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# Methodology for SNL Nuclear Facility Categorization

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# METHODOLOGY FOR SNL NUCLEAR FACILITY CATEGORIZATION

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# Change History

| Revision | Description of Changes | Effective Date | Primary Subject Matter Expert |
|---|---|---|---|
| 00 | Initial issue. | July 21, 2016 | Jeffrey W. Marr |
| 01 | **Deleted:** Stephen A. Coffing as an approver.<br>**Added:** Responsibility (to Section 2.4) for the nuclear facility safety basis engineer - "When the sum-of-ratios screening value is greater than or equal to 1, notify the owning organization and National Environmental Policy Act (NEPA) analysts to ensure the approved NEPA documentation is based on the new DOE STD 1027-92 values from NNSA SD G 1027." | August 24, 2016 | Jeffrey W. Marr |
| 01 | **Administrative changes only – AOP 09-05 was archived, so the following verbiage was removed:**<br>**Section 4.1.2**:<br>For explosives collocated with radioactive materials, the method described in AOP 09-05, "Mixed Explosive and Radiological Hazard Categorization Methodology," should be used to determine the respirable release fractions, which may be higher than those in NNSA SD G 1027 and in the associated facility categorization.<br>**Section 4.2**:<br>For explosives collocated with radioactive materials in containers, the method described in AOP 09-05, "Mixed Explosive and Radiological Hazard Categorization Methodology," may be used to determine modified release fractions and facility characterization. | February 15, 2018 | Jeffrey W. Marr |

# 1.0 INTRODUCTION

## 1.1 Background

As required in 10 CFR 830, *Nuclear Safety Management*, Subpart B, "Safety Basis Requirements," Section 202 (b)(3), the Department of Energy (DOE) nuclear facilities at Sandia National Laboratories (SNL) are categorized in accordance with DOE-STD-1027-92, Change Notice 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (hereafter DOE-STD-1027-92). In addition, supplemental directive NNSA SD G 1027, Admin Change 1, *Guidance on Using Release Fraction and Modern Dosimetric Information Consistently with DOE STD 1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, Change Notice No. 1 (hereafter NNSA SD G 1027), provides adjustments to threshold values based on modern dosimetry and alternate release fractions for final categorization. The guidance includes a revised process for facility hazard categorization, revised breathing rate, and recalculated threshold values. The methodology provided in DOE-STD-1027-92 is used in conjunction with NNSA SD G 1027 to provide a consistent approach for establishing hazard categorization.

The Primary Hazard Screening (PHS) software is the mechanism by which SNL documents the initial and final categorizations of a facility or activity. A PHS document is the minimum safety basis document required for all operations. Through an interactive question and answer process, the PHS software logic either assigns the hazard category or requires the input of a Nuclear Facility Safety Basis (NFSB) Engineer to review and assign the hazard category. Hazard categorization results may also be documented in other safety basis documentation (e.g., a documented safety analysis).

## 1.2 Purpose

This administrative operating procedure (AOP) provides the process for performing the initial and final hazard categorization for a nuclear facility or activity to ensure compliance with 10 CFR 830.202. This AOP provides guidance on the application of the PHS process (refer to MN471017, *Safety Basis Manual*, Appendix NF-01, "Nuclear Facility Hazard Categorization") and describes the analyses that might be required to finalize a facility's hazard categorization.

## 1.3 Scope

This AOP is used to ensure compliance with 10 CFR 830 and the proper categorization for facilities and activities that involve radioactive material. These facilities and activities are categorized as Hazard Category 1 (HC-1), Hazard Category 2 (HC-2), or Hazard Category 3 (HC-3) nuclear facilities, or as below HC-3 nuclear facilities (hereafter identified as radiological

facilities). Initial and final hazard categorizations are documented in a PHS document and/or in another approved safety basis document (e.g., a documented safety analysis). This AOP further ensures submittal of categorization results to appropriate SNL organizations and, if applicable, to National Nuclear Security Administration/Sandia Field Office (NNSA/SFO) for approval.

## *1.4 Applicability*

This AOP applies to SNL organizations, management elements, and sites that have facilities or activities involving radioactive material. Members of the Workforce, particularly facility managers, ensure the categorization process is documented using the PHS or another approved safety basis document.

## *1.5 Ownership and Technical Review*

The Environment, Safety and Health (ES&H) Planning Department and the controlled document owner are responsible for the structure and content of this AOP. Recommendations, comments, or suggestions for modification should be documented and submitted to the controlled document owner.

This AOP provides requirements and guidance for administrative activities and shall be reviewed at least every three (3) years from its effective date to ensure adequacy and applicability to requirements and work activities. Document revisions are listed and tracked in the change history.

# 2.0 ROLES AND RESPONSIBILITIES

## *2.1 Facility Manager (or Designee)*

The following are the responsibilities for a facility manager (or designee) that are relevant to the hazard categorization process. These responsibilities are assigned in ESH100.2.SB.1, *Establish the Safety Basis of Operations*, and in MN471017, *Safety Basis Manual*, and are listed here for completeness and clarity:

- Complete an electronic Primary Hazard Screening (PHS) document specific to the activity, operation, and/or facility.
- Submit the electronic PHS for review and concurrence.
- Update the PHS annually and when changes occur in the activity, operation, or facility.

## 2.2 ES&H Planning Department Manager

The following is the responsibility for the ES&H Department Manager:

- Review and concur with new/revised final hazard categorizations for Hazard Category 2 (HC-2) and Hazard Category 3 (HC-3) nuclear facilities[1] that require approval by the National Nuclear Security Administration/Sandia Field Office (NNSA/SFO). **Note:** Concurrence must be provided prior to submittal to NNSA/SFO for approval.

## 2.3 Nuclear Facility Safety Basis Program Lead (or Designee)

The following are the responsibilities for the Nuclear Facility Safety Basis (NFSB) Program Lead (or designee):

- Designate an NFSB Engineer to conduct the hazard categorization review.
- Notify the Industrial Facility Safety Basis (IFSB) Program Lead (or designee) when additional hazard analysis may be required for radiological facilities.

## 2.4 Nuclear Facility Safety Basis Engineer

The following are responsibilities for the NFSB Engineer (as applicable):

- Review and concur with new and revised PHS documents to verify accurate hazard categorization for HC-2 and HC-3 nuclear facilities[1] and for radiological facilities.
- Determine the type of hazard/safety analysis and any additional calculations required using a graded approach in accordance with DOE-STD-1027-92.
- Calculate and distribute threshold values for radionuclides not covered in NNSA SD G 1027, Attachment 2, "Hazard Categorization Threshold Tables for Dosimetric Update," Table 1, "Revised Thresholds for Radionuclides," as necessary for final hazard categorization of nuclear facilities.
- Use the methodology from NNSA SD G 1027 to adjust the Table 1 threshold values if the release mechanisms (e.g., explosives activities, dynamic experiments) or release fractions, assumed in Table 1 of Attachment 2 or in Exhibit A-1 of Attachment 6, could result in a different radiological release or exposure for scenarios being analyzed than assumed in the updated thresholds.
- When appropriate, aggregate the radionuclide content of a facility to determine the facility categorization in accordance with DOE-STD-1027-92. This review is performed whenever a PHS is updated to provide a real-time verification of the facility radionuclide content relative to the NNSA SD G 1027 threshold values and the facility categorization.

1 Sandia National Laboratories (SNL) has no Hazard Category 1 or Type A reactor facilities.

- When the sum-of-ratios screening value is greater than or equal to 1, notify the owning organization and National Environmental Policy Act (NEPA) analysts to ensure the approved NEPA documentation is based on the new DOE STD 1027-92 values from NNSA SD G 1027.

# 3.0 ACRONYMS AND DEFINITIONS

## *3.1 Acronyms*

**Acronyms**

| | |
|---|---|
| AOP | Administrative Operating Procedure |
| ARF | Airborne Release Fractions |
| DOE | Department of Energy |
| ES&H | Environment, Safety and Health |
| HC | Hazard Category |
| ICRP | International Commission on Radiological Protection |
| IFSB | Industrial Facility Safety Basis |
| NFSB | Nuclear Facility Safety Basis |
| NNSA/SFO | National Nuclear Security Administration/Sandia Field Office |
| PHS | Primary Hazard Screening |
| RF | Respirable Fractions |
| SNL | Sandia National Laboratories |
| SOR | Sum-of-Ratios (process) |
| TQ | Threshold Quantity |

## *3.2 Definitions*

**Safety Basis Program** – The program within the ES&H Planning Department comprising both Nuclear Facility Safety Basis personnel and Industrial Facility Safety Basis personnel.

**Sum-of-Ratios** – Summation of radionuclide threshold ratios for facilities or facility segments where there are combinations of radioactive materials. The sum-of-ratios process is described in DOE-STD-1027-92.

# 4.0 CATEGORIZATION METHODOLOGY

## *4.1 Initial Categorization*

Sandia National Laboratories (SNL) uses a two-stage process to categorize nuclear facilities: initial categorization and final categorization. The initial categorization process applies a graded approach to determine the type of hazard/safety analysis needed and becomes the screening criteria for new facilities and for major modifications. The assigned Nuclear Facility Safety Basis (NFSB) Engineer determines the type of hazard/safety analysis needed on a case-by-case basis. Information from the initial categorization is input for the final hazard categorization.

### 4.1.1 Perform Preliminary Categorization Review

Hazard Category 2 (HC-2) and Hazard Category 3 (HC-3) nuclear facilities[1] and radiological facilities must be categorized consistent with DOE-STD-1027-92 and NNSA SD G 1027. Therefore, as defined in DOE-STD-1027-92:

- Type B reactors are categorized as HC-2.
- Facilities that have a potential for nuclear criticality are categorized as HC-2, regardless of the threshold limits defined in NNSA SD G 1027. The procedures to determine the potential for criticality and to identify threshold limits for fissile inventories are provided in ESH100.2.SB.2, *Ensure Nuclear Criticality Safety*.

Because the reactor type or potential for criticality defines a facility's hazard categorization, no further validation of the initial hazard categorization is required for such facilities.

### 4.1.2 Perform Initial Categorization Review

If not categorized based on the criteria in Section 4.1.1, the initial hazard categorization process continues as described below.

The Primary Hazard Screening (PHS) process is used for the initial radiological hazards screening, in which the threshold limits for radioactive materials listed in DOE-STD-1027-92, Table A.1, "Thresholds for Radionuclides" are compared to the initial inventory of hazardous material at the facility. The following five (5) conditions are linked to relevant PHS questions and prompt hazard categorization review by an NFSB Engineer.

**Note:** An example PHS radioactive materials table is provided at the end of this section for reference (Figure 4-1).

1. Sum-of-Ratios (SOR) value is greater than or equal to 0.5, which requires NFSB evaluation for facility hazard classification **[PHS Question 2y(1)]**.

   The SOR methodology is described in MN471017, *Safety Basis Manual*, Appendix NF-01, "Nuclear Facility Hazard Categorization."

2. Conditions that make the PHS radioactive materials table inaccurate for SOR calculations or that require verification **[PHS Question 2a]**, including:
    a. A surrogate isotope (e.g., U-235 equivalent) is used in place of actual radionuclides.
    b. The PHS-calculated SOR value is not consistent with the SOR value used to manage the activity.
3. Inventory that identifies Pu-239, Pu-241, Ra-226, Th-232, or U-232 **[PHS Question 2b]**.

    These radionuclides have the potential to increase the SOR due to aging and ingrowth of daughter products with lower DOE-STD-1027-92 threshold limits.
4. Inventory that involves radioactive gases, liquids, or loose particulates (e.g., powders) that could be more dispersible than the form assumed in DOE-STD-1027-92 **[PHS Question 2o]**.

    Readily dispersible radioactive materials might not conform to the assumptions used to calculate threshold limits in DOE-STD-1027-92.
5. Activities involving any of the following **[PHS Question 2p]**:
    a. Explosives collocated with radioactive materials.
    b. Highly reactive chemicals collocated with radioactive materials.
    c. Experiments imparting high energy to radioactive materials (e.g., electrical or physical impact).

    These activities can impart additional energy to the radioactive material increasing dispersion beyond DOE-STD-1027-92 assumptions.

If any of these conditions apply to an activity or facility, the NFSB Engineer performs a review to determine if further safety analysis is needed to validate the hazard categorization provided by PHS. Further analysis may include a requirement for a stand-alone hazard analysis.

If Condition 4 or 5 apply to an activity or facility, the NFSB Engineer performs a review to determine if the Airborne Release Fractions (ARFs) or Respirable Fractions (RFs) in DOE-STD-1027-92 are challenged and if additional calculations are needed for bounding and unique events to validate the final categorization (refer to Section 4.2).

The NFSB Engineer documents analyses and determinations (e.g., in a calculation or report) that validate the hazard categorization identified in the facility's/activity's PHS.

**Radioactive Materials**

| Nuclide | Std. Nuclide | Form (gas, etc.) | Activity Level, microCuries | Special Form | ANSI Cert. | Excluded in 1027-92 | Screening HC3 Ratio | 1027-92 TQ Ratio |
|---|---|---|---|---|---|---|---|---|
| U-235 | U-235 | Solid | 1.92E5 | No | No | No | 4.57E-2 | 1.32E-2 |
| | Location: Site: SNLNM, Area: TA-X, Building: 20000, Room: OUTSIDE<br>Location Details: Stored in designated area located outside courtyard of 20000.<br>Comments: The source item is returned to property owner upon completion of project. | | | | | | | |
| activation products | activation products | Gas | 0 | No | No | No | 0 | 0 |
| | Location: Site: SNLNM, Area: TA-X, Building: 20000, Room: N/A<br>Location Details: ---<br>Comments: Oxygen-15 is vented and has a very short half-life. | | | | | | | |
| activation products | activation products | Gas | 0 | No | No | No | 0 | 0 |
| | Location: Site: SNLNM, Area: TA-X, Building: 20000, Room: N/A<br>Location Details: ---<br>Comments: Nitrogen-13 is vented and has a very short half-life. | | | | | | | |
| activation products | activation products | Solid (various metals) | 2.1E3 | No | No | No | 5E-2 | 1.44E-2 |
| | Location: Site: SNLNM, Area: TA-X, Building: 20000, Room: N/A<br>Location Details: ---<br>Comments: Components and parts that have been activated – i.e., activation products. The components have been activated primarily by n-gamma reactions. DOE-STD-1027-92 ratio modified to reflect ongoing work by safety basis. | | | | | | | |

**Footnotes**

**Std. Nuclide:** (Note: if the nuclide name is not available in the selection list, please contact the PHS technical support team as listed at the bottom of the screen.)

**Activity Level, microCuries:** (microCuries, numeric or engineering notation only; like 275000 or 2.75E5)

**Screening HC3 Ratio:** (ratio is 0 if 'Excluded in 1027' is checked)

**1027-92 TQ Ratio:** (ratio is 0 if 'Excluded in 1027' is checked)

**Comments:** (Note: comments size is limited to 650 characters, extra will not be saved)

Screening HC3 Sum-of-Ratios for all of the radioactive materials: 0.0957
Sum-of-Ratios (Category 3 Limits) for all of the radioactive materials: 0.0276
Sum-of-Ratios (Category 2 Limits) for all of the radioactive materials: 8.76E-5

**Figure 4-1. Example PHS Radioactive Materials Table**

## *4.2 Final Categorization*

The PHS system is also used to document the final hazard categorization, using the revised threshold limits from NNSA SD G 1027, Attachment 2, "Hazard Categorization Tables," Table 1, "Revised Thresholds for Radionuclides," and/or calculated threshold values considering collocated energy sources, dispersible material, or other local factors that cause the threshold values in NNSA SD G 1027 to be questioned.

**Note:** As stated in Section 4.1.1, the categorization of facilities with the potential for nuclear criticality cannot be less than HC-2 regardless of SOR results.

For facilities initially categorized as HC-2 or HC-3, final categorization shall be performed subsequent to the initial hazard categorization process.

For a facility that is categorized as a radiological facility in the initial hazard categorization, a final categorization should be performed when mechanisms exist that could result in a greater radiological release than assumed using the tabulated threshold values in NNSA SD G 1027.

Final hazard categorization starts with a comparison of the final facility radionuclide inventory to the threshold limits in NNSA SD G 1027, Attachment 2, "Hazard Categorization Tables," Table 1, "Revised Thresholds for Radionuclides" using the SOR process. The final facility radionuclide inventory is identified in the PHS Radioactive Materials Table (refer to example in Figure 4-1).

The NNSA SD G 1027 threshold values bound the most common accident scenarios (i.e., drops, spills, and fires), and comparison with these threshold values may increase or decrease the initial categorization. For isotopes not listed in NNSA SD G 1027, Attachment 2, "Hazard Categorization Tables," Table 1, "Revised Thresholds for Radionuclides," the NFSB Engineer calculates threshold values using the methodology from NNSA SD G 1027, Attachment 4, "Technical Basis for Revised Radionuclide Threshold Values."

Final categorization may adjust the NNSA SD G 1027 threshold values based on the results of additional safety analysis required by the initial hazard categorization (e.g., address the five conditions listed in Section 4.1.2)

Final categorization may adjust the NNSA SD G 1027 threshold values by taking additional unmitigated factors into consideration, such as material form, location, dispersibility, and interaction with available energy sources, passive design features that support segmentation, qualified container exclusions, or modified release fractions (ARF × RF).

Safety features (e.g., ventilation system, fire suppression) that can prevent or mitigate a release shall not be considered when developing a final hazard categorization unless the safety feature provides the conditions that allow for the phenomenon responsible for a modified release fraction. For example, the Z-Machine vacuum system provides the conditions that allow a radioactive target to be vaporized. If the vacuum system were unavailable, insufficient energy would be imparted to vaporize the target, and the resulting release fraction of the radioactive material would be bounded by the release fraction assumed in DOE-STD-1027-92.

The final hazard categorization may change if the credible release fractions or limiting exposure pathways are shown to be significantly different than the values in NNSA SD G 1027, Table 1,

"Revised Thresholds for Radionuclides" based on physical and chemical form and available dispersive energy sources. Hazard categorization may change in the following situations:

- Final hazard categorization may be decreased through analysis if the possible facility events are less energetic or less severe, or if the material is less dispersible than assumed in NNSA SD G 1027 (i.e. the applicable [ARF × RF] product for the scenario being evaluated is significantly less than that in NNSA SD G 1027).
- Final hazard categorization may be increased if:
    - the facility being categorized has a collocated energy source (e.g., material with explosive potential) not evaluated in NNSA SD G 1027;
    - the applicable (ARF × RF) product for the scenario being evaluated is significantly greater than that in NNSA SD G 1027;

For cases where the final hazard categorization is adjusted or in situations where scenarios exist involving release mechanisms (e.g., explosives activities or dynamic experiments) that could result in a greater radiological release than assumed in the updated thresholds, the NFSB Engineer documents the technical justification for the hazard categorization (e.g., in a calculation or report). Safety Basis Program personnel determine the type of hazard analysis required based on the graded approach concept in DOE-STD-1027-92.

## *4.3 Radiological Hazard Aggregation*

When a hazard categorization has not been performed and documented at the facility level (e.g., safety basis documentation comprises multiple operations-based PHS documents), a radiological hazard aggregation may be necessary to evaluate the cumulative effects of the radiological hazards of a facility. A radiological hazard aggregation includes the following steps:

1. Determine the relevant PHS documents for the facility.
2. Aggregate the list of isotopes and quantities from the relevant PHS documents.
3. Determine an aggregated facility SOR.
    a. If the facility SOR is less than 0.8, document the aggregated facility hazard categorization.
    b. If the facility SOR is greater than or equal to 0.8, continue with Step 4.
4. Remove nonapplicable radiological material (e.g., double-counted material) from the list of isotopes and update the aggregated facility SOR.
    a. If the updated facility SOR is less than 0.8, document the aggregated facility hazard categorization.
    b. If the updated facility SOR remains greater than or equal to 0.8, continue with Step 5.

5. Consider facility radiological inventory controls.
    a. If inventory controls ensure the SOR remains below 1.0 for the facility's radiological inventory (i.e. controls ensure the facility remains a radiological facility), document the rationale and the aggregated facility hazard categorization.
    b. If existing controls do not ensure the SOR remains below 1.0 for the facility's radiological inventory:
        i. Document the aggregated facility hazard categorization.
        ii. Assist facility management to determine a path forward (e.g., identify/implement additional inventory controls, or initiate safety basis documentation to increase the facility's hazard category).

## *4.4 PHS Updates*

The Environment, Safety and Health (ES&H) Planning Department's Safety Basis Program personnel review PHS updates as they occur, which is at least annually. If conditions discussed in the initial categorization change (refer to Section 4.1), Safety Basis Program personnel may initiate an additional safety analysis to validate the facility hazard categorization in accordance with DOE-STD-1027-92 and NNSA SD G 1027. This safety analysis may include an assessment of the quantity of material, form of the material, and possible energy sources that can impact the material and verify they are bounded by the assumptions in NNSA SD G 1027. In addition, increases in the radionuclide inventory of an individual PHS may require review of any associated radiological hazard aggregations. This PHS update review provides a real-time verification of the facility radionuclide content and the facility categorization.

# 5.0 RECORDS

Records are maintained in accordance with IM100.2.2, *Control Records*, and the *Sandia Records Retention and Disposition Schedule*. The Environment, Safety and Health (ES&H) Planning department directs its records to the appropriate location for retention. Information copies may be retained by the department. The following records are generated in support of this procedure.

- Documentation created to supplement the Primary Hazard Screening (PHS) for a facility's/activity's hazard categorization (e.g., calculations and reports that provide the technical justification and determinations).
- Hazard/safety analyses.
- Correspondence with facility managers, when needed.
- Completed PHS documents[2].

2 Final PHS documents are records that are managed by the electronic PHS system and owned by the facility/activity manager.

Records associated with development and revision of this procedure are also maintained according to IM100.2.2, *Control Records*, and the *Sandia Records Retention and Disposition Schedule*.

# 6.0 REFERENCES

## 6.1 Requirements Source Documents

10 CFR 830, *Nuclear Safety Management*, Subpart B, "Safety Basis Requirements."

DOE-STD-1027-92, Change Notice No. 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.*

NNSA SD G 1027, Admin Change 1, *Guidance on Using Release Fraction and Modern Dosimetric Information Consistently With DOE STD 1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance With DOE Order 5480.23, Nuclear Safety Analysis Reports, Change Notice No. 1.*

SNL, ESH100.2.SB.1, *Establish the Safety Basis of Operations.*

SNL, IM100.2.2, *Control Records.*

SNL, MN471017, *Safety Basis Manual.*

## 6.2 Implementing Documents

SNL, Primary Hazard Screening (refer to ESH100.2, *Analyze and Control Hazards*, and MN471017, *Safety Basis Manual*, Chapter 2, "Safety Basis Planning and Implementation").

## 6.3 Related Documents

10 CFR 30, *Rules of Safety Management*, *General Applicability to Domestic Licensing of Byproduct Material.*

SNL, ESH100.2.SB.2, *Ensure Nuclear Criticality Safety.*

SNL, PG470259, "Nuclear Facility Safety Basis Personnel Qualification Program."

SNL, PG470252, "Integrated Safety Management System Description."

SBDC-013-02, Rev. 2, "Hazard Categorization Calculations Using ICRP 68, 72."