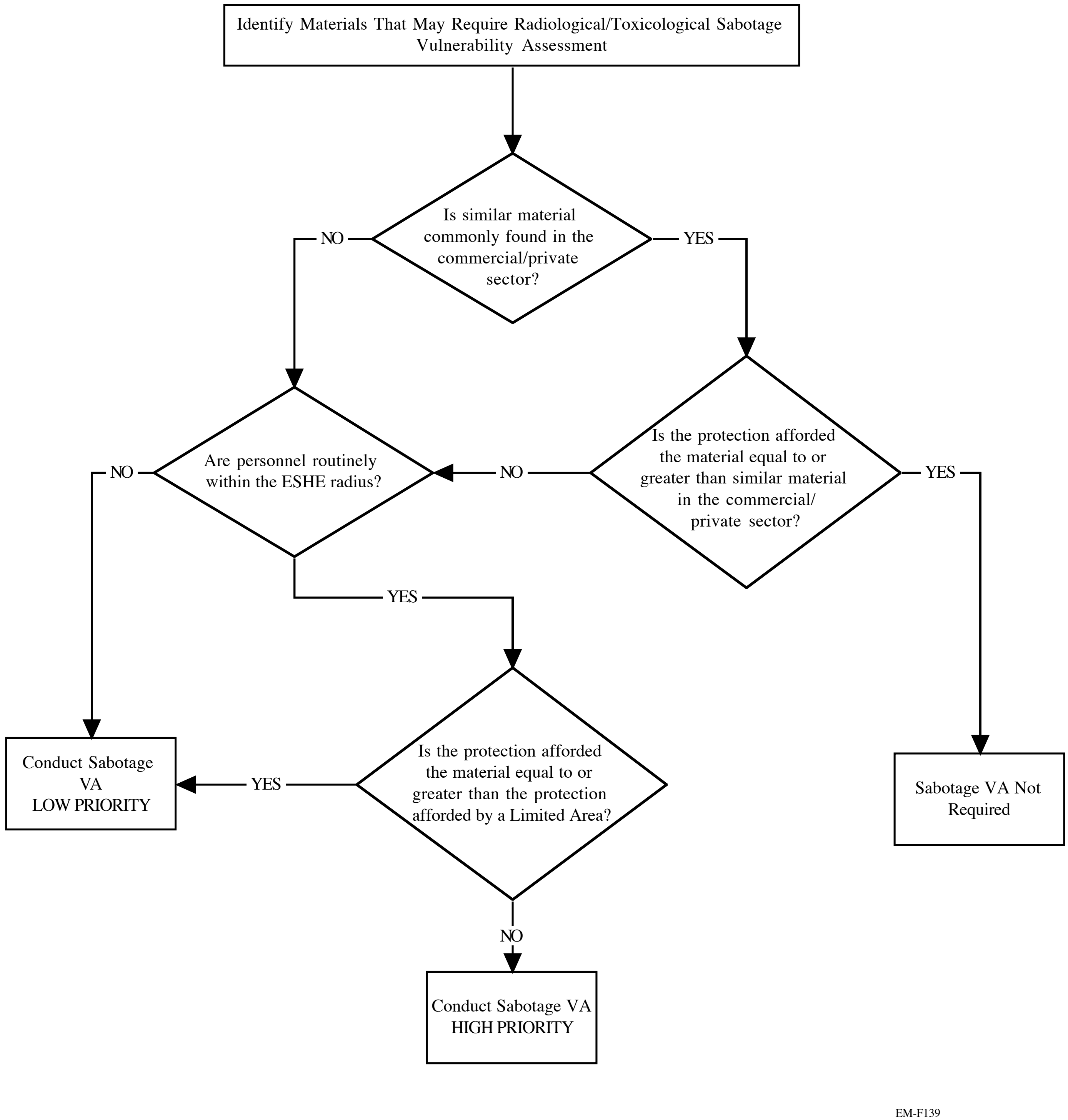


Fig. 1. Vulnerability assessment process flowchart

the form of the material and the degree of dispersal. Vulnerabilities should be identified by the security professional using a tabletop assessment approach.

STEP 5 - EVALUATE SABOTAGE RISK REDUCTION OPTIONS. After sabotage vulnerabilities are assessed, the vulnerability assessment team analyses are performed on actions that may reduce the risk of a successful sabotage event and/or mitigate the consequences. In addition, a reassessment process is initiated after cost-effective modifications and/or plans are identified.

Risk reduction and consequence mitigation actions that should be considered include the following:

1. Taking event-mitigating actions (e.g., establishing shelters, emergency notifications/evacuations, reducing and/or removing inventory quantities or changing storage locations).

2. Developing programs to reduce the probability of insider acts (e.g., personnel clearances, personnel assurance programs, and utilization of threat and intelligence information).

3. Adding safeguards and security features to prevent or detect adversary actions (e.g., access and materials controls, surveillance, additional barriers/alarms, and searches).

4. Implementing additional safety controls or adding equipment that prevents the sabotage release scenario (e.g., providing automatic shutdown if components fail, adding backup systems, and establishing vital areas).

Where operationally feasible, consideration should be given to reducing quantities of materials on-hand below the screening threshold or modifying process or production/operations equipment to reduce the consequence level of the sabotage act.

Safeguards and security methods for risk reduction through prevention of an act of sabotage is considered with safety and emergency planning mitigation activities to determine the most cost-effective approach to reducing risk to an acceptable level.

STEP 6 - SELECT AND IMPLEMENT PREVENTION AND MITIGATION OPTIONS. The vulnerability assessment team should analyze options to reduce the risk and/or consequences of sabotage events. The analysis includes risk/benefit optimization, feasibility, and difficulty of performing the sabotage act(s) and of implementing the proposed action, resource optimization to limit total risk, compliance with requirements, effectiveness of existing systems and programs, and site-specific factors. Upgrades should be selected for implementation based on these analyses to meet graded, cost-effective sabotage protection program objectives that emphasize risk/consequence for the most attractive sabotage targets. These selected upgrades are submitted to the contracting officer's representative for consideration and approval within overall site resource optimization, and to the cognizant program offices for information and funding support, as necessary, prior to implementation. Particular attention should be given to sabotage scenarios whose risks/consequences exceed those of corresponding accident scenarios. Risks should be accepted. For example, actions cannot be taken to reduce the potential for, or consequences of, a sabotage act event to zero.

However, an acceptable level of risk should be determined based on evaluation of a variety of facility-specific goals and considerations. Results from the vulnerability assessment process should identify accepted risks, the rationale for this conclusion, and exceptions to DOE orders and policies.

Selection of upgrades for implementation should be based upon risk reduction, operational and safety compatibility, and cost effectiveness. To evaluate the vulnerability reduction associated with each security upgrade set, the upgrades are assumed to have been applied and each target is reevaluated. The matrices and supporting rationale developed by the team in Steps 1 through 6 should serve as the documentation of the sabotage evaluation process.

STEP 7 - DOCUMENTATION AND PROGRAM VALIDATION.

7.1 Documentation

The results of Steps 1 through 6 of the sabotage evaluation process are documented in the Facility-Specific Hazards Assessment (or a classified appendix thereof). These results include the process, calculations, and rationale for results of Steps 3 through 6. Additionally, documentation of the sabotage evaluation process are referenced in applicable facility plans and reports (e.g., Emergency Readiness Assurance Plan and SSSP).

7.2 Program Validation

Once upgrading options have been selected and implemented, the facility personnel performance test their sabotage protection program to verify that the measures implemented are effective and that the changes have not caused other vulnerabilities in their protection system. The Contractor Officer's Representative (COR) should perform reviews and validate the results of facility sabotage vulnerability programs. In addition, facility personnel review at least annually and update as necessary their sabotage vulnerability assessments as part of the overall Hazards Assessment process. Performance testing is conducted in concert with vulnerability assessments when protection features, targets, or processes change. Validation results are provided to YSO.

Appendix E
ATMOSPHERIC TRANSPORT AND DISPERSION MODELS

Air Force Toxic Chemical Dispersion (AFTOX) Model

The Air Force Toxic Chemical Dispersion (AFTOX) model was developed as the result of a need by the U.S. Air Force to update its toxic corridor predictions capability. AFTOX is an interactive Gaussian puff/plume dispersion model designed to run on a desktop computer. The program, written in GW-BASIC language, is user-oriented and written in a conversational mode to allow its operation with only a minimum knowledge of the computer or the model. The model is designed to handle continuous and instantaneous liquid and gas, and surface and elevated releases from a point or area source. The model will (1) plot concentration contours and toxic corridor, (2) compute concentration at a specified point and time, and (3) compute maximum concentration at a given elevation and time. It contains a library of 129 chemicals but may be run for other chemicals as well. The model also predicts the dispersion of a continuous buoyant plume from a stack. The model has many unique features including the computation of a continuous stability parameter; the inclusion of the concentration averaging time and surface roughness; the ability to print now or save/print later; the ability to correct input data without restarting; easy access to the chemical data file for adding, deleting, and changing data; and a plot of the plume and 90% of the hazard area with automatic scaling.

Section 2 of the *AFTOX 4.0 User's Guide* presents a technical description of the model. This section is similar to the same section in the previous user's guide, but with some important differences. Section 3 is a user's guide to the operation of the model.

Area Locations of Hazardous Atmospheres (ALOHA)

The Area Locations of Hazardous Atmospheres (ALOHA) model is a tool for estimating the movement and dispersion of gases. The air model estimates pollutant concentrations downwind from the source of a spill, taking into consideration the toxicological and physical characteristics of the spilled material. ALOHA also considers the physical characteristics of the spill site, the atmospheric conditions, and the circumstances of the release. Like many computer applications, it can solve problems rapidly and provide results in a graphic, easy-to-use format, which can be helpful during an emergency response or planning for such a response. Keep in mind that ALOHA is only a tool whose usefulness depends on your accurate interpretation of the data.

ALOHA originated as an in-house tool to aid in response situations. In its original format, the model was based on a very simple approach used in the *Workbook on Atmospheric Dispersion Estimates* (Turner 1974). It has evolved over the years into a tool used for a wide range of response, planning, and academic purposes. However, an individual must still rely on his/her own common sense and experience when deciding how to respond to a particular incident. There are some processes that would be useful in a dispersion model that have not been included in ALOHA because of extensive input and computational time requirements (e.g., topography).

Atmospheric Release Advisory Capability (ARAC)

The Oak Ridge Reservation Emergency Operations Center (OREOC) is fully capable of accessing the Atmospheric Release Advisory Capability (ARAC). ARAC is a centralized emergency response service that provides federal and state agencies with real-time assessments of the environmental consequences of accidental releases of radioactive material into the atmosphere. In order to make assessments, ARAC uses complex, three-dimensional atmospheric transport and diffusion models. These models make use of real-time meteorological data from around the world, accident site-specific details about hazardous materials, as well as topographical, mapping, and dose-factor databases. The primary products of an ARAC assessment are contour plots of the radiation dose to humans and the contamination on the ground. An ARAC contour plot may aid the emergency response manager in making decisions regarding evacuation or cleanup due to an actual or potential release.

ARAC resides within the Regional Atmospheric Sciences Division at the Lawrence Livermore National Laboratory (LLNL) in Livermore, California. This division and its companion, Global Climate Research Division, form a center of excellence for the research and development of regional and global computer modeling of the atmosphere. Modeling complex meteorological conditions over the variety of topographic settings throughout the world demands considerable expertise and computer power.

Complex Hazardous Air Chemical Release Model (CHARM)

RADIAN Corporation's Complex Hazardous Air Chemical Release Model (CHARM) is a modeling software program that calculates and predicts the movement and concentration of airborne plumes from released chemicals. For emergency planning, CHARM provides a list of input fields that describes a particular release and the meteorological conditions. CHARM's chemical database contains data on the physical, chemical, and toxic properties of over 100 chemical compounds. The database can be expanded or modified through the CHARM editor. Default values for the selected chemical are automatically supplied as input, though all values can be changed by the user. Running CHARM in the planning mode creates spill scenarios that can be used for risk assessments and training.

During emergency response, CHARM uses stored release inputs from one or more scenario files. You can define and store maps that will display when the CHARM program is started. The maps can have icons that are selected by pointing and clicking the mouse button to run specific release scenarios. As real-time meteorological information becomes available, you can quickly modify the scenario to match real conditions.

A release can be described as instantaneous or continuous, contained or uncontained, liquid or gas. CHARM supports input for liquid pool fires, Boiling Liquid Expanding Vapor Explosions (BLEVE), and jet fires. Overpressures from the detonation or deflagration of a flammable vapor cloud can also be estimated. The release can be described as ground level or elevated, heavier or lighter than air, and the type of surface on which the spill occurred can be described.

Meteorological data for input in CHARM can be obtained from instruments brought to the site from a nearby meteorological station or from estimates prepared by a remote weather center. CHARM can also be set up permanently as part of a facility operation to automatically receive continuous data from a meteorological station.

Emergency Prediction Information Code

The Emergency Prediction Information Code (EPIcode) is a MS-DOS software package for health and safety professionals. EPIcode is used in emergency planning and response for fast risk assessment and estimation of the concentrations resulting from the atmospheric release of toxic substances. The EPIcode package comes with a comprehensive manual which includes detailed user instructions, full documentation and background on all algorithms, along with ten detailed examples.

EPIcode is based principally upon the Gaussian plume model and subject to all the limitations of this model. The software is intended as a screening tool for initial assessment of emergency situations. EPIcode will run on an IBM personal computer (PC) XT, AT, or compatible. EPIcode requires only a single disk drive and at least 512 Bs of RAM. Software is available in either a single 3.5-in or two 5.25-in diskettes.

The Gaussian model has been used and accepted by the Environmental Protection Agency (EPA). The adequacy of the Gaussian model for making initial dispersion estimates has been tested and verified for many years.

EPIcode contains a library of approximately 600 chemical substances along with the associated exposure levels accepted by various organizations and regulatory agencies; users can add other chemicals to a supplementary library.

EPIcode is documented in the *EPIcode Reference Manual* and the 4.0 Version of the *Liquid Spill Manual*.

Hazard Assessment System for Consequence Analysis (HASCAL)

Hazard Assessment System for Consequence Analysis (HASCAL) is a part of the Hazard Prediction and Assessment Capability (HPAC). HPAC and HASCAL include the capability to support a general hazard assessment capability for Nuclear, Biological, and Chemical (NBC) materials released for incidents or accidents at production and storage facilities or from NBC weapons events. HPAC also provides a workstation-based capability for modeling winds over complex terrain and forecasting weather, which is required for accurate hazard assessment in some locations and situations. Part of this capability was demonstrated for the Counter Proliferation Advanced Concept Technology Demonstration during the DIPOLE ORBIT Test series and DIPOLE ORBIT EAST 159 test at White Sands Missile Range.

HASCAL includes the SCIPUFF model for turbulent transport, a new and advanced technology that provides a highly efficient and accurate prediction for a wide range of hazard scenarios. SCIPUFF can also help answer the question—"How good is the prediction?"—providing probabilistic solutions to the atmospheric transport problem. Source terms for hazardous incidents are built by HASCAL or MEA for input to the atmospheric transport model, SCIPUFF (which is linked with HASCAL to make it user-friendly for the operator). The current code hosts operator-friendly "incident" setup capability for nuclear, biological, and chemical releases resulting from either weapon deployment or facility attack. Sample SCIPUFF projects are provided which may be edited to suit a wide range of user requirements or incidents. Additional improvements in the software are planned, but user feedback will ensure that these improvements include a user's perspective, not just a scientist's.

Hazardous Atmospheric Release Model II (HARM)

Hazardous Atmospheric Release Model II (HARM) is a numerical simulation model developed by the National Oceanic and Atmospheric Administration (NOAA) for the Department of Energy (DOE) in order to provide emergency planning activities for accidental atmospheric releases of hazardous materials. Airborne releases typically represent the most time-urgent situation and require a rapid emergency response on the part of emergency management. State-of-the-art techniques and interfaces have been integrated into HARM that provide for rapid emergency evaluation and will contribute to minimizing the consequences to workers and the general public from atmospheric releases of hazardous materials.

An inventory of hazardous materials and their locations was developed by utilizing the hazard summary sheets that are provided by the appropriate organizations, and the information is compiled and maintained on the hazardous material database. A user interface provides a graphical representation of the facilities and displays the hazardous material inventory of each facility, which is gathered and/or generated by the application, displays the state of the inventory, and lets the user control the application. The interface acts as an intermediary, providing for "real-time meteorology," and handling the dialogue between the user and the application. The interface receives minimal input from the user in the form of keystrokes, and/or mouse usage (point and click).

The HARM model is documented in the *HARM-II Technical Manual: Operator's Handbook*, Version 2.01, Rev. 0, dated October 1991. Additionally, Volumes I and II of the HARM II reference manuals provide further model documentation. Volume I is a collection of resources that may be useful to the HARM II user. Included in the HARM II technical manual are four sections of lecture notes and slides from an air pollution meteorology seminar held at NOAA/Atmospheric Turbulence and Diffusion Division (ATDD) in Oak Ridge on July 25-26, 1991. The two final sections are reprints of *Plume Rise* by G. A. Briggs and the *Handbook on Atmospheric Diffusion* by G. A. Briggs, S. R. Hanna, and R. P. Hosker, Jr. Volume II is a collection of notes and slides from lectures given by William R. Pendergrass during HARM II training sessions. Topics covered include information on the development of the HARM model and the basics of air pollution meteorology.

HOTSPOT Health Physics Code

The HOTSPOT programs were created to provide health physics personnel with a fast, field-portable calculation tool for evaluating accidents involving radioactive material. The software package contains 11 separate programs, ranging from general programs for downwind assessment following the release of radioactive material to more specific programs dealing with the release of plutonium, uranium, or tritium.

Other programs estimate the committed effective dose equivalent (CEDE) from the inhalation of various radionuclides and also estimate the effects of a surface-burst nuclear weapon.

The HOTSPOT codes provide a first-order approximation of the radiation effects associated with the atmospheric release of radionuclides.

HOTSPOT is based on the Gaussian plume model and subject to all the limitations of this model. The software is intended as an initial screening tool.

HOTSPOT will run on an IBM PC, XT, AT, or compatible with at least 256 kBs of RAM. Software is available in either a single 3.5-in or a single 360 kB 5.25-in disk.

The Gaussian model has been used and accepted by EPA. The adequacy of HOTSPOT for making initial dispersion estimates has been tested and verified for several years.

HOTSPOT is documented in the *HOTSPOT User's Manual*.

Radiological Assessment System for Consequence Analysis (RASCAL)

RASCAL is an acronym for Radiological Assessment System for Consequence AnaLysis. It is intended to be used as a screening tool to evaluate potential consequences of releases from nuclear power plants. The system includes modules to (1) estimate source terms, (2) evaluate the transport and diffusion in the atmosphere and deposition on surfaces, and (3) estimate doses from radionuclides in the environment. The output of the code relates dose estimates to both PAGs and early health effects. RASCAL is intended for use as a screening model. As such, it may be used as a planning tool or as a tool in evaluating potential actions in the event of an emergency. RASCAL is not intended for detailed assessments following an emergency.

The source term is constant once established. Multiple release points cannot be simulated. Despite using a Gaussian puff model, RASCAL is limited to meteorological data from a single location. In addition, it does not have the ability to model directional wind shears. Building wake is not included. There is no ingrowth of daughter products in the radionuclide decay scheme.

RASCAL is designed to run on a PC with 640 kB of RAM, a hard disk (1.6 MB required), a floppy disk, and DOS 3.0 or later. An 80286 or 80386 CPU, a math co-processor, and EGA are recommended. RASCAL has an option to generate device-independent, high-resolution graphics. The device drivers required to view or print the high-resolution graphics are not included with RASCAL.

The source, which may be elevated or at ground level, is located at the center of polar and Cartesian grids. Receptors are positioned at 0.5, 1, and 2 miles on the polar grid. The Cartesian grid is used beyond 2 miles.

Emission rates are computed within RASCAL code, given information on the release point, its status, and the accident scenario.

The effluent is assumed to be passive and utilizes a Gaussian puff model without plume rise. RASCAL requires a three-layer wind field based on surface or tower measurements. The wind field is time dependent, but horizontally uniform. Dispersion algorithms are based on Gaussian diffusion with diffusion coefficients estimated, using stability class and travel distance.

RASCAL is a replacement for the IRDAM code. The source term portion of RASCAL, which serves the purpose of the TACT code, is based on WASH-1400 and a source term estimation procedure developed by McKenna and Glitter. The transport and diffusion portion of RASCAL is taken from MESOI and MESORAD codes.

RASCAL is documented in the *RASCAL Version 1.3 User's Guide*, and NUREG/CR-5247 issued by the United States Nuclear Regulatory Commission.

SAFER Emergency Management System

SAFER has as its core a state-of-the-art dispersion model. This model is fully capable of handling the most complex situations, including dense gases in complex terrain (hills, etc.), pool evaporation with aqueous mixtures, three-dimensional views, and time-variant wind directionality with multiple meteorological stations. This model has been extensively reviewed for technical accuracy and compared to actual releases for verification.

SAFER models the formation, transport, and atmospheric dispersion of a vapor cloud resulting from an accidental release of a hazardous chemical. It takes into account the containment variables and calculates the flashing vapor, aerosol fraction, and liquid pool formation on the ground. The evaporation rate from the pool is then determined depending on chemical properties, release conditions, and meteorological variables (e.g., ambient temperature, wind speed, solar radiation, etc.). SAFER models different types of releases (i.e., instantaneous, continuous, or time-varying releases). The algorithms used by SAFER have been evaluated using actual field test data and incorporates the effects of cloud density, surface roughness, and atmospheric stability. The projected path of the plume is updated when significant changes of meteorological conditions occur. The plume path, concentration, dosage, and arrival/dissipation times are calculated and graphically displayed on square or radial grids or on maps of the site and surrounding community.

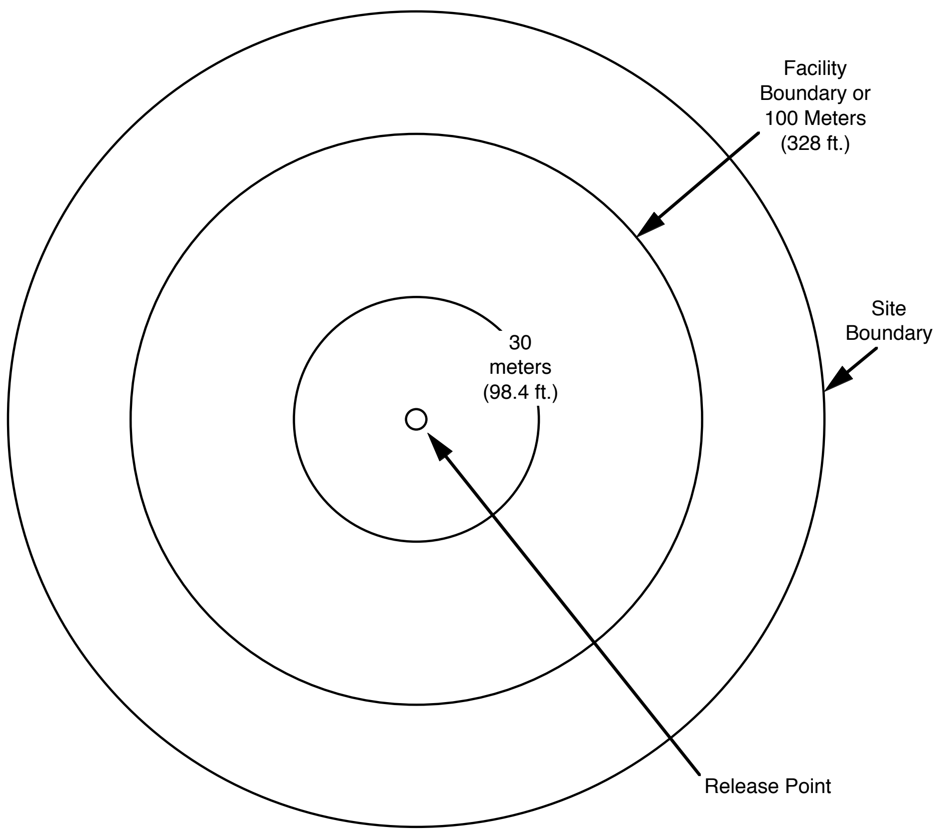
Appendix F

ISODOSE CONCEPT TABLE

CLASS	ISODOSE	WHERE
Alert	> 1 rem TEDE > ERPG-2 or equivalent	At 30 meters (98.4 ft) to facility boundary
SAE	> 1 rem TEDE > ERPG-2 or equivalent	Beyond facility boundary to site boundary
GE	> 1 rem TEDE > ERPG-2 or equivalent	Beyond the site boundary

NOTE:

ERPG Emergency Response Planning Guideline
GE General Emergency
SAE Site Area Emergency
TEDE Total Effective Dose Equivalent



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Appendix G
CONSEQUENCE THRESHOLDS FOR USE IN FACILITIES HAZARDS ASSESSMENT

Introduction

The consequence thresholds used in the accident analysis section of the Hazards Assessment are the same as those used for classification of Operational Emergencies. The protective action criteria (PAC) include a radiological and nonradiological threshold.

Radiological Protective Action Criteria

The bases for radiological PACs are the Environmental Protection Agency (EPA) Protective Action Guidelines, Department of Energy (DOE) Order 151.1 and DOE Emergency Management Guide for Hazards Assessment requirements. The radiological PACs to be used are

1. A projected dose of 1 rem total effective dose equivalent (TEDE), where TEDE is the sum of the effective dose equivalent (EDE) from exposure to external sources and the committed effective dose equivalent (CEDE) from inhalation;

   or

2. A projected committed dose equivalent (CDE) to the adult thyroid of 5 rem.

   If a fraction of TEDE previously mentioned results from inhalation of radionuclides with long effective half-lives in the body that result in a dose of < 500 mrem/year for the entire 50-year dose period, the fact that the dose is delivered over a long time is considered. For such cases, facilities can use a 5-rem TEDE value for emergency planning and Hazards Assessment purposes.

Nonradiological Protective Action Criteria

The bases for nonradiological PACs are DOE Order 151.1 requirement that specify the use of emergency response planning guidelines (ERPGs) for the consequence threshold for classification of Operational Emergencies.

ERPG values are developed and approved by the American Industrial Hygiene Association (AIHA). The ERPG value to be used is the ERPG-2 or equivalent value.

ERPG-2 is defined as the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. For the purpose of applying ERPG-2 exposure levels, the definition is expanded to mean a 15-min peak concentration of the substance in air that equals or exceeds ERPG-2 or equivalent value for that substance.

The DOE-Headquarters (HQ) Office of Emergency Planning and Operations Subcommittee on Consequence Assessment and Protective Actions (SCAPA) has promoted the use of Temporary Emergency Exposure Limits (TEELs) as alternative criteria if ERPGs are not available. TEELs include, but are not limited to, other alternative protective action criteria.

If an ERPG is not available for a substance of interest, utilize alternative guidelines listed in EMPO-502, *Rationale for Correlation Between Exposure Levels and Emergency Classes*, November 11, 1998.

If no suitable exposure criterion can be found for a substance of interest, a facility-specific value will be developed from available data. Limits that have been derived for large populations are used as planning bases when they are available. A method such as AIHA ERPG protocol may be used to establish facility-specific values.

Mixed Hazard Protective Action Criteria

PACs for mixed hazards are not a straight forward calculation. Depending on the hazards involved, the effects on personnel may or may not be additive. The Hazards Assessment Team evaluates mixed hazards on an individual basis and develops a specific PAC. Include the basis for PAC in the Hazards Assessment.

Threshold for Lethal Effects (TLE) Criteria

The EPZ determination section of the Hazards Assessment makes use of the maximum distance at which a facility accident could produce TLEs as one element in the determination of EPZ size. The definitions below are intended only for use in the facility Hazards Assessment process.

TLEs are defined as

1. For radiological releases: A dose equivalent of 100 rem TEDE.

or

2. For nonradiological release: A peak 15-min concentration of the substance in air that equals or exceeds the ERPG-3 or equivalent value for that substance.

Appendix H
Initiating Event Scenarios

A. OPERATIONAL "ACCIDENT" EVENTS

- Fires
- Explosions
- Loss of confinement or containment (i.e., spill or atmospheric release of material)
- Criticality
- Onsite transportation accidents

1.0 Operational "Accident" Events

The hazards of *primary concern* for the purpose of emergency response planning are hazardous materials (1) whose release to the environment immediately threatens those who are in close proximity, (2) have the potential for dispersal beyond the immediate vicinity in quantities which threaten the health and safety of onsite personnel or the public in collocated facilities and/or offsite, and (3) have a rate of transport and dispersion sufficient to require time-urgent emergency response to implement protective actions. Also, the term release primarily means an airborne release, as this pathway typically represents the most *time-urgent* situation and requires a rapid coordinated emergency response on the part of the facility, collocated facilities, and surrounding jurisdictions to protect workers, the public, and the environment. Spills 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 airborne release. When a spill 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.

In order to provide a complete perspective on design basis or evaluation basis accidents, the facility EMHA will summarize in this subsection the major accidents or hazards situations (i.e., fire, explosions, loss of confinement/contamination, or criticality) that may occur.

Onsite transportation activities will be analyzed in conjunction with those facilities with which the transported material is associated. The transportation list of hazardous materials/wastes includes both those generated from within the facility and those outside. Material routed through the facility is not included.

B. NATURAL PHENOMENA EVENTS

- Earthquakes
- Tornadoes/winds
- Floods
- Winter storms
- Lightning and hail

1.0 Natural Phenomena Events

Natural phenomena hazards such as earthquakes, tornadoes, floods, heavy snow loads and, lightning strikes are also considered. The consequence of the initiating events may be similar to operational accident events. In some instances, the evaluation of natural phenomena events may be included in the safety basis authorization documentation. Natural phenomena events should be considered as initiating events for the event scenarios that may cause a release of the hazardous materials.

1.1 Earthquake Initiating Event Scenario

Scenario

A 5.75 to 6.5 magnitude earthquake located within 25 miles of the Y-12 Plant is used as the worst-case initiating event scenario for Y-12 facility-specific EMHA. This magnitude earthquake is considered to be a catastrophic event and carries with it the following emergency planning assumptions:

a. A catastrophic earthquake is an event or series of events that will result in large (probably less than 100) numbers of deaths and injuries; significant damage to a large percentage of facilities that provide and sustain human needs (i.e., power, water, sewer, and storm drains); overwhelming demand on state and local response resources; long-term effects on general economic productivity; and have major effects on state, local, and private sector initiatives to begin and sustain initial recovery efforts.

b. Earthquakes may occur without warning and at a time of day that will produce a maximum number of casualties. Access to and from the damaged areas may be severely restricted for hours and perhaps days. Communications and life support systems will be severely disrupted or destroyed.

c. Earthquakes and resulting aftershocks may trigger secondary events such as fires, landslides, liquefaction, flooding, and release/spread of hazardous materials. Nonfederal dam failures are also likely to occur following major earthquakes.

d. Damage resulting from a catastrophic earthquake will be significant in the epicentral area of the earthquake extending out over 100 miles from the epicentral area. Ground motions will vary within a geographical region, and so will resulting damage. There may be high concentrations of damage in some areas with only slight damage in others. Complete Y-12 Plant shutdown may be required for some period of time. The maximum work force may be present at the time of the event, and personnel at work will want to return home to check on their families and property.

e. A catastrophic earthquake will result in the immediate declaration of a state of emergency by the governor of Tennessee, and followed later by a Presidential Disaster declaration. This will allow state and federal life support and emergency response operations to begin. These resources may not be available, however, for the first 72 hours, and even then may be insufficient to meet the need.

f. Local government resources will probably be inadequate to respond to the needs of the local private business sector after a catastrophic earthquake. Business and industry should plan to be self-sufficient for the first 72 hours after the event occurs. Local governments will likely request the use of DOE resources for the restoration of utilities, communications, and transportation networks which service both the community and the Y-12 Plant.

If the 5.75 to 6.5 magnitude earthquake can result in structural failure of the building and/or loss of containment that results in a hazardous material release, the facility-specific EMHA will analyze MAR from the anticipated inventory in the consequence assessment process.

1.1.1 Emergency Planning Basis

The Y-12 Plant is located in the western part of the geological Valley and Ridge Province at the narrowest part of the Appalachian foreland fold-thrust belt. In this area, the Valley and Ridge Province is dominated by several west-directed thrust faults that formed when the huge Blue Ridge sheet to the east pushed the Valley and Ridge sedimentary succession in front of it. Faulting in the Valley Ridge province is quite extensive, with a southeast-to-northwest trend. The White Oak Mountain fault and the Cooper Creek fault (both inactive faults) are the closest faults in the vicinity of the plant site. None of the known faults in the region around the plant site have been identified as active or capable, and none of the faulting has been correlated with the on-going seismicity of the region. Based on these facts, the historical seismicity in the regions around the plant site form the bases for establishing the earthquake criteria for emergency planning purposes.

Seismic activity in the region around the Y-12 Plant has occurred primarily in the Valley and Ridge Province, although some historical activity has occurred in the Cumberland Plateau to the west of the plant site. To the east of the Valley and Ridge Province, a similar amount of seismic activity has occurred in the Blue Ridge Province, and some scattered activity has occurred farther east in the Piedmont Province. Farther east, major historical seismic activity has occurred in a northwesterly band of the Atlantic Coastal Plain Province centered in South Carolina. Another area of major historical seismic activity is west of the plant site near New Madrid, Missouri.

Review of the historical seismicity in the regions around the Y-12 Plant indicates that only four earthquakes may have had any significant impact on the area where the plant site is located. In chronological order, the first earthquake is the 1811-12 New Madrid, Missouri series of earthquakes located about 280 miles from the plant site. This series of earthquakes have been estimated as having an epicentral Modified Mercalli Intensity (MMI) of X to XII and a MMI of V to VI at the plant site. MMI is a subjective earthquake scale related to earthquake damage observations developed for use before seismic instrumental recordings were available to measure earthquake magnitudes. The effects of MMI V to VI are that most people will feel the shaking, dishes may be broken, slight damage may occur to poorly built buildings, fall of plaster, overturned furniture, etc. Correlations of the MMI of earthquakes to earthquake magnitudes determined from recordings have been made which suggest the magnitude of the New Madrid earthquakes was about 7.5 to 8.0.

The second earthquake was the 1886 Charleston, South Carolina which occurred about 325 miles from the plant site. This earthquake was estimated as having an epicentral MMI of X and a MMI VI at the plant site. The magnitude of this earthquake may have been about a 7.0 to 7.5. The third earthquake was the 1897 Giles

County Virginia earthquake which occurred about 225 miles from the plant site. This earthquake was estimated as having an epicentral MMI of VII to VIII and a MMI V to VI at the plant site. The magnitude of this earthquake may have been about a 6.0 to 6.5.

The fourth earthquake was nearest the Y-12 Plant area occurring northwest of Knoxville in 1913, approximately 40 miles from the plant site. It was estimated as having an epicentral MMI of VII and an MMI of V to VI at the plant site. The magnitude of this earthquake may have been about a 5.0 to 5.5.

The most recent significant earthquakes to occur in the area around the Y-12 Plant occurred on November 30, 1973, and June 17, 1998. The 1973 earthquake was centered at Maryville, Tennessee, 21 miles southeast of the Y-12 Plant. This earthquake was estimated to have an epicentral MMI of VI and the magnitude (determined from recorded seismograph records) was about 4.6. The earthquake was felt and recorded at the plant site, but no damage occurred at the site. The 1998 earthquake was centered in an area about 9 miles from the plant site. The magnitude of this earthquake was about 3.6 and was felt at the plant site, but no recordings were obtained and no damage occurred.

A seismic hazard study, based on the historical seismicity in the regions around the Y-12 Plant, has been completed (References 1 & 2). These studies show that the earthquake threat at the plant site is controlled by earthquakes with magnitudes ranging from 5.0 to 6.5 and occurring within 25 to 50 miles of the site. The larger earthquakes which could occur in the New Madrid and Charleston regions are located at such large distances that they do not control the earthquake hazard at the plant site.

Based on previous information, the earthquake which is considered for emergency planning purposes at the Y-12 Plant, ranges in magnitude from 5.0 to 6.5 and is located within 25 to 50 miles of the site.

References:

1. Y/EN - 4683, *Seismic Hazard Evaluation for Department of Energy Oak Ridge Reservations, Oak Ridge, Tennessee*, September 1992.

2. ES/CNPE-95/2, *Seismic Hazard Criteria for the Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio U.S. Department of energy Reservations*, December 1995.

1.2 Tornado Initiating Event Scenario

Scenario

An F-3 magnitude tornado (wind speed between 158-206 mph) and associated tornado-generated missiles are used as the worst-case initiating event scenario for Y-12 facility-specific EMHA. This magnitude tornado is considered to be a catastrophic event and carries with it the following emergency planning assumptions:

a. A typical F-3 tornado is a swirling storm of short duration, with winds of up to 206 mph, having a near vacuum at its center. It appears as a rotating funnel-shaped cloud, from gray to black in color, extending towards the ground from the base of a thundercloud. Tornadoes normally cover a very limited geographical area and usually give off a roaring sound. A tornado is the most concentrated and the most destructive form of weather phenomena.

b. Tornadoes are usually the result of the interaction of a warm moist air mass with a cool or cold air mass. They often occur out of squall lines and thunderstorms, particularly in the afternoon. Nocturnal occurrences are infrequent but have been recorded. Tornadoes may occur in any season but are more prevalent in the spring and summer.

c. The usual measurement is the estimated wind speed at the core, degree of damage to structures and the number of persons injured or killed. Often, the total dollar cost of rehabilitating tornado damaged structures is used as a measure criteria. An F-3 tornado will have observed effects that include roofs and some walls torn from some well-constructed buildings; heavy equipment/trains overturned; most trees in forests uprooted; and heavy storage containers lifted from the ground and thrown.

d. Usually flash flooding, electric power outages, transportation system and communication system disruption and fires are secondary effects of tornados.

e. Whenever weather conditions develop which may indicate that tornadoes are expected, the National Weather Service will issue a Tornado Watch to alert people in a designated area for a specific time period (usually 6 hours). The Tornado Watch is upgraded to Warning when a funnel cloud is actually sited.

If the F-3 magnitude tornado and associated tornado generated missiles can result in structural failure of the building and/or loss of containment that results in a hazardous material release, the facility-specific EMHA will analyze MAR from the anticipated inventory in the consequence assessment process.

1.2.1 Emergency Planning Basis

The Y-12 Plant is located in Anderson County in eastern Tennessee in a broad valley between the Cumberland Mountains, which lie to the northwest, and the Great Smoky Mountains, which lie to the southeast, both of which are a part of the Southern Appalachian Mountains. The general terrain of the region is heavily wooded rolling hills with intervening valleys. Elevations of the ridge crests range between 900 and 1200 feet above sea level.

The broad valleys are characterized by a series of parallel ridges separated by long, narrow valleys extending in a northeast-southwest direction. The Y-12 Plant lies in one of these narrow valleys. Differences in elevation have a measurable influence on climate along a NE-SW line and stations at similar elevations have similar annual mean temperatures and precipitation normals.

The prevailing winds in the region reflect the channeling of air flow caused by the orientation of valleys and ridges of the southern Appalachians resulting in winds which are generally northeasterly or southwesterly.

Wind speeds have been measured in the Oak Ridge vicinity intermittently since 1942 (Reference 1). The longest continuous record of wind speeds was collected at the Knoxville airport which is located about 30 miles east of the Y-12 Plant. The Oak Ridge wind data taken near the surface of the ground show a strong influence by the local topology. The wind speeds and directions recorded at the Knoxville airport differ from those measured in Oak Ridge. The difference is probably due to the differences in topology between the two sites. The peak gust wind speed for the Oak Ridge area is about 60 mph and at the Knoxville airport it is about 80 mph.

The Y-12 Plant is located in an area which historically is infrequently subjected to tornadoes (references 2 and 3). For the purpose of comparison, Tennessee ranked 23rd among all states in reporting the greatest number of tornadoes from 1950 to 1994. The deadliest tornado year for Tennessee was in 1952. Two tornadoes in Tennessee have been rated as F5 tornadoes. They are one in 1952 at Moscow, Tennessee, and one in 1998 in Waynesboro, Tennessee. If the state is divided along the 86th meridian, the western half has reported three times as many tornadoes as observed in the eastern part (which includes the Y-12 Plant) of the state (Reference 3). The most recent tornado which occurred in the vicinity of the Y-12 Plant was in June 1994. This tornado caused some damage to the eastern end of the Y-12 Plant resulting in some economic losses, but no reported injuries or releases of any hazardous materials. It was determined that the wind speeds associated with this tornado ranged from 40 mph at the lower end to probably as high as 130 mph (Reference 4). The tornado was rated as an F1 to F2 tornado.

The wind/tornado hazard for the Y-12 Plant has been evaluated and the results are documented in Reference 5. Based on the results of the study, straight peak gust wind speeds of 90 mph can be expected to occur at the plant site and are appropriate for emergency planning purposes. This wind speed of 90 mph is also in agreement with the model building codes used for the area.

The results of the hazard study also indicates that a tornado peak gust wind speeds of 150 to 200 mph (equivalent to a high F2 and F3) is a worst-case tornado suitable to be used for emergency planning purposes. In addition to the hazards presented by the tornado wind speeds, tornado missiles should also be considered in the emergency planning. Tornado wind speed of 150 to 200 mph can pick up debris which can become damaging missiles and impact buildings in the pathways of the missiles. Typical missiles used in tornado evaluations are 2-by-4-in. timber planks and 3-in.-diam steel pipes.

References:

1. J.Z. Holland, *A Meteorological Survey of the Oak Ridge Area*, USAEC Report ORO-99, U.S. Atomic Energy Commission, Oak Ridge Operations, Oak Ridge, Tennessee, 1953.

2. Vaiksnoras, J.V., *Tornado Occurrences in Tennessee, 1916-1970*, State Climatologist for Tennessee, National Weather Service Office, Nashville, Tennessee, April 1971.

3. Pantz, M.E., *Severe Local Storm Occurrences, 1955-1967*, ESSA Technical Memorandum WBTM FCST, ESSA, Silver Springs, Md., 1969.

4. ES/ESH-35 - *Tornado Special Study Report*, June 1993.

5. ES/CNPE-95/3 - *Recommended High Speed Straight Wind and Tornadic Hazard levels for the Oak Ridge, Tennessee Department of Energy Reservation*, September 1995.

1.3 Flood Initiating Event Scenario

Scenario

A worst case flood, based on 9.5 in. of rain in 1 h with saturated antecedent moisture conditions, is used as an initiating event scenario for Y-12 facility-specific EMHA. This severe flood event carries with it the following emergency planning assumptions:

f. The severity of a flood is defined either in terms of the maximum height of the water above flood stages, or as the maximum amount of water flowing past a certain point. Height typically is recorded in linear feet, and is easier to understand than the water flow or discharge rate which is measured in cubic feet per second. The discharge rate is the most accurate basis for comparing floods occurring in the same place at different times.

g. Secondary effects of flooding may include dam/levee failures, transportation accidents, landslides, power failures and water supply contamination/failure. Floods may also cause considerable indirect damage from ill health, disease, and lost work time to businesses. Flood caused soil erosion resulting in the downstream settlement of silt and sediment cause damage by clogging reservoirs and drainage systems.

h. In a storm of this magnitude, the Y-12 storm drainage system will become surcharged and will not reduce peak flood levels within the plant. The majority of the storm runoff will drain toward East Fork Popular Creek (EFPC) through the streets between the buildings of the plant.

i. No Y-12 Plant building is completely safe from flooding during this storm. Runoff from rooftops (whose drainage systems will also quickly become surcharged) may cause limited flooding in any areas where water is allowed to pond next to doors, vents, windows, or other openings. Buildings with doors or windows below the grade of adjacent roads are also subject to flooding, with flood levels dependent upon the topography in that location.

j. Flood elevations in EFPC during this event are critical to this analysis for several reasons. First, flood elevations in the Y-12 Plant are influenced primarily by the ability of EFPC to convey water away from the site. Second, backwater from EFPC will effect submergence of at least part of the storm water drainage system that discharges to EFPC, which directly impacts flood levels in areas lying adjacent to the creek. Finally, flood levels in EPPC can influence water surface elevations in any surface drainage features (such as ditches, sidewalks, or roads) that carry water directly to the creek.

If the worst-case flood can result in structural failure of the building and/or loss of containment that results in a hazardous material release, the facility-specific Hazards Assessment will analyze MAR from the anticipated inventory in the consequence assessment process.

1.3.1 Emergency Planning Basis

The Y-12 Plant is located in Anderson County in eastern Tennessee in a broad valley between the Cumberland Mountains, which lie to the northwest, and the Great Smoky Mountains, which lie to the southeast, both of which are a part of the Southern Appalachian Mountains. The general terrain of the region is heavily wooded rolling hills with intervening valleys. Elevations of the ridge crests range between 900 and 1200 ft.

The broad valleys are characterized by a series of parallel ridges separated by long, narrow valleys extending in a northeast-southwest direction. The Y-12 Plant lies in one of these narrow valleys. Differences in elevation have a measurable influence on climate along a NE-SW line and stations at similar elevations have similar annual mean temperatures and precipitation normals.

The region has a mild climate, i.e., humid, with a mean temperature for the warmest month of the year in excess of 72°F and no distinct dry season. March is normally the wettest month and October the driest. Precipitation is heaviest from December through March when cyclonic activity is high and in the July-August period from convective showers.

The most rain in a 24-h period was 7.75 in. which occurred at Oak Ridge Area Station X-10 in September 1944 (Reference 1). Maximum monthly and annual precipitation recorded in the Oak Ridge area was 19.27 in. in July 1967 and 68.77 in. in 1967. Recently on July 22-23, 1997, the Y-12 Plant received about 6 in. of rain in about 2 h (Reference 2). The July 1997 rainfall caused significant economic consequences at the Y-12 Plant, but there were no injuries reported and no hazardous releases occurred.

The Y-12 Plant has a history of flooding problems with localized heavy rainfalls over a short duration. The reason for this is the topography of the site. The Y-12 Plant is built in a valley formed by Pine Ridge to the north and Chestnut Ridge to the South with a watershed of about 760 acres. EFPC lies at the bottom of the valley and numerous buildings have been constructed adjacent to EFPC. Heavy localized rainfalls flow down the sides of the ridges into EPFC resulting in potential flooding of buildings from rainfall runoff on the sides of the valley and potential stream flooding of buildings located adjacent to EFPC.

The flood hazard for the Y-12 Plant has been evaluated and the results are documented in References 3, 4, and 5. The flood hazard studies considered flooding from adjacent rivers and streams, upstream dam failures, and localized flooding from rainfalls occurring at the Y-12 Plant.

The closest river to the Y-12 Plant is the Clinch River. The maximum flood level on the Clinch River closest to the plant site is elevation 817 resulting from the probable maximum flood (PMF). PMF is defined as the most severe flood that can reasonably be predicted to occur at a site as a result of hydrometeorological conditions. It assumes an occurrence of probable maximum precipitation (PMP) critically centered on the watershed and a sequence of related meteorologic and hydrologic factors typical of extreme storms.

Norris Dam is located on the Clinch River upstream of the Y-12 Plant area. The maximum flood level from a Norris Dam failure on the river closest to the plant site is elevation 846. The lowest elevation in the Y-12 Plant is about 900. Based on this, the plant is not impacted by flooding on the Clinch River and Norris Dam failure. The only facilities associated with Y-12 which might be impacted by river and dam failure flooding are the water plant facilities locate adjacent to the river. The water plant facilities adjacent to the river are located at about river mile 41.5. The flood elevations from PMF and dam failure at this location are about 812 and 835. The general surface elevation in the area of the water plant facilities is about 800+. These flood levels will impact the water plant facilities, particularly the flooding from dam failure. (The probability of PMF is generally thought to be less than 10^{-6}. TVA has never assigned a probability for failure of Norris Dam. A more reasonable maximum flood is the maximum probable flood (MPF) which has a probability somewhere between 10^{-4} to 10^{-5}. The MPF elevation at the water plant is about 802, which would not be a significant impact. If we go with the MPF and dam failure scenarios, we need to visit the site to really assess the impact on the chlorine-handling building.)

The assessment of the flood hazard indicates that the Y-12 Plant is most significantly impacted by localized flooding from intense short duration rainfalls and resulting flooding from the runoff into EFPC.

The localized intense rainfalls have the potential to impact the majority of buildings on the plant site. For buildings located adjacent to EFPC, the stream flooding has the potential to impact the buildings. For buildings not located adjacent to EFPC, flooding of the buildings can result from the rainfall runoff where doors ,vents, windows, or other openings are located below the elevation of adjacent roads. In addition, ponding of the rainfall may occur on buildings which have parapets around the perimeter of their roofs. This ponding of water may result in roof loads that exceed the allowable roof design load. This could lead to sagging of the roof allowing considerable water to enter a building through cracks in the roof.

The localized intense rainfalls can be defined over a range of rainfall levels and durations of time, therefore the different amounts of rainfall and durations were reviewed to determine the rainfall which has the most potential for flooding. The flood hazard studies suggest that a 1-h rainfall of 9.5 in. has the most potential for flooding at the Y-12 Plant.

Based on this information, the flood which should be considered for emergency planning purposes at the Y-12 Plant is a 1-h rainfall of 9.5 in. with saturated antecedent moisture conditions, i.e., previous rainfalls have saturated the ground such that none of the rainfall is absorbed in the ground and the storm sewer drainage system is surcharged.

References:

1. *Maximum Recorded United States Point Rainfall for 5 Minutes to 24 Hours at 296 First Order Stations*, Technical Paper No. 2, U.S. Department of Commerce, Weather Bureau, Revised 1963.

2. Y/QS-0003, *Lessons learned from the July 22-23, 1997, Flood Incident at the Y-12 Plant*, December 5, 1997.

3. ES/CNPE-95/1 - *Flood Analyses for Department of Energy Y-12, ORNL and K-25 Plants*, May 1995.

4. Y/EN-5457 - *Assessment of Flood Potential for Seven Buildings at the Y-12 Plant*, November 1995.

5. Y/EN-5380 - *Assessment of Flood Potential for Eight Buildings at the Y-12 Plant*, December 1997.

1.4 Winter Storm Initiating Event Scenario

Scenario

A worst-case winter storm, based on a total accumulation of 20 in. of snowfall, is used as an initiating event scenario for Y-12 facility-specific EMHA. This winter storm event carries with it the following emergency planning assumptions:

k. There are two distinct types of winter storms: the ice storm and the snow storm. Ice storms are characterized by freezing rain which forms a layer of ice on roads, trees, and other objects.

l. Snow storms are characterized by the presence of the precipitation for which they are named, and can range in severity from light intermittent flurries to the perilous blizzard.

m. Ice storms glaze roads and bring about many traffic-related injuries and deaths. Thick layers of ice on tree limbs and utility cables cause them to collapse bringing about injuries to people, damage to property, and frequently, power-outages of disastrous proportions.

n. One-third of winter storm deaths are caused by automobile and other accidents; another one-third are attributed to overexertion and resulting heart attacks, ten percent are due to overexposure and fatal freezing, and the remainder to a variety of causes including home fires, carbon monoxide poisoning in stalled cars, falls on ice, electrocution from downed wires, and building collapse.

1.4.1 Emergency Planning Basis

The Y-12 Plant is located in an area where winter storms typically produce snowfalls of 1.0 to 2.0 in. (References 1 and 2). The area can expect about two to three snowfalls per year where 1 in. or more of snow accumulates. It is unusual to have snow cover for more than a week at a time. There have been a few instances where snowfalls in excess of 5 in. have occurred. Two extreme cases were in March 1960 when approximately 21 in. of snow accumulated and in March 1993 when approximately 20 in. accumulated (References 3 and 4). The model building codes define a design snow load for roofs in the Y-12 Plant at approximately 9 in.

In addition to snowfall, ice storms occur in the area of the Y-12 Plant. Freezing rain can occur during the normally colder months of the year, when rain falls though a very shallow layer of cold air from an overlying warm layer. The rain then freezes on contact with the ground or other objects to form an ice glaze. Based on historical data, ice storms producing a significant amount of glazed ice on the ground, trees, power lines, etc. occur on an average of one storm every 2 years (References 5 and 6).

Based on the two large snow storms previously noted, the snow storms which should be considered for emergency planning purposes at the Y-12 Plant is about 20 in. of snow accumulation on the building roofs. This accumulation is equivalent to about a 25-psf roof loading. In addition, an ice storm should also be considered for emergency planning purposes. The effects of a maximum ice storm scenario on building roofs should be less than the snow storm scenario, but the ice storm could cause greater damage to power lines leading to and within the Y-12 Plant.

References:

1. *Climates of the States, Tennessee: Climatography of the Unites States,* No. 60-40, U.S. Department of Commerce, Weather Bureau, Washington, D.C.

2. *The Winter of '95 - '96, A Season of Extremes,* National Climatic Data Center Technical Report 96-02, May 1996.

3. *Local Climatological Data with Comparative Data, 1972, Oak Ridge, Tennessee*, Weather Service Office, U.S. Department of Commerce, NOAA Environmental Research Laboratories, ATDL, Oak Ridge, Tennessee.

4. *The Big One! A Review of the March 12-14, 1993 "Storm of the Century"*, NOAA TR 93-01, May 1993.

5. *Glaze - Its Meteorology and Climatology, Geographical Distribution and Economic Effects*, Technical Report EP-105, Quartermaster Research and Engineering Command, Natick, Mass., March 1959.

15. *National Climatic Data Center Storm Event Database*, Internet Web Site http://www.ncdc.noaa.gov/ May 1999.

1.5 Lightning and Hail Initiating Event Scenario

Scenario

A worst-case lightning event, based on a severe thunderstorm with a lightning strike that results in the initiation of a major facility fire, is used as an initiating event scenario for Y-12 facility-specific EMHA.

1.5.1 Emergency Planning Basis

The Y-12 Plant is located in an area where thunderstorms tend to occur at least once a month throughout the year, with a high average of 11 storms occurring during the month of July. The annual lightning strike density for the area around the plant site is 10 to 19 strikes/mile^2/year (References 1, 2, and 3).

Hail storms are not too frequent, but do occur with spring thunderstorms usually associated with the passage of squall lines or cold fronts. Since 1959, 25 hail storms with hail sizes of at least 0.5 in. have occurred in the surrounding area of the plant (Reference 4).

Based on this information, potential lightning strikes and hail storms are considered for emergency planning purposes at the Y-12 Plant.

References:

1. *Lightning Activity at Cities in the United States*, Workshop on Lightning Hazards for Nuclear and other Energy Facilities, February 1993.

2. NUREG/CR-3579, *Lightning Strike Density for the Contiguous United States from Thunderstorm Duration Records*, U.S. Nuclear Regulatory Commission, 1983.

3. Hasbrough, R.T., Lawrence Livermore National Laboratory, telephone conversation with K. E. Fricke, Lockheed Martin Energy Systems, Inc., and fax, *Lightning Ground Flash Density at DOE Sites*, April 1997 and May 1997.

4. *National Climatic Data Center Storm Event Database*, Internet Web Site http://www.ncdc.noaa.gov/ May 1999.

C. EXTERNAL EVENTS

- Aircraft crash
- Offsite transportation accidents
- Adjacent facility events

1.0 External Events

External hazards that originate from facilities beyond the Y-12 site boundary will be considered. At minimum, the Oak Ridge Utility District propane storage facility will be considered as a potential initiating event scenario. Other external events that will adversely impact Y-12 facilities include an aircraft crash.

Relative to offsite transportation activities, Scarboro Road is the only transportation artery that will be considered in Hazards Assessment and emergency planning.

1.1 Aircraft Crash Accident Methodology

Scenario

Moderate and severe aircraft crash initiating event scenarios are used in the Y-12 EMHA. The moderate event scenario assumes a Cessna 172 aircraft with a fuel load of 50 gal of 100 octane aviation gasoline strikes the facility.

The severe event scenario assumes a KC-135 military aircraft with a fuel load of 28,000 gal of jet fuel strikes the facility.

1.1.1 Emergency Planning Basis

The approach is based on the structural screening method in DOE-STD-3014-96, (Reference 1), *Accident Analysis for Aircraft Crash into Hazardous Facilities*. This method uses a sequential, two-step approach, first evaluating local damage to the structure and then global damage of the structure. For the Oak Ridge facilities, the aircraft crash will be assumed and no calculation of crash probability will be done associated with the Hazards Assessment. Although a variety of aircraft are operating in the vicinity, primarily out of McGhee Tyson Airport, for the purposes of the Hazard Assessment, two aircraft will be evaluated for each crash accident. To address the large number of private aircraft, the single engine Cessna 172 will be used. The Cessna 172 is the most popular small aircraft currently in production and is typically operated at low altitudes by non-professional pilots, so the likelihood of this type of aircraft crashing into a Y-12 structure is believed to be greater than that for twin engine business aircraft, typically flown at higher altitudes and by professional pilots. To address the large commercial carriers and military tankers, a large KC-135 military tanker with a full fuel load will be used.

The structural screening approach is explained in Section 3.3 of DOE-STD-3014-96. The screening consists of simplified but conservative structural evaluation of the facility using two bounding missiles, one for building local damage evaluation and the other for global damage / building collapse evaluation. The results of the evaluations are compared with the structural screening guidelines listed in Section 4.3 of DOE-STD-3014-96. If the guidelines are not exceeded, then no release of hazardous material is expected as a result of the structural damage associated with the impact. If the guidelines are exceeded, the hazardous material release is determined as shown next. The guidelines are given in terms of wall thicknesses required to prevent penetration for the case of local damage, and in terms of permissible ductility ratios for global damage / collapse.

Any plane crash is likely to be accompanied by a fire and/or explosion associated with the fuel. For the Cessna 172, assume a fuel load of 50 gal of 100 octane aviation gasoline. For the KC-135, assume a fuel load of 28,000 gal of jet fuel.

The structural evaluation begins with the assessment of whether any building wall or roof will be penetrated when struck by the large aircraft. If the large aircraft penetrates the wall, then an assessment is made of whether the large aircraft will cause major structural deformation/collapse. Following these two assessments, the evaluation is repeated for the small aircraft. Not all cases need to be evaluated, as shown by the following logic in Fig. 1.

For the purpose of assessing the release of hazardous material following missile penetration, a damage zone is established for each exterior wall. Any tanks or process lines containing hazardous material of concern within the damage zone inside the exterior wall of the facility are assumed to be failed if the wall is penetrated, and the total amount of material in them released. Thus, the amounts of material within the damage zone must be determined for each wall, and the maximum amount is assumed released if the wall is penetrated. If the exterior walls are significantly different structurally, then each wall type is evaluated for penetration.

For the situation in which the aircraft impact is determined to produce global damage / structural collapse, the total dispersible combustible or hazardous material inventory is assumed to be released.

The technical details of performing the structural screening are given in Chapter 6 of DOE-STD-3014-96, and will not be repeated here.

The results of a preliminary screening based on the type of structures located at the Y-12 Plant are discussed next.

The affects of aircraft impact on structures are very dependent on the size and type of structure involved in the impact. The majority of the structures at the Y-12 Plant are either wooden, prefabricated steel, steel frame with exterior masonry infill walls, concrete frame with exterior masonry infill walls, or unreinforced masonry structures. The roofs of the structures are generally either precast gypsum, concrete planks, or metal decking. There are some reinforced concrete shear wall (vault type) structures where material is stored.

These reinforced concrete shear wall structures may be independent structures or they may be located inside other structures.

The wooden, prefabricated steel, and the unreinforced masonry structures at the site in general are relatively small structures. Therefore, both types of aircraft would probably collapse the structure. There may be a few larger structures of these types at the site which would only suffer local damage from the small aircraft. Based on the weight, velocity, impact area, etc., the small aircraft would penetrate the exterior walls and roofs of these structural types. Definition of the damage zone resulting from the penetration will depend on the specific layout of the structure. The damage zone resulting from the small aircraft penetration into the wooden, prefabricated steel, and unreinforced masonry structures and the resulting potential explosion of the aircraft fuel will be evaluated on a case-by-case basis following the guidelines in DOE-STD-3014-96.

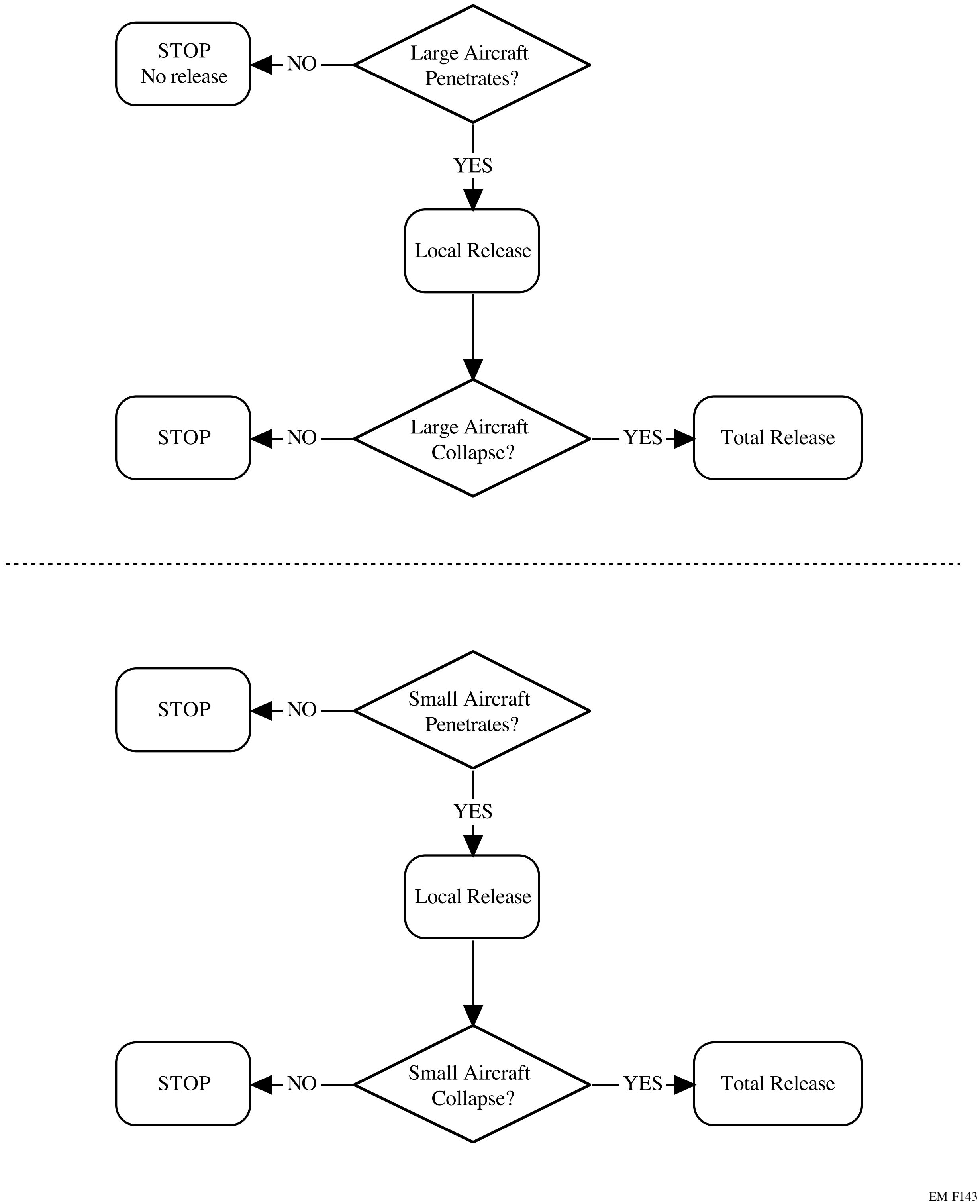

Fig. 1. Aircraft crash logic

For the steel and concrete frame structures with exterior masonry infill walls, the infill walls and the roofs are the weak links of the structures when evaluating the local damage from aircraft. Both aircraft will cause local damage in these structures by penetrating the unreinforced masonry infill walls or the thin roofs.

Based on the data for the small aircraft, it would penetrate the exterior masonry infill wall panels or the roofs. The part of the small aircraft that would penetrate is primarily the engine. The exterior masonry wall panel impacted by the small aircraft would collapse into the structure and any equipment located in the area affected by the wall collapse could be damaged (typical sizes of the wall panels range from 20 by 15 ft to 30 by 30 ft). In addition, the engine would continue on past the damage zone associated with the wall panel and could impact equipment. The damage zone associated with the continued penetration of the engine would be basically the size of the engine. The engine would probably stop after impacting the first piece of equipment, although this is dependent on the type and size of the equipment and will be evaluated on a case-by-case basis. If the roofs of these structures are impacted, the engine would penetrate and probably come to rest at the first floor slab located beneath the roof. This assumption is based on the first floor slab being constructed of reinforced concrete. The damage zone associated with the roof penetration depends on the type of roof and the spacing of roof supporting beams and purlins. The damage zone resulting from the small aircraft penetration into the steel and concrete frame structures and the resulting potential explosion of the aircraft fuel will be evaluated on a case-by-case basis following the guidelines in DOE-STD-3014-96.

The effects of the large aircraft on the steel and concrete frame infill structures will, for most of the structures at the site, cause collapse, unless the structure is significantly larger than the aircraft. Based on the size of the large aircraft and the size of these existing structures, the structures will collapse resulting in total damage.

The reinforced concrete shear wall structures have a greater capacity to resist aircraft impacts than the other types of structures at the plant site, particularly those that are located within a structure. The damage depends on the thickness of the reinforced concrete walls/slabs and any protection provided by a surrounding enclosure structure. Based on the aircraft data, the small aircraft will probably not penetrate these type of structures, but the large aircraft probably would depending on the thickness of the wall/slab. These types of structures will be evaluated on a case-by-case basis following the guidelines in DOE-STD-3014-96.

Depending on the location of the aircraft impact into the structure, the utilities leading into the structures, i.e., electrical lines, steam lines, gas lines, etc., could be destroyed affecting the operation inside the building. These consequences should be considered along with the structural damage.

References:

1. DOE-STD-3014-96, *Accident Analysis for Aircraft Crash into Hazardous Facilities,* 1996.

2. LMES Document, *Estimated Total Annual Aircraft Crash Frequency for Generic Y-12 Building*, 1999.

1.2 Transportation Accident Methodology

Scenario

A major transportation accident is an unexpected incident involving any means of transportation used resulting in a situation beyond the control of local public safety personnel.

1.2.1 Emergency Planning Basis

There are two different situations that need to be addressed regarding transportation accidents. The first situation involves offsite accidents on roads, rivers, and railways adjacent to the Y-12 Plant. These accidents could affect multiple facilities on the site. A specific evaluation of these accidents will be performed and the consequences will be used in the individual facility Hazard Assessments for those facilities possibly affected. The second situation involves accidents within the Y-12 Plant involving vehicles delivering hazardous or flammable materials to specific facilities. These evaluations will be done as part of the Hazard Assessment for the particular facility. There are no active railway lines close to the Y-12 Plant. Likewise, there are no waterways close to the Y-12 Plant which are used to transport hazardous or flammable materials. Thus, these situations are not a factor in offsite accident considerations.

The primary concern for offsite accidents associated with transportation of hazardous or flammable materials arises from nearby roads to the east (Scarboro Road and Tennessee Highway 62), north (Oak Ridge Turnpike), and south (Bethel Valley Road) of the Y-12 Plant. All of these roads are essentially unrestricted with regard to the transportation of bulk quantities of hazardous or flammable materials. The closest road to the Y-12 facilities, which in fact traverses the Y-12 Plant in an east-west direction, Bear Creek Road, is not used for offsite transportation of such materials and will not be considered in these accidents. The road to the west of Y-12, Tennessee Highway 95, is far enough away from the Y-12 Plant that accidents on that road are unlikely to affect Y-12 and will not be considered.

To determine the toxic concentrations resulting from any accidental release of hazardous materials, the accident will assume that the entire volume is released from the carrier vehicle, accompanied by a fire of 50 gal of gasoline from the truck fuel tank. The actual release fractions associated with aerosol and vapor production in the accident can be estimated using the release fraction values given in DOE-STD-1027-92, Attachment 1, pages A-8,9, and shown below in Table 1.

Table 1. Airborne release fraction values

Hazardous material	**Release fraction**
Gases	1.0
Highly volatile/combustible (phosphorus, sulfur, potassium, iodine, sodium, bromine)	0.5
Semivolatile (selenium, cesium, polonium, tellurium, ruthenium, carbon)	0.01
Solid/powder/liquid (any material not listed above)	0.001

These accidental releases will be modeled as a fire plume, and the toxic concentrations as a function of distance from the roads will be determined. Based on these calculations, the appropriate emergency planning response will be determined for the various areas of the Y-12 Plant.

For flammable materials, the concern is not the direct radiation heating from the fire because the roads are far enough away that radiation heat transfer will be minor at the Y-12 facilities. Rather, the concern is the possibility of an explosion of the flammable materials with resulting large overpressure. For the purpose of this group of accidents, all of the material is assumed to be spilled. If it is a gas, assume that all of the gas detonates. If the material is a liquid at atmospheric pressure, assume that all of the liquid spills and immediately spreads out to a 5-mm thick layer. Determine the amount of vapor that is formed during the first 10 min after the spill using[1]

$$m_g = [\lambda_s (T_a - T_b) / [H_{vap} (\pi a_s t)^{½}],$$

where

m_g is the evaporation rate (kg/s);
T_a is the ambient temperature (K);
T_b is the saturation temperature of the liquid (K);
λ_s is the coefficient of heat conduction of the surface (W/mK);
a_s is the thermal diffusivity of the surface (m^2/s).

Typical values for these surface characteristics are shown in Table 2.

Table 2. Typical values for surface characteristics

Surface	λ_s (W/mK)	a_s (m^2/s)
Concrete	1.1	1.3×10^{-7}
Ground (8% water)	0.9	4.3×10^{-7}
Dry sand	0.3	2.3×10^{-7}
Wet sandy ground	0.6	3.3×10^{-7}
Gravel	2.5	1.1×10^{-6}

Assume that the sum of (1) all of the vapor formed during 10 min, and (2) the mass times the release fraction from STD-1027 explodes. The second term, (mass times the release fraction from STD-1027) is included to account for the liquid that flashes to a gas and the liquid droplets that become airborne as an aerosol. If the spilled material is a liquefied gas (e.g. LPG) or a very volatile liquid (e.g. ether), assume the total amount spills and all immediately vaporizes and explodes.

[1] Techniques for Assessing Industrial Hazards, World Bank Technical Paper Number 55, The World Bank, Washington DC, 1988, pp 46-51.

An acceptable approach to estimating explosion damage is to calculate the predicted damage radius in meters, R_n, for various characteristic damage ranges, n. R_n can be estimated using[2]

$$R_n = C_n [N E]^{1/3}$$

where

C_n is an experimentally derived constant based on actual vapor cloud explosions;

$C_1 = 0.03\ mJ^{-1/3}$	Heavy damage to buildings and process equipment; serious projectile wounds and overpressure caused deaths to unprotected personnel; all contained hazardous materials are released.
$C_2 = 0.06$	Repairable damage to buildings; some projectile wounds to personnel; external tanks are ruptured; 50% of all hazardous materials inside structures is released.
$C_3 = 0.15$	Glass broken; personnel injured from flying glass; 50% of external tanks are ruptured; no materials inside buildings are released.

E is the total energy of the explosion; obtained by multiplying the heat of combustion (J/g) of the material by the mass (g) of vapor assumed to explode;

N is a yield factor, i.e., the proportion of the energy, E, available for pressure wave propagation. A conservative upper bound for N is

$$N = 0.10.$$

These simplified correlations will allow the analyst to predict the amount of hazardous materials released as a result of explosion of accidentally spilled transported materials.

If the materials being transported are potential asphyxiants, the total amount in the vehicle should be assumed to be spilled and the oxygen concentration at occupied locations in the Y-12 Plant determined using an appropriate atmospheric dispersion model. The release fractions and/or evaporation model previously discussed should be used to determine the source term for the dispersion model.

Reference:

1. Techniques for Assessing Industrial Hazards, World Bank Technical Paper Number 55, The World Bank, Washington DC, 1988, pp 46-51.

1.3 Oak Ridge Utility District (ORUD) Liquid Propane Gas (LPG) Boiling Liquid Expanding Vapor Explosion C

Scenario

A fire at the ORUD Peak Shaving Plant could result in the over-pressurization of a propane storage tank, railcar, or tank truck and subsequently cause vessel failure, resulting in a BLEVE, a BLEVE fireball, and generation of large vessel fragments that may be propelled long distances. C

C

[2] Ibid., pp 90-91.

Moderate and severe events were postulated in the Y-12 EMHA. The moderate event assumes the BLEVE of a single storage tank (full inventory of 249,000lb of LPG). The severe event assumes an event initiated by a high energy explosion that would involve multiple vessels at the facility with an inventory of 997,000lb of LPG. C

1.3.1 Emergency Planning Basis C

The ORUD Peak Shaving Plant is a privately owned and operated non-DOE facility. A Hazard Assessment was conducted to identify and analyze hazards at the ORUD facility that could pose a threat to the Y-12 Plant. Therefore, the emphasis of the Hazard Assessment was on hazards that may extend beyond the boundary of the ORUD Peak Shaving Plant and not on hazards that are contained within the boundary of the ORUD facility. C

The ORUD Peak Shaving Plant (603 Scarboro Road) is located northeast of the east end of the Y-12 Plant in Oak Ridge, Tennessee. The ORUD Peak Shaving Plant purchases LPG (propane) for temporary storage and then pumps the LPG into the underground local natural gas line when the cost of natural gas exceeds the cost of LPG. LPG is periodically delivered to the ORUD facility by tank trucks and railcars. The LPG is off-loaded into one of four 60,000-gal storage tanks located outdoors. The LPG is then pumped into the local natural gas line as needed. C

The events analyzed in the *Oak Ridge Utility District (ORUD) Peak Shaving Plant Hazards Assessment*, EMPO-514/HA-025, include BLEVEs, flash fires, and vapor cloud explosions involving releases of propane. The consequences of a BLEVE event are (1) the blast wave that is generated as a result of the rapid expansion of the superheated liquid, (2) the fireball thermal radiation generated as a result of the rapid combustion of the released flammable material, and (3) the potential vessel fragments that may be propelled as missiles. The consequence of flash fire is flame impingement that results from combustion of the released material. For a vapor cloud explosion, the consequence is the overpressure blast wave that is generated as a result of the rapid propagation of the flame through the unburned flammable material. This section summarizes the various calculational models, assumptions, data, and results of the consequence assessment performed for these types of events. C

The method used to evaluate the overpressure effects associated with BLEVE events is documented in two reference texts published by the Center for Chemical Process Safety (CCPS) of the American Institute of Chemical Engineers (AIChE): *Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, Flash Fires, and BLEVEs*, CCPS (1994) and *Guidelines for Chemical Process Quantitative Risk Analysis*, CCPS (1989). C

The blast wave resulting from a BLEVE event is estimated by calculating the total work done by the superheated liquid as it expands from the vessel internal pressure at the time of failure to atmospheric pressure. As recommended by CCPS (1994), the internal pressure within the storage vessel at the time of failure is assumed to be 21% higher than the relief valve setpoint of 250 psig, or 320 psia. The liquid propane is assumed to be at saturated conditions corresponding to 320 psia, or 144 ˚F. Blast overpressure and impulse curves presented in CCPS (1994) are used to determine the peak overpressure and impulse as a function of distance for the BLEVE events. C

Facility damage may result from exposure to severe overpressures and/or impulses generated from a BLEVE. Tables 1 and 2 (CCPS [1994]) summarize the type of damage that may occur as a result of exposure to various levels of peak overpressure and combined overpressure/impulse. C

Table 1. Peak overpressure damage criteria for blast waves from explosions

C

Damage description	Peak overpressure (psig)
Shearing/flexure failure of brick wall panels	7 - 8
Overturning of loaded boxcars	7
Wooden utility poles snap	5
Rupturing of oil storage tanks or collapse of self-framing steel buildings	3 - 4
Shattering of concrete or cinder block wall panels (not reinforced) 8 or 12 in. thick	2 - 3
Failure of main connections of wood siding panels for standard house construction, allowing the panels to be blown in Failure of connections of corrugated steel or aluminum panels, followed by buckling of panels Shattering of corrugated asbestos siding	1 - 2
Shattering of glass windows and occasional window frame failure	0.5 - 1

Table 2. Peak overpressure/impulse damage criteria for blast waves from explosions

C

Damage description	Peak overpressure (psig)	Positive impulse (psig-msec)
Severe damage such as 50 to 75% of bearing walls fail in brick houses	≥ 5.8	≥ 68
Moderate damage such as partial collapse of roof and some bearing wall failures in brick houses	≥ 2.5	≥ 42
Light damage to brick houses	≥ 0.67	≥ 16

Personnel may also be injured as a result of direct or indirect effects of a BLEVE. Direct effects result from direct exposure to the blast wave or thermal radiation generated from a BLEVE. For example, eardrum rupture can occur from direct exposure to excessive overpressures. Table 3 presents the likelihood and peak overpressure criteria for which eardrum rupture may be expected to occur for direct exposure to blast waves (i.e., for personnel outdoors). The eardrum rupture criteria come from *Vulnerability Model - A Simulation System for Assessing Damage Resulting from Marine Spills* by Eisenberg et al. (1975). Indirect effects of a BLEVE include injuries resulting from building damage (e.g., collapse of a wall or roof) or flying fragments. The overpressure/impulse criteria presented in Tables 1 and 2 provide indications as to what overpressures/impulses might be expected to injure personnel as a result of building damage. C

C

Table 3. Peak overpressure eardrum rupture criteria for exposure to a blast wave

Likelihood of Eardrum Rupture	Peak Overpressure (psig)
90%	12.2
50%	6.3
10%	3.2
1%	1.9

BLEVE events often generate large vessel fragments that may be propelled long distances. In fact, in many cases, the longest reaching hazard associated with a BLEVE event is projectiles or rocket-type fragments. The fragments associated with a BLEVE are generally not evenly distributed. The vessel's axial direction usually receives more fragments than the side directions, but it is not unusual for a vessel to pivot or spin during failure. Therefore, fragments can be launched in any direction. The trajectory of the propelled fragments can also be changed by bouncing off terrain or structures. Guidelines from *BLEVE Response and Prevention: Technical Documentation* by Dr. A. M. Birk (1995) were used to establish the distances that vessel fragments may be propelled.

C

The detailed BLEVE overpressure and missile calculations are presented in a report entitled *Consequence Assessment for ORUD Propane Facility East of the Y-12 Plant*, Report No. LR-233.59-92, issued in July 1999 to Mr. David Renfro of LMES by Mr. Michael Roberts of ABS Group Inc. Risk & Reliability Division (ABS Group).

C

The thermal radiation generated from BLEVE fireball events is estimated using a solid flame model that assumes that the fireball is a spherical ball resting on the ground as the flammable material is burned. The diameter of the fireball and the duration of the fireball are estimated using empirical relationships from CCPS (1994 and 1989).

C

Personnel injury resulting from exposure to a BLEVE fireball is dependent upon the thermal dose (the integral of the thermal flux over the duration of the fireball). Table 4 summarizes the types of injury and thermal dose criteria that may be associated with the injury type for direct exposure (i.e., personnel outdoors within line-of-sight of the fireball) to thermal radiation on bare skin. The thermal dose criteria are from "Quantitative Evaluation of Fireball Hazards," *Process Safety Progress*, by Mr. Richard Prugh (April 1994).

C

Table 4. Thermal dose injury criteria for BLEVE Fireball exposure C

Injury description	Thermal dose (Btu/ft^2)
Third-degree burns (99% fatal)	106
Third-degree burns (50% fatal)	44
Third-degree burns (1% fatal)	22
Second-degree burns (blisters)	13
First-degree burns (sunburn)	8.8
Threshold of pain	3.5

The detailed BLEVE fireball calculations are presented in a report entitled *Consequence Assessment for ORUD Propane Facility East of the Y-12 Plant,* Report No. LR-233.59-92, issued in July 1999 to Mr. David Renfro of LMES by Mr. Michael Roberts of ABS Group. C

Flash fire events were modeled using the Complex Hazardous Air Release Model (CHARM), Version 9.1, developed by Radian International. CHARM is a modeling program that calculates and predicts the movement and concentration of airborne plumes from postulated accidental releases of dense or neutrally buoyant vapor clouds. The impact zone for a flash fire event was estimated as the maximum distance from the point of release that the concentration of the vapor cloud exceeded the lower flammability limit (LFL) of the hazardous material. The LFL for propane is 2.1 vol%. Personnel within the LFL zone may suffer serious burns if a flash fire were to occur. C

The detailed flash fire calculations are presented in a report entitled *Flash Fire/Vapor Cloud Explosion Consequence Assessment for Hypothetical Propane Releases*, Report No. LR-233.60-92, issued in November 1999 to Mr. Eddie Bailiff of LMES by Mr. Michael Roberts of ABS Group. C

A vapor cloud explosion event occurs when a flammable vapor cloud (i.e., a cloud with a concentration between the LFL and the upper flammability limit [UFL]) ignites and the flame front propagates through the cloud at a speed sufficient to generate damaging ovepressures. For flammable vapor clouds released in open environments, rapid flame acceleration usually requires (1) a powerful ignition source or (2) the presence of partial confinement, repeated obstacles, or other sources of turbulence. In the absence of a strong ignition source or turbulence, a vapor cloud ignited by a low energy ignition source will generally not generate significant overpressures but will result in a flash fire. The CHARM program was used to calculate the maximum distance to the LFL (i.e., the maximum distance from the point of release that the cloud may be ignited), and the encircled area was studied to identify potential congested areas or other sources of turbulence that could enhance flame propagation (i.e., generate significant overpressures). Based on the CHARM flash fire calculations, no potential congested areas or other sources of turbulence were identified that could lead to vapor cloud explosions generating significant overpressures as a result of low energy ignition sources. C

As previously indicated, the detailed flash fire calculations are presented in a report entitled *Flash Fire/Vapor Cloud Explosion Consequence Assessment for Hypothetical Propane Releases*, Report No. LR-233.60-92, issued in November 1999 to Mr. Eddie Bailiff of LMES by Mr. Michael Roberts of ABS Group. C

The consequence analyses for events involving BLEVE overpressure/missiles, BLEVE fireballs, flash fires, and vapor cloud explosions are documented in the *Oak Ridge Utility District (ORUD) Peak Shaving Plant Hazards Assessment,* EMPO-514/HA-025. The potential for significant damage to the Y-12 Plant and the surrounding community is very likely in the worst-case events evaluated. Effects on Y-12 facilities closer to the ORUD facility would be more severe than facilities located at the west end of the Y-12 Plant. C

To reduce duplication of analysis and documentation efforts at the Y-12 Plant, preparation of the EMHA begins with the identification of safety documentation previously developed for a facility. Because the ORUD Peak Shaving Plant is not owned or operated by DOE, it is not subject to the same regulations and guidance as the Y-12 Plant. Therefore, no safety documentation has been previously developed for this facility. The following documentation was used, however, in performing the EMHA for the ORUD facility: C

References:

EMPO-508/HS-038, Rev.0, *Oak Ridge Utility District (ORUD) Peak Shaving Plant Hazards Survey*, December 1999.

ABS Group Report LR-233.59-92, *Consequence Assessment for ORUD Facility East of the Y-12 Plant*, July 1999. C

ABS Group Report LR-233.60-92, *Flash Fire/Vapor Cloud Explosion Consequence Assessment for Hypothetical Propane Release*, November 1999.

1.4 Oak Ridge Water Treatment Plant (ORWTP) Chlorine Release C

Scenario C

A severe chlorine release, analyzed under worst case conditions, from the ORWTP could result in chlorine concentrations of ERPG-3 levels at 2.2 miles and ERPG-2 levels at 6.4 miles. C

1.4.1 Emergency Planning Basis

The ORWTP is a public owned and operated non-DOE facility. An Emergency Management Hazards Assessment was conducted to identify and analyze hazards at the ORWTP that could pose a threat to the Y-12 Plant. Therefore, the emphasis of the Hazards Assessment was on hazards that may extend beyond the boundary of the ORWTP and not on hazards that are contained within the boundary of the ORWTP. C

The ORWTP is located on Chestnut Ridge, north of the east end of the Y-12 Plant in Oak Ridge, Tennessee. The Water Treatment Plant Complex consists of two primary structures: the main water plant building and the chlorine feed building. The main building contains chemical feed systems (with the exception of the chlorine injection system) sedimentation basins, filters, reservoirs for treated water, and associated equipment. The chlorine feed building contains chlorine gas cylinders and a chlorine gas-injection system. C

Systematic analyses were conducted and documented in the facility *Hazards Assessment for the Oak Ridge Water Treatment Plant Complex*, EMPO-514/HA-002, which identifies the hazards associated with the operation of the ORWTP facilities and defines the accident scenarios involving those hazards. The systems analyzed are the chemical receiving operations, the storage units, chemical feed systems, chlorine injection systems, and usage. The design of the facility and the plan for its operation include features that reduce the likelihood of accidents or upset conditions and limits the potential impacts. C

Each aspect of the water treatment process has its own individual controls to ensure that activities within the operation are properly controlled to achieve expected results and to comply with applicable requirements. These systems of control cover all operations and activities internal to the ORWTP facilities organization, which includes the entire spectrum of the facility operation chemical receiving and storage, chemical feed preparation, and maintenance. Engineering controls incorporated in the facility design include containment systems, line transfer of liquids and/or gaseous chlorine dissolved in liquids, liquid level controls, chemical feed controls and adjustments, local exhaust ventilation to scrubber system, and specific alarm systems. Management practices and proper handling methods chlorine gas cylinders, chemical fed systems, and loading operations are addressed and implemented in the various operational procedure. C

Cylinders of chlorine are stored in the chlorination building located at the Water Treatment Plant. The cylinders are lifted and moved by means of a forklift or hoisting systems at the facility. The event scenarios involving the release of chlorine gas are summarized in EMPO-514/HA-002 and identify possible methods that could cause a release of chlorine. In each prescribed scenario, the primary and secondary barriers are considered to have failed; otherwise, any chlorine release would be negligible. C

C

Unintended chlorine releases have occurred as a result of industrial accidents involving equipment such as tanks, pipelines, relief valves, and vents.

Chlorine releases can be modeled as either instantaneous puff releases or continuous releases. During an instantaneous release, such as a cylinder rupture, large amounts of chlorine are released in a relatively short period of time. In a continuous release, such as the failure of a gasket, the chlorine release rate is maintained over a period of time until it is controlled or until the cylinder is depleted. C

Initially, during a cylinder release, either gaseous or liquid chlorine, or both, may be released. As a result of the release, the pressure and temperature in the cylinder decreases, slowing the release rate. On release, pressurized liquid chlorine cools to its boiling point (-29°F) and boils off. Mixing with the atmosphere is delayed because the liquid must first evaporate. Chlorine vapors, however, mix immediately. If released under pressure, liquid chlorine can flash to a vapor, resulting in a two-phased jet release. C

During the intermediate phases of a chlorine release, the chlorine is most influenced by atmospheric conditions. It continues to mix with the air and with moisture in the air. Depending on atmospheric conditions, aerosols may form. Eventually, a dense gas plume forms. This heavier-than-air plume remains at ground level as it moves downwind until, through dilution, its density equals the density of air. C

Because of the atmospheric variability, stability classes are used to predict the dispersion of the plume. In the morning, the atmosphere is stable. Daytime solar heating creates air movement and an unstable atmosphere. Dispersion is also affected by the wind, the mixing height, and the terrain. C

The consequence analyses of a chlorine release from the ORWTP are documented in the *Facility Hazards Assessment for the Oak Ridge Water Treatment Plant Complex*, EMPO-514/HA-002. Two bounding case scenarios identify a significant impact on the Y-12 Plant and the surrounding community. C

A large release of chlorine gas from the primary barrier (1-ton compressurized cylinders) can occur at the Water Treatment Plant. The high vapor pressure of the gaseous chlorine and the rapid evaporation rate of the liquid chlorine being released during these scenarios, will produce airborne concentrations of chlorine in the atmosphere. These release scenarios will exceed the ERPG-2 value within the Y-12 Site Boundary, resulting in the need to implement onsite protective actions. C

Other release scenarios involve the release of chlorine gas from the primary barrier (1-ton compressurized cylinders) during a fire situation or thermal conditions that could cause the fusible plug in each cylinder to melt and release the chlorine gas. These release scenarios will also exceed the ERPG-2 value within the Y-12 Site Boundary resulting in the need to implement onsite protective actions. C

D. MALEVOLENT ACT EVENTS

- “Minor” scenario
- “Moderate” scenario
- “Extreme” scenario

1.0 Malevolent Act Events

Malevolent acts, including the use of explosives or flammable material, are possible release initiators within the scope of emergency planning. EMHA will typically include malevolent act scenarios identified as a “minor” scenario, a “moderate” scenario and an “extreme” scenario. The *Design Basis Threat for Department* *of Energy Program Facilities (U)*, dated February 1999, is utilized for scenarios in establishing the planning basis.

“Minor” scenarios are those that could be initiated by a single individual using materials readily available for tools in the facility, or small quantities of flammables.

“Moderate” and “extreme” scenarios, such as those used in vulnerability assessments and/or radiological and toxicological sabotage assessments are those that provide the upper bound on the severity level of potential consequences.

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