0015310

SUPPORTING DOCUMENT

1. Total Pages 33

2. Title
Implementation Guideline For Hazard Documentation

3. Number
WHC-SD- GN-ER-301

4. Rev. No.
0

5. Key Words
Hazard Guidance

6. Author
A. R. Schade
Name (Type or Print)
Signature
39000 / 2J3910
Organization/Charge Code

7. Abstract

This document provides Westinghouse Hanford Company (WHC) guidance for determining the potential consequences of hazards contained within facilities or encountered during activities controlled by WHC.

APPROVED FOR PUBLIC RELEASE
5-28-91

AUG 1991 RECEIVED EDMC

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9. Impact Level
2

10. D. R. Ellingson
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11. RELEASE STAMP

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WHC-SD-GN-ER-301, REV 0

IMPLEMENTATION GUIDELINE FOR HAZARD DOCUMENTATION

Prepared by
Regulatory Policy

September 1990

Westinghouse Hanford Company
Safety Analysis and Regulation
Regulatory Review Programs

For
U.S. Department of Energy
Richland Operation Office
Richland, Washington

IMPLEMENTATION GUIDELINE FOR HAZARD DOCUMENTATION

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IMPLEMENTATION GUIDELINE FOR HAZARD DOCUMENTATION

1.0 INTRODUCTION

This section provides Westinghouse Hanford Company (WHC) guidance for determining the potential consequences of hazards contained within facilities or encountered during activities controlled by WHC. This section recommends an approach to requirements of the U.S. Department of Energy, (DOE Order 5480.5, DOE Order 5481.1B, DOE Order 6430.1A) as they apply to the determination of facility or activity hazard consequence, the documentation of that determination and the use of that documentation.

The guidance described includes terms that are key to understanding the approach. Hazard classification is the part of the hazard assessment that provides the basis for the level of DOE and WHC review and approval of a hazard within a facility or encountered by an activity. Facility Segment Use Category (FSUC) is the part of the hazard analysis that provides the bases for design and safety classification by identifying specific hazards and specific hazard issues that may require further development. The two parts, hazard classification and FSUC, are the major parts of a hazard assessment.

The hazard assessment process determines the potential consequences of an inventory of material associated with a facility or activity, exclusive of engineered features or administrative controls. The process should be initiated early in a life-cycle of an activity, new facility, facility modification and/or addition to identify the appropriate management and technical attention.

The direction provided within this section should only be used as guidance. There are too many different types of hazards to have covered all assumptions, methods and applications. When approved, this section will contain the accepted values and methodology for determining WHC Hazard Class and FSUC. Where alternative values or methods are needed to solve a particular problem, the alternative should undergo an equivalent review and approval before it is used in a WHC document.

2.0 SCOPE

The scope of hazard documentation embraces all Department of Energy, Richland Operations (DOE-RL) facilities and activities for which WHC has assumed management and operations. The process should be applied to non-reactor facilities and activities, existing or planned, to aid in identifying unacceptable consequences of hazards which can be identified at this early stage. The process can also be used to identify areas needing further development where insufficient data is available for conclusions.

3.0 DEFINITIONS

The following are definitions of terms used in this section. Other terms used are defined in the references.

Engineered Features

Engineered features are man-made, passive or active barriers that are used to prevent or mitigate the potential consequence of a hazard. They are the features that reduce the risks associated with operation or activity.

Facility

A facility is the buildings and other structures, their functional systems and equipment, and other fixed systems and equipment that have been installed; outside plant, including site development features such as landscaping, roads, walks, and parking areas; outside lighting and communication systems; central utility plants; utility supply and distribution systems; and other plant features.(1)

Facility Segment Use Category (FSUC)

The FSUC is the classification of a division or part of a facility or activity that can be independently evaluated to categorize its potential to do harm. This definition is an expansion of that used in UCRL 15910. Further information is provided in section 7.0.

General Use

A classification of a facility or activity that is associated with hazards that are routinely encountered and generally accepted in the course of everyday living by the vast majority of the general public.

Hazard Classification

A rating system used to classify the worst case consequence due to the intrinsic hazard contained within a facility or encountered within an activity.

Hazard/Intrinsic Hazard

Hazard or intrinsic hazard is the unmitigated potential of a material inventory contained within a facility or encountered in an activity that could do harm to facility workers, on-site and/or off-site personnel and/or the environment.

4.0 RESPONSIBILITIES

This section provides guidance regarding the WHC management organizations that have responsibilities and charters concerning hazard documentation.

4.1 LINE MANAGEMENT

It is the responsibility of line management, whether operating management or project management, to ensure that facility hazard evaluation is properly performed, documented, reviewed and approved. Line management is also responsible for ensuring that planned facility or operational changes that may result in a change to the associated hazard are documented and appropriately reviewed, and the review documented. Operating management is responsible where operating management and project management exist concurrently.

The applicable operating division is responsible for submitting to the Safety Department by August 1 of each year, information on safety analyses to be completed within 3 years, including the review and authorization recommendation. The information should be provided in the format requested in DOE-RL Order 5481.1 (9).

4.2 SAFETY

The Nuclear Safety organization is responsible for providing technical overview and resolution approval of nuclear issues addressed in hazard assessment documents. The Nuclear Safety organization is the focal point (receipt, distribution and coordination of comments) for independent safety review where the preponderance of hazards are nuclear.

The Industrial Safety and Fire Protection organization is responsible for providing technical overview and resolution approval of fire protection, toxicological and industrial issues. They are the focal point for independent safety review where the preponderance of hazards are in their area of expertise.

4.3 SAFETY ANALYSIS AND REGULATION

The Process Operations Safety Development (process facilities) and Waste Operation Safety Development organizations are responsible to provide guidance, liaison and coordination services between individual projects and other WHC organizations for development and internal approval of hazard assessment and other safety documents.

The Safety Support Services organization is responsible to provide analytical expertise based on data and accident scenarios provided by line management organizations. They will also assist in scenario development upon the request of line management.

5.0 HAZARD DOCUMENTATION PROCESS

The hazard documentation process is the first step in the safety process. The information developed is the foundation for further evaluations and analysis. Hazard classification helps to determine the review and authorization requirements. The FSUC assessments help to determine specific actions for design and criteria selection. Figure 1 depicts the flow of the hazard assessment process. Also during the hazard documentation process, a facility can be determined or verified to be a Nuclear or Non-Nuclear Facility which determines the appropriate criteria that needs to be considered but not necessarily applied.

Early implementation will help to determine the amount of resources required to resolve hazard issues. Another benefit is that design basis and other actions can be developed more effectively. The planned actions will then have a basis that minimizes the uncertainties regarding safety of people and the environment.

5.1 TIMING FOR THE HAZARDS DOCUMENTATION

The hazard documentation should be initiated during the engineering study or the earliest phase when the necessary, specific facility information is known (e.g., material inventories, the rudiments of function, and the basic process). Ideally, the assessment should be available before the commencement of functional criteria preparation to the degree the design allows. Normally, the documentation will be transmitted to DOE-RL as part of the approval package with the Functional Design Criteria (FDC) either as an attachment or separate supporting document.

5.2 CONTENT OF THE HAZARDS ASSESSMENT DOCUMENTATION

The hazard assessment documentation for a facility should include the following information:

(1) A brief facility description, as pertinent to the Hazards Assessment (e.g., facility location, preliminary layout, main process, hazard source information).

(2) Determination of nuclear facility status (See Section 6.0 and Figure 4).

(3) Hazards Assessment - models, assumptions, and results.

(4) Determination of the FSUC for each Facility segment (See Section 7.0).

(5) Determination of the facility hazard class (See Section 8.0).

(6) Information to assist facility design personnel in the identification of safety class items and Operational Safety Requirements (OSR's), as feasible with the information available.

6.0 NUCLEAR FACILITY

A nuclear facility is defined in DOE 5480.5[2] and DOE 6430.1A[1] as: "A facility whose operation involves radioactive materials in such form and quantity that a significant nuclear hazard potentially exists to the employees or the general public. Included are facilities that: (1) produce, process, or store radioactive liquid or solid waste, fissionable materials, or tritium; (2) conduct separation operations; (3) conduct irradiated materials inspections, fuel fabrication, decontamination, or recovery operations; or (4) conduct fuel enrichment operations. Incidental use of radioactive materials in a facility operation (e.g., check sources, radioactive sources, and x-ray machines) does not necessarily require the facility to be included in this definition. Particle accelerators and production reactors and their operations are not included."

In summary, the focus of the nuclear facility classification is on the "use" of the facility (i.e., the handling and processing of radioactive materials). See Figure 4 for a graphic illustration of the change. Facilities that are not specifically defined as a nuclear facility may be defined by evaluating the radiological inventory. As an aid to the determination of General Use, TABLE A, (page 19) has been provided. Verification that the radiological inventory is less than the values in Table A will classify it as a non-nuclear facility.

7.0 FACILITY SEGMENT USE CATEGORY (FSUC)

The use of FSUC is expanded in comparison to the use recommended in UCRL 15910. The UCRL documentation uses the FSUC as a classification of structures as related to potential hazards from potential natural forces events such as, earthquakes, tornadoes and high winds. The use of FSUC in this guideline is to classify the potential consequences of an inventory, radiological or non-radiological, or to do harm to people or the environment. While this guidance considers credible events, ($\geq 10^{-6}$ probability) including natural forces, they are only a part of the considerations. Figure 3 depicts the FSUC flow in the hazard process.

Consideration to likely and anticipated events, potential equipment and operator initiated events and the resulting consequences should be emphasized in the early part of FSUC evaluations. This approach will facilitate the discovery of the wide spectra of potential consequences from which subsequent considerations can determine the consequences initiated by natural events.

7.1 GUIDELINE TO SELECTION

Each facility may be divided into portions, herein called facility segments (e.g., a specific process, outside tank farm storage, a disposal unit, chemical storage, office area, etc.). A FSUC is the classification for each facility segment (e.g., one FSUC may be "high hazard," while another FSUC may be "low hazard"). The basic notion with this partitioning process is to permit the flexibility to determine appropriate requirements for a facility segment commensurate with the hazard presented by that segment.

The modeling assumptions and numerical criteria for determining the FSUC for a facility segment are presented in Attachment A. Included in the FSUC determination are considerations of: (a) both radiological and chemical hazards, and (b) the (consequence) receptor groups: facility worker,"off-site" personnel, "on-site" personnel and the environment. It is important to note that for the purpose of FSUC determination of the "on-site" receptor is regarded to be persons inside the site boundary (100 meters or nearest "on-site" receptor from the facility), but not within the facility under evaluation.

It should be noted that the FSUC determination, using the methods and assumptions in Attachment A, is based solely on consideration of the health effects due to the short-term release of air contaminants (e.g., inhalation effects and including direct radiation exposure from the cloud). This approach is based on the assumption that the health effects from these contributors are good indicators of the overall consequences. However, special considerations may be warranted for a unique type of hazard where these contributors do not adequately represent the degree of hazard. For example, this could include a large spill causing potential ground water contamination.

7.2 GUIDELINE TO CONTENT

The recommended content of the FSUC portion of the hazard documentation is as outlined in the following:

(1) A description of the facility segment;

(2) A qualitative and quantitative basis of inventory;

(3) A description of the process related to the inventory, including any changes in form of the inventory;

(4) A statement of the potential consequences;

(5) The resultant hazard classification of that segment, the FSUC.

Attachment A provides additional guidance regarding methods and assumptions for determining the FSUC. Attachment B provides an example of the hazard documentation process.

7.3 GUIDELINE TO IMPACTS

The impacts of the FSUC classification are as follows:

(1) **DESIGN.** The input from the FSUC will help to determine the structural design requirements for resistance to natural forces events contained in DOE 6430.1A[1], the related UCRL documents (4, 5 & 6) and Hanford Plant Standard SDC-4.1[8].

(2) **SAFETY CLASS REQUIREMENTS.** The FSUC is a valuable input towards the development of safety classification.

8.0 FACILITY HAZARD CLASS

It is important to understand the use of the Facility Hazard Class (FHC) in this guideline. FHC is a categorization of the worst case; unmitigated, hazard based consequence associated with the entire facility. The FHC can be used as follows:

(1) FHC can be a quick identifier to determine, early on, the appropriate management attention and review and authorization requirements;

(2) FHC can assist with the determination of the operating requirements of a facility regarding the DOE Order 5480.5(2);

(3) FHC can assist in estimating the resource requirements and determining scheduling needs.

Figure 2 depicts FHC flow in the hazard process.

8.1 GUIDELINE TO SELECTION

At a minimum, the FHC will be equivalent to the highest FSUC determined for any facility segment (from Section 7.0). For example, if two facility segments exist, where one FSUC equals "low hazard" and the other FSUC equals "moderate hazard," the minimum FHC would be a "Moderate Hazard".

The models and assumptions used in FHC are basically the same as described for the FSUC process in section 7.0. The possible need to identify the minimum review and authorization requirements early, makes the worst case estimate of consequence appropriate. Again, if the methods and assumptions noted in section 7.0 and Attachments A and B are not appropriate, other methods and assumptions should be used. The FHC intent is to address all potential (consequences) receptors, facility workers, on-site personnel, off-site personnel and the environment, based on the worst case inventory within a facility.

8.2 GUIDELINE TO IMPACTS

The FHC determines the required review and approval authorization for safety documentation required for supporting projects.

The minimum review and authorization levels as defined in DOE 5481.1B(3) are as follows:

REVIEW AND AUTHORIZATION

FACILITY HAZARD CLASS	REVIEW	AUTHORIZATION
High	WHC,DOE-RL, and DOE-HQ	DOE-RL and/or DOE-HQ
Moderate	WHC, DOE-RL and/or DOE-HQ	DOE-RL and/or DOE-HQ
Low	WHC, DOE-RL	WHC (DOE-RL for OSR)

An additional classification has been added at the request of the DOE. General Use is a facility hazard classification that has a minimum review by the WHC.

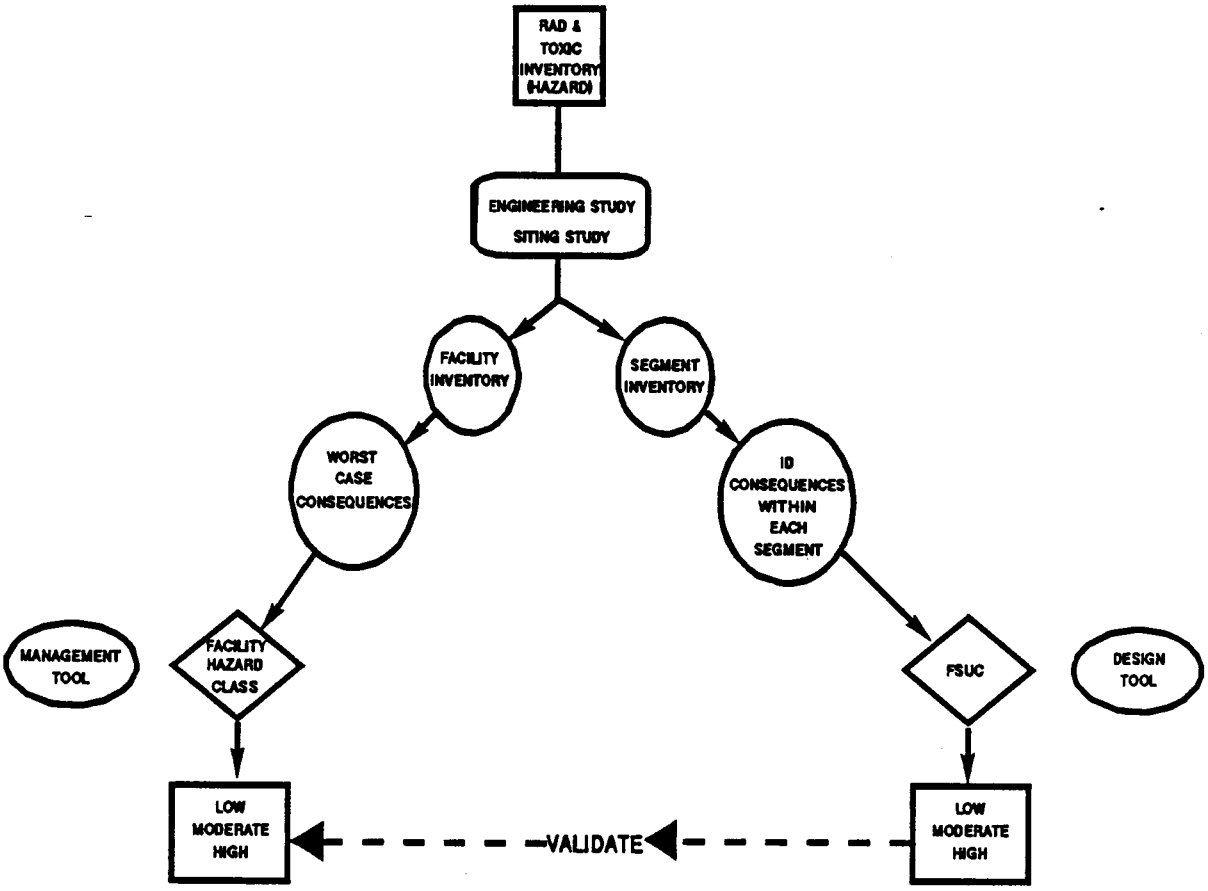
The FHC determines the review and authorization level required consistent with DOE Project Management System, DOE 4700.1.

9.0 REFERENCES

1. DOE Order 6430.1A, General Design Criteria.
2. DOE Order 5480.5, Safety of Nuclear Facilities.
3. DOE Order 5481.1B, Safety Analysis and Review System.
4. UCRL-15910, Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomena Hazards.
5. UCRL-53582, Natural Phenomena Hazard Modeling Project: Seismic Hazard Models for DOE Sites.
6. UCRL-53526, Natural Phenomena Hazard Modeling Project: Extreme Wind/Tornado Hazards Models for DOE Sites.
7. WHC-CM-4-46, Nonreactor Facility Safety Analysis Manual.
8. Hanford Plant Standards, Standard Arch-Civil Design Criteria, SDC-4.1, Revision 11.
9. DOE-RL 5481.1, Safety Analysis and Review System.

FIGURE 1.

HAZARD ASSESSMENT FLOWSHEET



FUNCTIONS

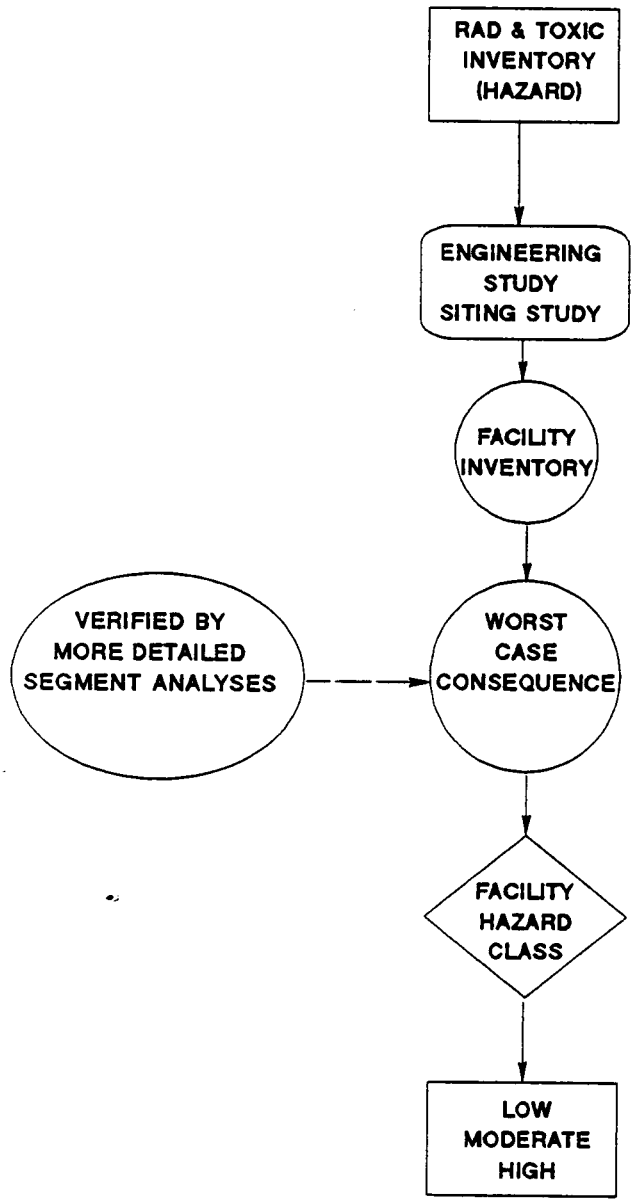
- PROVIDES QUICK IDENTIFICATION FOR MANAGEMENT ATTENTION
- REVIEW AND AUTHORIZATION (CONTRACTOR AND DOE)
- RESOURCE ALLOCATION
- SCHEDULES
- AIDS IN DETERMINING OPERATING CRITERIA

FUNCTIONS

- IDENTIFIES SPECIFIC HAZARDS
- IDENTIFIES ISSUES NEEDING FURTHER DEVELOPMENT
- PROVIDES A LEAD INTO SAFETY CLASSIFICATION & PSE
- HELPS IDENTIFY GENERAL CRITERIA FOR FDC

FIGURE 2.

MANAGEMENT

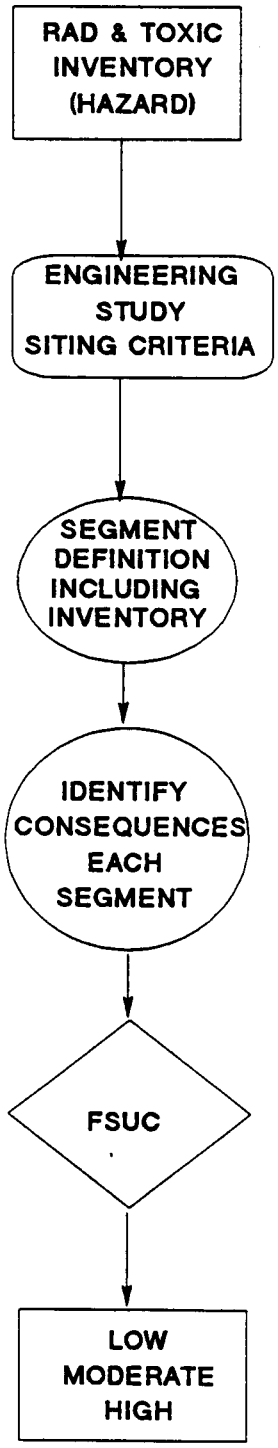


FUNCTIONS

- PROVIDES QUICK IDENTIFICATION FOR MANAGEMENT ATTENTION
- DEFINES MINIMUM REVIEW AND AUTHORIZATION (CONTRACTOR AND DOE)
- ASSISTS IN RESOURCE ALLOCATION
- ASSISTS IN SCHEDULING
- ASSISTS IN DEFINING OPERATING CRITERIA

FIGURE 3.

DESIGN

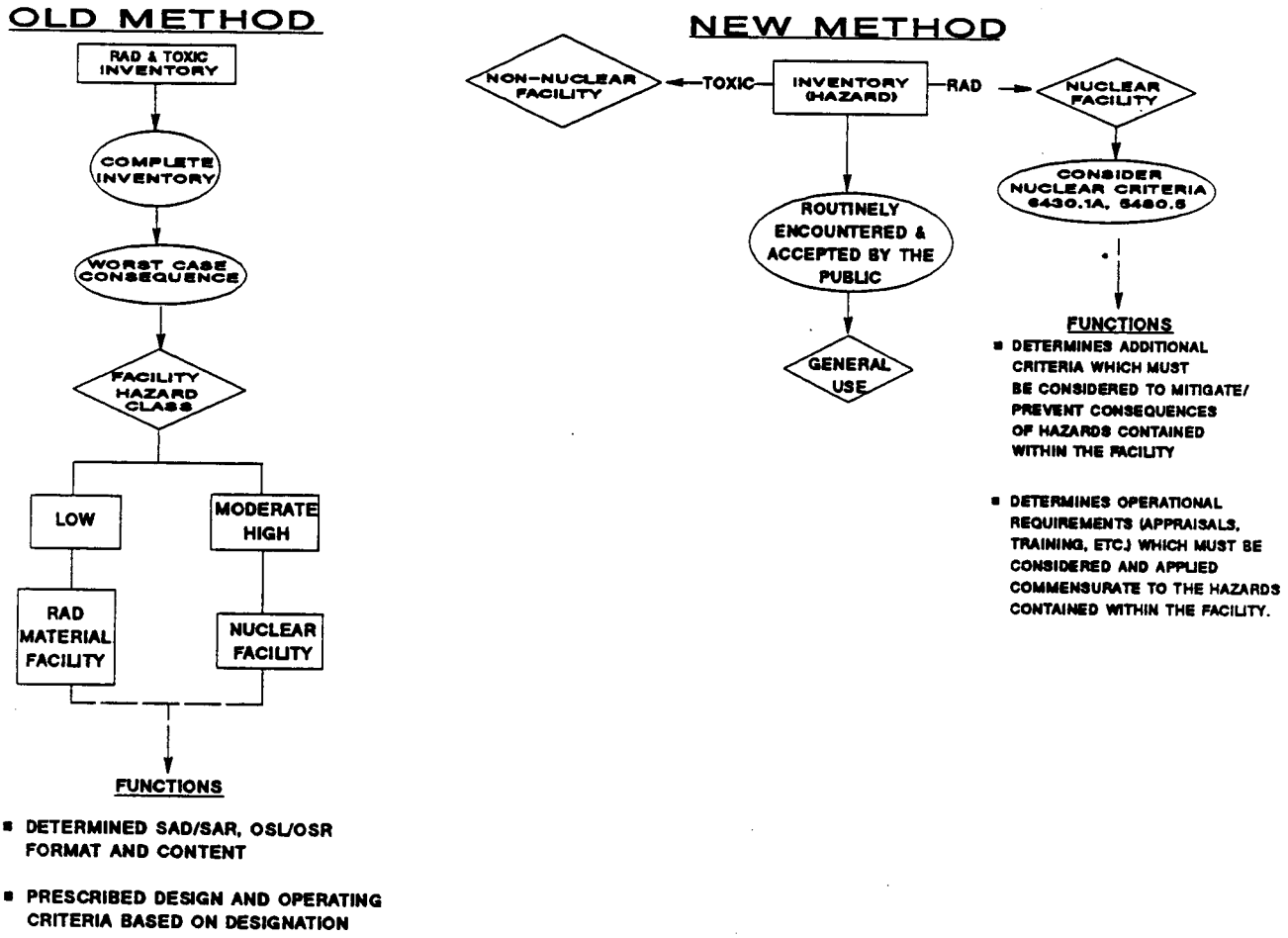


FUNCTIONS

- IDENTIFIES SPECIFIC NATURAL FORCES AND PROCESS HAZARDS
- IDENTIFIES ISSUES NEEDING FURTHER DEVELOPMENT
- PROVIDES A LEAD INTO SAFETY CLASSIFICATION & PSE
- HELPS IDENTIFY GENERAL CRITERIA FOR FDC
- VERIFIES WORST CASE CONSEQUENCE (GREATER LEVEL OF DETAIL)

FIGURE 4.

NUCLEAR FACILITY DESIGNATION METHODOLOGY



ASSUMPTIONS AND VALUES USED IN FACILITY SEGMENT USE CATEGORY

A-1.0 INTRODUCTION

In this attachment, threshold values, assumptions and modeling guidance are presented for determining the FSUC. **It should be emphasized that the hazard assessment described in this Attachment is NOT intended to be a risk analysis typically presented in a Safety Analysis Report (SAR).** Therefore, the level of technical sophistication and rigor incorporated in the assumptions and modeling in this Attachment are less than those used in an SAR. The assumptions and models employed here are generally conservative. Other methods and assumptions may be used in lieu of those presented within this section. Alternative assumptions and methods used in the assessment process will be documented, including: basis, justification and results, and approved by Nuclear Safety or Industrial Safety, as appropriate.

A-2.0 GENERAL PROCEDURE

A facility may be divided into segments if the hazard sources within the facility can be separable by process function. See Section 7.0, Facility Segment Use Category.

A hazard assessment should be performed for each facility segment to determine the FSUC for the segment. The hazard assessment should consider radiological hazards, chemical hazards, and nuclear criticality hazards.

The hazard assessment should evaluate the potential consequence to all receptors. The receptors to be considered are: facility worker, on-site personnel, off-site personnel, and the environment.

A-3.0 HAZARD THRESHOLD VALUES

Consideration of radiological and non-radiological inventory and their associated processes need to be evaluated in the hazard assessments. To assist the evaluation process, radiological and chemical threshold values are provided. Table A, General Use Quantities are also included to provide values in determining nuclear and non-nuclear facilities.

HAZARD THRESHOLD VALUES
RADIOLOGICAL

FSUC	Facility Worker	Onsite	Offsite
General Use	< Table A(1)	----	----
Low Hazard	≥ Table A < 25 rem	≥ 0.1 rem < 5.0 rem	≥ 0.01 rem < 0.5
Moderate Hazard	≥ 25 rem	≥ 5.0 rem < 100 rem	≥ 0.5 rem < 5 rem
High Hazard	- - - - -(2)	≥ 100 rem	≥ 5 rem

(1) Unsealed quantities (Table A) involved in a process or activity. These quantities, if used in commercial industry, would require a NRC Specific License.

(2) Facility worker radiological dose consequence is <u>not</u> in the classification of high hazard.

Chemical

FSUC	Facility Worker	On-site	Off-site
General Use	---- ---- ----	< ERPG-1 < 0.1 IDLH < $5X10^{-5}$ ICR	< 0.1 ERPG-1 < 0.01 IDLH < $1X10^{-6}$ ICR
Low Hazard	---- ---- ----	≥ ERPG-1 ≥ 0.1 IDLH ≥ $5X10^{-5}$ ICR	≥ 0.1 ERPG-1 ≥ 0.01 IDLH ≥ $1X10^{-6}$ ICR
Moderate Hazard	---- ---- ----	≥ ERPG-2 ≥ 1 IDLH ≥ $5X10^{-4}$ ICR	≥ ERPG-1 ≥ 0.1 IDLH ≥ $5X10^{-5}$ ICR
High Hazard	---- ---- ----	≥ ERPG-3 ≥ 5 IDLH ≥ $1X10^{-2}$ ICR	≥ ERPG-2 ≥ 1 IDLH ≥ $5X10^{-4}$ ICR

NOTE:
ERPG = Emergency Response Planning Guidelines
IDLH = Immediately Dangerous to Life and Health
ICR = Incremental Cancer Risk
Explanations are found on page 21.

General Use

Basis for Table A

Table A is unsealed quantities above which the Nuclear Regulatory Commission would require a "Specific Domestic License". These quantities represent the values above which there is regulatory concern and which require some form of radiation protection program.

Although licensing is not applicable to DOE facilities, the philosophy of a "regulatory concern" amount is sound. This quantity would denote the amount above which some form of control and employee protection is appropriate and some aspect of the Nuclear Safety Program in DOE Order 5480.5 would be applied. The type and amount of control and protection will vary, depending on the hazard level.

The values in Table A were taken from 10 CFR 20, Appendix C where they were referenced under the section describing posting requirements. Review of the various schedules listing "exempt" quantities identified that the values are identical. Another advantage of Appendix C is that the quantities are contained in a single table. Part 20 also provides an indication of dose values in unrestricted areas (an indicator of posting requirements). These doses are less than 0.5 rem in a calendar year, less than 2 millirem per hour and less than 100 millirem in any seven consecutive days. These "doses" provide an indicator of the hazard level allowing a graded approach to be developed for the protection program.

TABLE A
GENERAL USE QUANTITIES (Exempt Quantity)

Matl	Microcuries
Ag-105	10
Ag-110m	1
Ag-111	100
Am-241	.01
As-73	100
As-74	10
As-76	10
As-77	100
Ba-131	10
Ba-133	10
Ba-140	10
Bi-210	1
Br-82	10
Cd-109	10
Cd-115m	10
Cd-115	100
Ca-45	10
Ca-47	10
C -14	100
Ce-141	100
Ce-143	100
Ce-144	1
Cs-131	1000
Cs-134m	100
Cs-134	1
Cs-135	10
Cs-136	10
Cs-137	10
Cl-36	10
Cl-38	10
Cr-51	1000
Co-58m	10
Co-58	10
Co-60	1
Cu-64	100
Dy-165	10
Dy-166	100
Er-169	100
Er-171	100
Eu-15292h	100
Eu-152 13yr	1
Eu-154	1
Eu-155	10
F -18	1000
Gd-153	10
Gd-159	100
Ga-72	10
Ge-71	100
Au-198	100
Au-199	100
Hf-181	10
Ho-166	100

Matl	Microcuries
H -3	1000
In-113m	100
In-114m	10
In-115m	100
In-115	10
I -125	1
I -126	1
I -129	0.1
I -131	1
I -132	10
I -133	1
I -134	10
I -135	10
Ir-192	10
Ir-194	100
Fe-55	100
Fe-59	10
Kr-85	100
Kr-87	10
La-140	10
Lu-177	100
Mn-52	10
Mn-54	10
Mn-56	10
Hg-197m	100
Hg-197	100
Hg-203	10
K -42	10
Mo-99	100
Nd-147	100
Nd-149	100
Ni-59	100
Ni-63	10
Ni-65	100
Nb-93m	10
Nb-95	10
Nb-97	10
Os-185	10
Os-191m	100
Os-191	100
Os-193	100
Pd-103	100
Pd-109	100
P -32	10
Pt-191	100
Pt-193m	100
Pt-193	100
Pt-197m	100
Pt-197	100
Pu-239	.01
Po-210	0.1
Pr-142	100

Matl	Microcuries
Pr-143	100
Pm-147	10
Pm-149	10
Ra-226	.01
Re-186	100
Re-188	100
Rh-103m	100
Rh-105	100
Rb-86	10
Rb-87	10
Ru-97	100
Ru-103	10
Ru-105	10
Ru-106	1
Sb-122	100
Sb-124	10
Sb-125	10
Sm-151	10
Sm-153	100
Sc-46	10
Sc-47	100
Sc-48	10
Se-75	10
Si-31	100
Na-24	10
Sr-85	10
Sr-89	1
Sr-90	0.1
Sr-91	10
Sr-92	10
S -35	100
Ta-182	10
Tc-96	10
Tc-97m	100
Tc-97	100
Tc-99m	100
Tc-99	10
Te-125m	10
Te-127m	10
Te-127	100
Te-129m	10
Te-129	100
Te-131m	10
Te-132	10
Tb-160	10
Tl-200	100
Tl-201	100
Tl-202	100
Sn-113	10
Sn-125	10
Tl-204	10

Matl	Microcuries
Th(natural)	100
Tm-170	10
Tm-171	10
W -181	10
W -185	10
W -187	100
U(natural)	100
U -233	.01
U -234/235	.01
V -48	10
Xe-131m	1000
Xe-133	100
Xe-135	100
Yb-175	100
Y -90	10
Y -91	10
Y -92	100
Y -93	100
Zn-65	10
Zn-69m	100
Zn-69	1000
Zr-93	10
Zr-95	10
Zr-97	10

Any alpha emitting radionuclide not listed on this page or mixtures of alpha emitters of unknown composition .01

Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition .1

See notes 1 & 2 on the following page.

Note 1: Many radioisotopes disintegrate into isotopes which are also radioactive. In expressing the quantities in Table A, the activity stated is that of the parent isotope and takes into account the daughters.

Note 2: Where there is a combination of isotopes, the limit for the combination should be derived as follows:

Determine for each isotope in the product the ratio between the quantities present in the product and the exempt quantities established in Table A for the specific isotope when not in combination. The sum of such ratios may not exceed "1" (i.e., unity).

Example:

$$\frac{\text{Quantity of Isotope A in Product}}{\text{Exempt quantity of Isotope A}} + \frac{\text{Quantity of Isotope B in Product}}{\text{Exempt quantity of Isotope B}} < 1$$

A-4.0 EXPLANATIONS OF TERMS

The following are explanations of the terms used in Attachment A:

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

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

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

IDLH is the maximum concentration of a substance in air from which, in the event of failure of a respirator being worn, a worker could escape within 30 minutes without experiencing escape-impairing or irreversible health effects (NIOSH-85). The IDLH is considered a maximum concentration above which only a highly reliable breathing apparatus providing maximum worker protection is permitted.

ICR is a relative unit used to express the statistical probability of a substance (toxicological or radiological) to cause cancer. The radiological ICR is expressed as 1 rem equal to 1 E-4 (NRC) to 1 rem equal to 5 E-4 (EPA and FDA). The toxicological ICR are listed by individual chemicals derived by the EPA/FDA and generally listed in American Industrial Hygiene Association publications of hazardous substances.

A-5.0 ASSUMPTIONS AND MODELS

The assumptions used in hazard assessment are intended to represent worst case (credible) inventory and process conditions to determine the unmitigated hypothetical consequences. The consequences are estimates to the receptors: facility workers, on-site personnel, off-site personnel and the environment. The following guidance provides recommended approaches for radiological, chemical and criticality hazard assessments.

A-5.1 ASSUMPTIONS AND MODELS FOR RADIOLOGICAL HAZARDS

(1) Radiological hazard analyses for onsite and offsite maximum exposed individuals should be based on airborne radioactivities due to radioactive source inventories in a facility segment. The radiological hazard analyses for facility workers should include direct irradiation (including criticality where that potential exists) as well as inhalation and submersion hazards. The radioactive source inventories may be determined based on design-basis process and storage capacity of the segment.

(2) No credit should be taken for engineered features or administrative controls for the source terms calculation. "Source Terms" means the worst

case amounts of potential airborne radioactive materials and curie/gram values used in calculating the hazards.

(3) Inherent physical, chemical, and radiochemical characteristics associated with the hazard source materials could be considered in source terms calculations. The parameters suggested in NUREG-1320[a] may be used as guidance. Consideration also needs to be given to the energy (pump pressure/pipe rupture, fire, explosion, seismic, criticality, etc.) which is imparted to the parent material causing it to go airborne and the physical form of the source terms. This can create Source Reduction Factors (SRFs) which would be different for each combination of inherent characteristics and accident energies. Judgement will be required to arrive at the appropriate SRFs for the particular condition being analyzed.

The SRFs discussed below are basically transfer coefficients for radionuclides from liquid or solid phase to the airborne phase. The SRFs have been developed for use in reactor accidents. Where other data is not available, these reactor SRFs could be used as a starting basis and reduced further to more appropriately estimate the "worst case" source terms for a facility or segment.

SRF VALUES

Hazard Phase	SRF
Gaseous (Kr, Xe, Ht, etc.)	1.0
Liquid (Halogen)	1.05
Liquid (Dissolved Solid)	0.01
Liquid (Non-dissolved Solid)	0.001
Solid (Unconsolidated Powder)	0.5*(1)
Solid (Untreated)*(2)	0.001
Solid (Treated)	0.0001

* Note: (1) This value may be adjusted for particle size distribution.

(2) Here, an UNTREATED SOLID means radionuclides that are not physically or chemically bound to the medium. Examples of untreated solids are contaminated trash in a cardboard box or contaminated air filter elements. The TREATED SOLID means radionuclides that are physically or chemically bound to the medium. Examples of treated solids are stabilized or solidified liquid wastes.

Credit in the SRFs can be taken for the "form" of the radioactive material provided that the change in form is not part of the facility segment process being analyzed <u>and</u> the accidents being considered do not result in a form change. For example: A sealed source need not be considered a potential source of aerosol unless a) the process within the segment being analyzed involves creation of a sealed source from a liquid or powdered source or b) the accident involves sufficient energy to violate the seal (crushing, burning, etc.) and create an aerosol.

(4) The GEN-II computer code[b] is the accepted code for Hanford calculations. The following parameters are recommended:

A downwind distance of 100 meters is recommended in general for the "on-site" receptor. Facilities located near the site boundary may consider other downwind distances.

The off-site receptor is located at the site boundary in the worst sector.

Release duration should be assumed to be 0-8 hours, (LA-10294-MS)[g] and the corresponding site-specific atmospheric dispersion factors (X/Q) may be used. The worst case meteorological data base should be used.

All releases may be assumed to be at ground level. Building wake effects or plume-terrain interaction need not be considered. Elevated releases were not recommended to keep these preliminary indicator evaluations simplistic. The impact of ground level versus elevated releases may be only 10% to 25% difference. This is a negligible concern, given the other uncertainties in the hazard assessment process.

Radiological Modeling Resource; GEN-II is used on the Hanford Reservation to model hypothetical accidents intended in prospective consequence assessments such as site evaluations, environmental impact statements, SARs and in retrospective assessments of the potential consequences of routine releases. Although it is not intended for use during the course of an accident, the dose computation portions of the systems might be used following an accident to refine earlier consequence assessments.

A-5.2 ASSUMPTIONS AND MODELS FOR CHEMICAL HAZARDS

(1) Many WHC facilities handle a large number of materials and chemicals. It is not intended that a hazard assessment specifically analyze every material/chemical present, rather only those chemicals that are easily dispersible and present a potential hazard to the receptors. Examples of materials/chemicals that may be excluded from specific evaluation for the HAD are: (a) materials not listed by the EPA[c, d & e] and WDOE WAC-173-303[i] as hazardous materials (b) materials in types and amount that are routinely accepted by the public, and (c) materials in chemical/physical forms not readily dispersible.

This guide references the EPA list 40 CFR 302[e], although it is considered to be a comprehensive list (to include 100% of the EPA list 40 CFR 116[c] and 117)[d] of hazardous materials, there might be some omissions. In particular, care and consideration should be exercised for a chemical not specifically listed but for which similar chemicals are listed.

(2) The chemical hazard analysis should be based on airborne chemicals due to release of chemical inventories in a facility segment. The chemical source terms should be based on design-basis process and storage capacity of the segment.

(3) The Emergency Response Planning Guidelines (ERPG)-based criteria, AIHA[j] shall be used first. If the subject chemicals do not have ERPG levels defined, the Immediately Dangerous to Life and Health (IDLH)-based criteria shall be used for non-carcinogenic chemicals. For carcinogenic chemicals (but no ERPG defined), the Incremental Cancer Risk (ICR) shall be calculated

in addition to the IDLH analysis and its necessary parameters. The necessary parameters for the ICR calculation may be found in various EPA reports (e.g., Integrated Risk Information System or IRIS). A case-by-case ICR evaluation may be performed for a carcinogen not listed in the IRIS data bank. For a given chemical, the more conservative criteria of the IDLH or ICR shall be used to determine the FSUC. The basis being that the ICR risk and the IDLH analysis provides a measure of the risk due to other effects.

(4) If neither the ERPG or IDLH exists for a hazardous chemical, a case-by-case examination should be performed with suitable justification provided for the conclusion.

(5) The modeling resource EXTRAN[f] can be used in hazard evaluations. It is intended to also be used in elimination of designs and the emergency preparedness planning phase. The source term portion of the code may also be appropriate for incorporation in simple response models.

(6) Airborne chemical concentrations shall be calculated using the following Equation [A-1]:

$$C = S*(X/Q) \qquad [A-1]$$

where C is air concentration;
S is release rate; and
X/Q is defined as the (worst case) site specific atmospheric dispersion factor.

In determination of the release rate (S), such factors as total inventory, volatility of the chemical, evaporation rate, entrainment rate, and chemical reaction products may be considered. A suitable model should be developed to depict the release rate.

(7) The following alternative equation [A-2] may be used for liquid chemical sources only if the Equation [A-1] is not readily applicable.

$$C = I*SRF*RR*(X/Q) \qquad [A-2]$$

where C is air concentration;
I is chemical inventory;
SRF is Source Reduction Factor; and
RR is Release Rate.

A-5.3 ASSUMPTIONS AND MODELS FOR CRITICALITY HAZARD

The potential for criticality must be evaluated on a case-by-case basis. However, as a general rule, if the inventory of fissionable materials within a segment is greater than the critical mass taking into account the form, distribution, and composition of the materials, the segment should be classified as Moderate or High Hazard.

If the On-site and Off-site consequences due to criticality within a segment is equal to or greater than 100 rems and 5 rems, respectively the FSUC for the segment should be classified as High Hazard. The radiological consequences are based on external exposure due to prompt neutron and gamma radiation and short-term immersion in a radioactive plume.

(1) Inherent nuclear and chemical properties and distribution of the source materials can be considered in determining whether a nuclear criticality hazard exists or not.

(2) The following distances can be assumed for calculation of external dose due to a criticality:

On-site: 100 meters
Off-site: shortest site boundary distance

(3) Fission yield values recommended in LA-10294-MS[g] should be used for the external dose calculation. Alternative fission yield values may be used with justification.

(4) The external dose due to prompt neutron and gamma radiation should be calculated using appropriate methods. The method suggested in the NRC's Regulatory Guide 3.35[h] or similar alternative methods are acceptable.

(5) GEN-II or approved Hanford codes may be used for calculation of immersion dose using source terms in Reference (g). Contribution from short-term inhalation is minor for a criticality accident and can be ignored.

A-8 REFERENCES IN ATTACHMENT A

(a) NUREG 1320 - Nuclear Fuel Cycle Facility Accident Analysis Handbook.

(b) PNL-6584, GEN II - The Hanford Environmental Radiation Dosimetry Software System.

(c) US EPA 40 CFR 116 - Designation of Hazardous Substances.

(d) US EPA 40 CFR 117 - Determination of Reportable Quantities of Hazardous Substances.

(e) US EPA 40 CFR 302 - Designation Reportable Quantities and Notification.

(f) PNL-xxxx, EXTRAN - A Computer Code for Estimating Concentrations of Toxic Substances At Control Room Air Intakes.

(g) LA-10294-MS - A Guide to Radiological Accident Considerations for Siting and Design of DOE Nonreactor Nuclear Facilities.

(h) Regulatory Guide 3.35 - Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Plutonium Processing and Fuel Fabrication Plant (July 1979).

(i) Washington Department of Ecology, Washington Administrative Code, WAC-173-303.

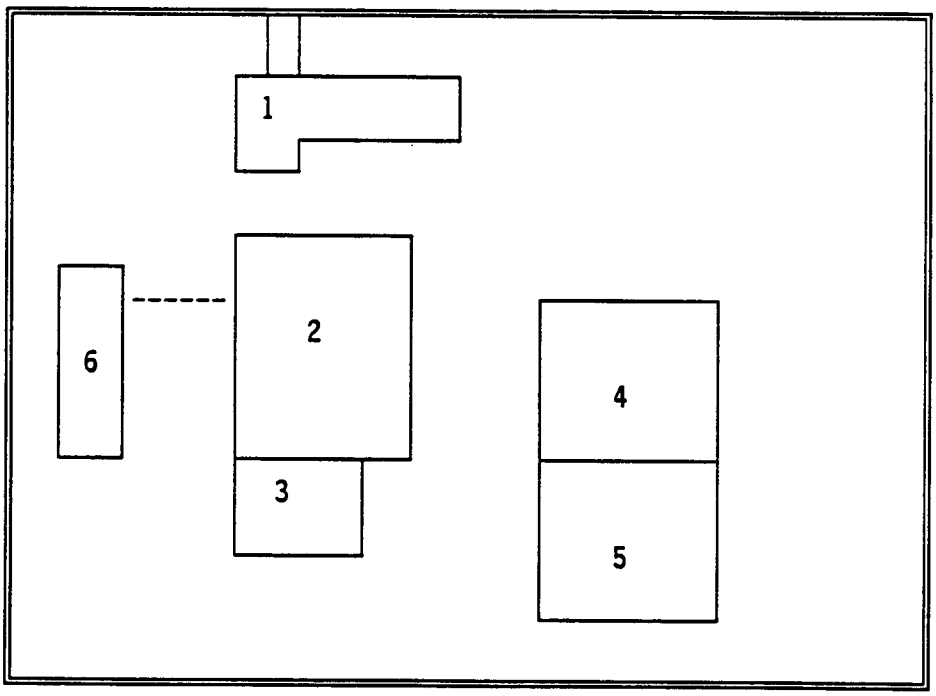
(j) AIHA, Emergency Response Planning Guidelines, American Industrial Hygiene Association, Suscribe, 475 Wolf Ledges Parkway, Akron, Ohio, 44311-1987.

HAZARD ASSESSMENT EXAMPLE

The following example is a Hazard Assessment for a fictitious facility, Super Waste Treatment Facility (SWTF) to illustrate the concepts presented in this Guide.

B-1.0 BRIEF FACILITY DESCRIPTION

The SWTF processes low-level liquid and solid nuclear wastes by mechanical compaction and solidification in cement. The SWTF is located in X-Area, and the shortest distance to the site boundary is 1500 meters. The preliminary layout is as follow;



Legend:
1. Admin/Cafeteria Building
2. Processing (Compaction/Solidification)
3. Sand Filter/Exhaust Stack
4. Solid Waste Storage (Non-Compacted)
5. Treated Solid Waste Storage
6. Tank Farm (Liquid Waste, Chemicals)

B-1.1 DIVISIONS OF FACILITY INTO SEGMENTS

(1) Segment 1: Administration/Cafeteria building is (or planned to be) separated from other units.

(2) Segment 2: Central processing unit, sand filter housing and exhaust stack are associated with a common process. (2 and 3 on the layout drawing).

(3) Segment 3: Solid waste storage units (4 and 5 on layout drawing) handle a similar inventory and process function, hence, they are considered to be a single segment.

(4) Segment 4: Liquid wastes stored in the Tank Farm (6) are fed to a solidification system through overhead 2" pipes into a batch tank. The waste tank is an atmospheric tank. Thus, "passive isolation" of the waste tank inventory can be expected. The waste farm potentially represents specific hazard considerations. Thus, the Tank Farm is considered as a separate segment.

B-1.2 HAZARD INVENTORIES

(1) Segment 1: The Admin/Cafeteria building does not store or process any hazardous materials of type or quantity above that routinely accepted by the general public.

(2) Segment 2: Based on the maximum processing capacities of the mechanical compaction system, cement processing system, and the maximum sand filter loading, the following inventories are estimated. Here, L, S1 and S2 in parenthesis denote liquid source, untreated solid source and treated solid source, respectively.

Hazard Source	Compaction	Cement	Filter
Cs-137	---	10 Ci (L) 9 Ci (S2)	5 Ci (S1)
Pu-238	2 Ci (S2)	---	1 Ci (S1)

(3) Segment 3: Based on the maximum storage capacity of the Solid Waste Storage units, the following inventories are estimated.

Hazard Source	Untreated	Treated
Cs-137		150 Ci (S2)
Pu-238	6 Ci (S1)	15 Ci (S2)

(4) Segment 4: Based on the maximum storage capability of the liquid waste tank in the Tank Farm, the following inventories are estimated.

Hazard Source	Tank
Cs-137	100 Ci (L)
Benzene	2×10^4 Kg (L)

From the above estimates, the following summary table is prepared.

SUMMARY HAZARD INVENTORY TABLE

FACILITY NAME: Super Waste Treatment Facility (SWTF)

HAZARD SOURCE	FACILITY SEGMENTS			
	SEGMENT 1	SEGMENT 2	SEGMENT 3	SEGMENT 4
Radioactive				
Cs-137	None	10 Ci (L) 5 Ci (S1) 9 Ci (S2)	150 Ci (S2)	100 Ci (L)
Pu-238	None	1 Ci (S1) 2 Ci (S2)	6 Ci (S1) 15 Ci (S2)	
Chemical				
Benzene	None	None	None	2×10^4 Kg

B-2.0 NUCLEAR FACILITY

The SWTF processes and temporarily stores low-level radioactive wastes on a regular basis. The SWTF falls under the description of DOE 6430.1A, Division 1324 Radioactive Solid Waste Facility (RSWF). Facility segment 4, the Tank Farm, should comply with DOE Order 6430.1A, Division 1323, Radioactive Liquid Waste Facility (RLWF), but does not require the facility designation of RLWF. The function or purpose of the facility is to create solid waste forms. The function of an RSWF and the basis of inventory, greater than generally accepted by the public, justifies the status of a nuclear facility.

B-3.0 HAZARD ASSESSMENT AND MODELS/ASSUMPTIONS

The only fissionable material in the SWTF is Pu-238. The largest inventory of Pu-238, 21 Curies, is in the Segment 3 storage units, which is less than 2 grams total (specific activity of Pu-238 is 17 Ci/gm). This inventory is several orders of magnitude below the minimum critical mass for Pu-238. Hence, the nuclear criticality hazard is excluded from further consideration.

B-3.1 ON-SITE HAZARD ANALYSIS

(1) Segment 1: Since no hazard source is present in this segment, a hazard analysis is not necessary.

(2) Segment 2: Source Terms,

Cs-137; (10*0.01)+(5*0.001)+(9*0.0001) = 0.1059 Ci,
Pu-238; (1*0.001)+(2*0.0001) = 0.0012 Ci.

The on-site dose can be calculated with the above source terms and a site-specific X/Q value. If the site-specific X/Q values are not defined for the X-Area, use X/Q = 0.012 sec/m^3 (see Attachment C). An actual computer calculation was not performed in this example, but the calculated on-site dose is assumed here to be 10 rems at 100 m.

(3) Segment 3: Source Terms:

Cs-137; (150*0.0001) = 0.015 Ci,
Pu-238; (6*0.001)+(15*0.0001) = 0.0075 Ci.

Again, the GEN-II can be used for the on-site dose calculation with the above source terms. For the purpose of this example, the calculated on-site dose is assumed to be 63 rems at 100 m.

(4) Segment 4: Source Terms:

Cs-137; 100*0.01 = 1 Ci,

The on-site dose shall be calculated with GEN-II. For the purpose of this example, the calculated on-site dose is assumed to be 1 rem at 100 m.

The ERPG level for benzene is not defined yet. The IDLH for benzene is 2000 ppm according to the 1985 NIOSH Handbook. Using Equation A-2 and the above X/Q value

$$C = 2 \times 10^4 * 0.01 * 5.6 \times 10^{-4} * 0.012 * 10^6$$
$$= 1300\ mg/m^3 \text{ at 100 m. (or 320 ppm)}$$

However, the IDLH for benzene was removed from the latest NIOSH Handbook due to carcinogenic concern.

Using the EPA method (cancer potency factor for benzene is 2.9×10^{-2} per mg/Kg body weight/day), an incremental cancer risk due to inhalation of 1300 mg/m^3 for 0.5 hour is calculated as follow:

$$ICR = (1300*20*0.5/70*613200)*2.9 \times 10^{-2}$$
$$= 8.8 \times 10^{-6} \text{ lifetime incremental cancer risk}$$

B-3.2 OFF-SITE HAZARD ANALYSIS

The X/Q value at 1500 meters is 1.0×10^{-4} sec/m^3 (see the Figure in Attachment C). This value is 0.008 of the X/Q value at on-site receptor. Comparing this ratio with the off-site/on-site criteria ratios (0.05-0.1 for radiological criteria and 0.01-0.1 for benzene), it is concluded that the on-site dose and air concentration are the controlling factors for the SWTF FSUC.

B-4.0 FACILITY SEGMENT USE CATEGORY

The results of Hazard Assessment are summarized as follows:

SEGMENT	ON-SITE DOSE	CHEM AIR CONCENTRATIONS
Segment 1	None	None
Segment 2	10 rems	None
Segment 3	63 rems	None
Segment 4	1 rem	320 ppm 8.8×10^{-6} ICR

The above results are compared with the numerical criteria in Attachment A, Section A-6.2, and the FSUCs are determined as follows:

Admin/Cafeteria building:	General Use
Central Processing/Filter Unit:	Moderate Hazard
Solid Waste Storage Units:	Moderate Hazard
Tank Farm:	Low Hazard*

Note *: IDLH is more conservative than ICR criteria.

B-5.0 FACILITY HAZARD CLASS

The highest FSUC in the SWTF Facility is Moderate Hazard. Therefore, the overall facility is classified as Moderate Hazard. The SAR should be prepared, reviewed, and approved according to the requirements for the Moderate Hazard category in DOE 5481.1A.

B-6.0 SAFETY CLASSIFICATION

The following considerations are offered for developing safety class requirements and selecting natural forces criteria. The selection should be based on design and operational considerations and commitments to be made in the completion of the functional criteria.

(1) No safety class functions are associated with the Admin/Cafeteria building.

(2) Confinement/containment and off-gas treatment functions of the Tank Farm should be considered for their safety related functions.

(3) Confinement/containment barriers and effluent treatment functions for the Central Processing unit and Solid Waste Storage units are safety class candidates (further risk analysis may be necessary for this determination).

(4) All radioactive effluent monitors are candidates for consideration of safety class requirements.

ATMOSPHERIC DISPERSION FACTOR, (X/Q)

The atmospheric dispersion factors are determined based on the Gaussian Plume dispersion model at near ground level in Reference (c) of Attachment A. For conservatism, Pasquill-Gifford stability category F is assumed with windspeed of 2 m/sec.

$$X/Q = (2\pi u^* y^* z)^{-1}$$

where X/Q is dispersion factor;
u is wind speed; and
y and z are horizontal and vertical standard deviations

The following formulas by Briggs are used to calculate horizontal and vertical standard deviations:

$$y = 0.4d(1+0.0001d)^{-1/2}$$

$$z = 0.016d(1+0.0003d)^{-1}$$

Here, d is downwind distances [m].

The following failures are calculated.

d(m)	y(m)	z(m)	X/Q(sec/m^3)
50	2.0	0.8	5.0(-2)*
100	4.0	1.6	1.2(-2)
1000	38.0	12.0	1.7(-4)
10000	280.0	40.0	7.1(-6)

* Notation for 5.0×10^{-2}