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Radiological Threshold Tracking

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Content Description

Radiological Threshold Tracking for OIG audit in FY18.

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SANDIA NATIONAL LABORATORIES
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LIFE CYCLE MATERIAL MANAGEMENT DEPARTMENT

RADIOLOGICAL AND CLASSIFIED WASTE OPERATIONS

RADIOLOGICAL THRESHOLD TRACKING

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SF 2042-TRA, *Radioactive or Mixed Waste Disposal Request Form*

1.0 PURPOSE, SCOPE, AND OWNERSHIP

1.1 Purpose

This procedure describes the processes used by the Life Cycle Material Management Department (LCMMD or Department) to control the inventory of radioactive material (both fissile and non-fissile) at LCMMD's Radiological and Classified Waste (RCW) facilities.

Radionuclide inventory control is used to maintain quantities of radioactive materials below 90 percent of the Hazard Category 3 threshold quantities published in Supplemental Guidance NA-1 SD G 1027. This does not imply restricting radionuclide inventory to 90 percent of the criticality list values for U-233, U-235, and Pu-239 (ref. DOE-STD-1027-92). All references to radionuclide inventory limits are based on the activity limits of NA-1 SD G 1027 and SBDC-013-01, *Hazard Categorization Calculations Using ICRP 68, 72*. This applies to all references to radionuclide inventory in this procedure.

Fissile inventory control precludes the potential for criticality by complying with ESH100.2.SB.2, *Nuclear Criticality Safety Program*, and NCS-PDD-2016, *Nuclear Criticality Safety (NCS) Program Description Document*, which allow managing inventory using a fissile equivalent mass (FEM) limit (700 gram (g) U-235 FEM). Fissile inventory control using U-235 FEM is conservative relative to the criticality list values for U-233, U-235, and Pu-239 (ref. DOE-STD-1027-92) because it includes additional radionuclides from ESH100.2.SB.2 and NCS-PDD-2016.

1.2 Scope

This procedure addresses radionuclide and fissile inventory tracking and control at the Department's RCW facilities, including:

- Radioactive and Mixed Waste Management Facility (RMWMF).
- Manzano Storage Bunkers.

This procedure only applies to waste or material with a radiological component, such as radioactive waste, mixed waste, radioactive material, and accountable nuclear material.

The following personnel perform the activities described in this procedure:

- Radioactive Field Technicians (Handlers).
- Operations Supervisor.
- Personnel who have completed and are current in NCS 220, *Advanced Nuclear Criticality Safety*.

The items and activities described in this procedure include:

- Acquisition and management of radionuclide inventory data.
- Use of the data to ensure that the radionuclide inventory at the RCW facilities for each segment does not exceed 90 percent of the Hazard Category 3 threshold quantities.
- For FEM-managed areas, use of the data to ensure that the fissile material mass at the RCW facilities for each segment does not exceed 700 g U-235 FEM.
- Facility segmentation.
- Documentation requirements.
- Quality assurance and recordkeeping.

Fissile inventory control in Criticality Safety Index (CSI) arrays is not addressed in this procedure. CSI storage arrays are addressed in FOP 00-02, *Waste Handling*, and FOP 09-11, *Open Container Operations*.

1.3 Ownership

The Department Manager and the author are responsible for the structure and content of this procedure. Recommendations for improvement and comments regarding the modification of this procedure should be forwarded to the Department Manager or the author/point-of-contact in accordance with AOP 94-12, *Technical Work Document Processing System*.

1.4 Frequency of Review

This procedure provides requirements and guidance for administrative activities that do not frequently change. Therefore, this document shall be reviewed at least every three years and revised in accordance with AOP 94-12, *Technical Work Document Processing System*.

2.0 TRAINING AND QUALIFICATIONS

The Radioactive Field Technicians who perform the activities described in this procedure are qualified and trained as defined in the *Weston Qualification and Training Program*.

Qualification and training for the Operations Supervisor are described in PRG 00-01, *Training Program*, and PRG 00-02, *Operations Training Program.*

The personnel who perform the activities described in this procedure read this procedure and sign an Authorized Users List for it.

3.0 HAZARDS

This procedure involves the use of barcode readers to collect data and computers to perform calculations and generate reports. There are no occupational hazards associated with these activities to the extent they are performed.

4.0 EQUIPMENT AND MATERIALS

The following equipment may be required to perform the activities described in this procedure:

- RadTrack – a custom database application used to store waste characterization and inventory data and to generate printed reports.
- Barcode readers – allow for inventory data capture rapidly and accurately and for electronic transfer of the data to the database by the Radioactive Field Technicians.
- Computers to maintain and access the inventory database.

5.0 DATA ACQUISITION AND MANAGEMENT

Document Control Staff transfer the waste nuclide and activity data into the RadTrack database from Disposal Request forms (DRs) (SF 2042-TRA) and ensure that the data in the database accurately reflect the information provided in and with the DR through a data verification process (AOP 99-10, *Disposal Request Custodian Procedures).*

Radioactive Field Technicians capture waste inventory and location information using a barcode reader (FOP 00-02, *Waste Handling*).

Radioactive Field Technicians transfer the data from the barcode readers to the RadTrack database (AOP 99-09, *Information Management Procedures*).

Radioactive Field Technicians update and verify the Hazard Category 3 threshold values that are stored in the database to ensure that the current Hazard Category 3 threshold values, as defined in NA-1 SD G 1027 or provided by the Sandia National Laboratories (SNL) Safety Basis Department (e.g., SBDC-013-01, *Hazard Categorization Calculations Using ICRP 68, 72*), are used in the calculations performed by the database.

6.0 INVENTORY CONTROL

6.1 Radionuclide Inventory Control

Radionuclide inventory control is achieved by ensuring that the ratio of the radionuclide curie content to its Hazard Category 3 threshold limit, when summed, is less than 0.9 for waste in each facility segment being monitored.

The radioactive/mixed waste or material radionuclide inventories are derived from information provided by radioactive/mixed waste or material generators and recorded in RadTrack. To verify the radionuclide inventories are below 0.9 of their corresponding Hazard Category 3 thresholds, Equation 1 is used to calculate the sum of fractions for each segment (S_n) (ref. DOE-STD-1027-92):

$$S_n = \sum \frac{A_i}{T_i} \qquad \text{Equation 1}$$

where,

A_i is the activity of nuclide i in the segment (Curies (Ci); from all parcels in the segment).

T_i is the Hazard Category 3 threshold limit for nuclide i (Ci) from NA-1 SD G 1027, or as provided by the Safety Basis Department (SBDC-013-01).

The summation includes all parcels stored in the segment. This computation is performed for all n segments and facilities.

In addition, the following guidelines affirm that the radioactive/mixed waste or materials are stored and processed in a safe manner and preclude comingling between segments (See Section 7.0, Segmentation):

- The S_n for individual radioactive/mixed waste or material containers or packages is <0.9.
- The S_n for each segment is <0.9.

6.2 Radionuclide Inventory Report (Cat Roll-Up) and Criticality Analysis Report

The following reports are generated for all segments. Document Control Staff can use the information from these reports to update the Facility Status Boards on a monthly basis or if update/current status is specifically requested.

- Radionuclide inventory report that includes the ratios of radionuclide curie content to 90% of the Hazard Category 3 threshold limits.
- Criticality analysis report that compares fissile inventory to a 700 g U-235 FEM limit and provides inventory information for CSI arrays. *NOTE: Containers in CSI arrays are not included in the affected segment's U-235 FEM roll-up. The containers are included in the radionuclide inventory for calculating hazard category roll-ups.*

To determine the cumulative radionuclide inventory data for a segment using RadTrack, personnel do the following:

1. Enter RadTrack.
2. From the RadTrack Main Menu, select the "Sub Cat III Reporting" button.
3. From the next screen, select the "CAT Roll-up Reports" button.
4. A form with three tabular selections is used to generate the necessary threshold reports. The first tab is labeled "CAT/Fissile Reports". This form is used to generate various reports.
5. The user selects a report from the "Report Selection" field. The reports will provide information for all selected facilities. If only one segment or facility is desired, the user may specify the choice using the pull-down menu. The user may also specify a particular container and/or nuclide of interest.
6. Reports appear via the pull-down menu on the "Report Selection" option. After a report is selected, the user presses the "View Report" button to see the applicable report. To print the report, the user selects the printer icon in the Windows toolbar.
7. The "Segment Summary" report is selected and printed for all RCW segments.
8. Identify the segment totals in percent from the "Segment Summary" report.

   Included in the percent of Hazard Category 3 threshold limit is a manual percentage. The manual percentage has been determined for specified segments to account for activities from wastes that are not inventoried in RadTrack, such as legacy waste for which there is minimal characterization data (Longley, 2005) and sample containers in the Radiation Protection Sampling Diagnostics Laboratory (Sansone, 2004). The manual percentages may be changed with prior approval from the Operations Supervisor.
9. The user selects the third tab labeled "FEM Reports" to generate the criticality analysis report. The summary report is the usual option selected. The criticality analysis report also lists the U-235 FEM stored in CSI arrays but then subtracts this mass from the segment total.
10. Update the Facility Status Boards located in the Weston Trailer conference room.

6.3 The 75% Rule

If the cumulative radionuclide inventory for a segment is ≥75% of the Hazard Category 3 threshold values, or ≥75% of the U-235 FEM threshold limit, the package move is evaluated prior to receipt of each additional package into that segment. Radioactive Field Technicians perform the evaluations using the Virtual Movement Report function in RadTrack. Instructions for performing virtual movement reports are included in Section 6.4 of this procedure.

6.4 Virtual Movement Reports

A virtual movement report must be generated when radioactive waste or material is moved:

- Into an RCW facility (RMWMF or Manzano Storage Bunkers).
- Between RCW facilities (i.e., between RMWMF and a Manzano Storage Bunker or between bunkers).
- Into a segment that is ≥75% of the Hazard Category 3 threshold quantity, or ≥75% of the U-235 FEM threshold limit.

A virtual movement report must also be generated if movement involves a container or parcel that contains:

- ≥10% of the Hazard Category 3 threshold values.
- ≥10% of the U-235 FEM threshold limit.

The virtual movement report function in RadTrack calculates the quantities of radionuclides in each segment and lists them in a report. The report allows personnel to verify that radionuclide inventories remain below 90% of the applicable Hazard Category 3 thresholds (ref. NA-1 SD G 1027) and that the 700 g U-235 FEM limit will not be exceeded.

To generate the Virtual Movement Report for a facility segment using RadTrack, the Radioactive Field Technician does the following:

1. Enter RadTrack.
2. At the RadTrack Main Menu, select “Subcat III Reporting”. At the next menu, select the “Virtual Movement Report” button.
3. A tabular form with three steps is used to create the virtual movement report. At Step 1, use the “Clear All” button to remove all containers and parcels from the list.

4. Continuing with Step 1, select the waste proposed for movement by adding the parcel or container numbers to the appropriate blank and click the "Add" button. For new waste pickups, the parcel number will be the "Old P#" from the "Waste Pickup Report." Parcels and/or containers may be removed from the container/parcel list by highlighting listed parcels/containers and clicking the "Remove" button. Waste parcels or containers appear on the list only if the nuclides and activity data for the waste have been entered into RadTrack.
5. Click the "Next" button or the "Step 2" tab.
6. Select the segment to receive the proposed waste from the pull-down menu.
7. Press the "Generate Virtual Temp Tables" button. This button must be pressed to run any report. Wait until the computer stops processing.
8. Click the "Next" button or the "Step 3" tab.
9. Identify and run the appropriate facility virtual movement report(s) that include radionuclide and criticality analysis information for affected facilities.

   Select a summary or detail report. The summary report presents the threshold values for the proposed waste movement, the existing hazard category limit for the segment, the Type B container exclusion, the manual roll-up percent, the corrected segment total, and the U-235 FEM roll-up. The detail report additionally presents a listing of all containers, nuclides, and activities.
10. Click the "Open Report" button to view the report.
11. Print the report by clicking the "Print" icon in the MS Access tool bar at the top of the screen.
12. Exit the "Virtual Movement Form" by clicking the "Close Form" button.

The virtual movement report is accurate for the day it is printed. The report will indicate the move is not acceptable in red text if the sum-of-the-fractions for Hazard Category 3 threshold values is greater than or equal to 0.9. In addition, if the proposed move involves a container under CSI control, the report will indicate that it is a CSI move. For CSI moves, personnel with NCS 220 training must sign as person responsible for running the report. There is also a comments field where the person signing can add additional notes for CSI moves. Finally, the report will indicate the move is not acceptable in red text if the U-235 FEM exceeds 700 g for the segment. The person generating the report must sign and date the report. The Operations Supervisor or designee must review, sign, and date the report prior to the radioactive/mixed waste or material movement.

If RadTrack is not available, manual computations can be performed to determine hazard category threshold roll-ups and U-235 FEM roll-ups. The manual computations for U-235 FEM must be performed by personnel with NCS 220 training. All hand calculations must be independently verified, signed, and retained as quality records.

6.5 The 10% Rule

Based on the information included in the DR, Radioactive Field Technicians identify waste containers with a radionuclide inventory greater than 10% of the Hazard Category 3 threshold quantity in a conspicuous manner (prominent label) indicating that the container holds more than 10% of the Hazard Category 3 threshold quantity for the facility segment in which it is stored.

7.0 SEGMENTATION

DOE-STD-1027-92 states, "The concept of independent facility segments should be applied where facility features preclude bringing material together or causing harmful interaction from a common severe phenomenon." Facility features such as independent buildings and the storage of radioactive/mixed waste or materials at the RMWMF meet the criteria stated in the DOE Standard. The RMWMF compound is therefore divided into independent facility segments, thus providing greater flexibility in operations, storage, and processing of the waste in accordance with the *Qualitative Analysis of RMWMF Segmentation*.

The Department Manager approves RMWMF segmentation based on the following:

- An area is maintained free of waste materials around each segment to prevent comingling of materials from different segments.
- An analysis is performed and documented, indicating the capacity of each segment to prevent comingling from adjacent segments during any credible accident.
- The purpose of utilizing segmentation is to provide for greater flexibility in operations, both storage and processing.

The *Qualitative Analysis of RMWMF Segmentation* includes a diagram of the current segmentation map. Document Control Staff ensure that facilities and segments are labeled according to the current segment map.

The sum of radionuclide fractions of the Hazard Category 3 thresholds is calculated separately for each segment at the RMWMF. Each Manzano Storage Bunker is a separate segment for calculating Hazard Category 3 roll-ups. Segmentation also applies to control of fissile material using U-235 FEM.

8.0 CRITICALITY SAFETY ANALYSIS

Criticality safety in U-235 FEM storage operations at the RMWMF and calculations used to generate the criticality analysis reports (see Section 6.2, No. 9, and Section 6.4, No. 9) are addressed in Attachment 1, "Criticality Safety at the Radioactive and Mixed Waste Management Facility (RMWMF)". Criticality safety in waste processing operations and in CSI storage arrays are addressed in FOP 09-11, *Open Container Operations*, and FOP 00-02, *Waste Handling*.

9.0 QUALITY ASSURANCE

Hazard category threshold roll-ups and U-235 FEM limit calculations are done in RadTrack. The RadTrack application has been evaluated for quality classification in accordance with SS-R89727, Appendix B, Section B.1, "Safety Software Determination Procedure", and has been determined to be safety software. Therefore, design, implementation, and configuration management of RadTrack are controlled in accordance with PLA 10-09, *Software Quality Assurance Project Plan*. Changes to RadTrack application functions and/or reference databases (e.g., Hazard Category 3 threshold value data table) are verified and validated prior to implementation, in accordance with PLA 10-09. Hand calculations can be performed for virtual movements if RadTrack is unavailable. All hand calculations must be independently verified, and U-235 FEM calculations must be performed by NCS220-trained personnel.

10.0 RECORDS

Document Control Staff maintain the following documentation in accordance with AOP 94-19, *Records Requirements*, with a copy accessible to personnel at the RMWMF:

- Memo from the Operations Supervisor directing the Document Control Staff to make changes to the manual percentages (refer to Section 6.2, #8).
- Hand calculations performed as alternative to RadTrack virtual movement reports.

Note that the virtual movement reports are created in accordance with this procedure to support on-site transfer activities and are typically issued as subordinate documents to waste collection/handling quality records (ref. FOP 00-02, *Waste Handling*).

The Operations Supervisor may maintain a collection in the RMWMF Library or in an online electronic folder that consolidates commonly referenced or requested information (e.g., segmentation map, segmentation analysis, manual percentages memos, and relevant reference documents). The collection is not a controlled document and is not a quality record.

11.0 REFERENCES

Benedict, Manson, Thomas Pigford, and Hans Wolfgang Levi, *Nuclear Chemical Engineering, 2d ed.* (New York: McGraw Hill Book Company, 1981)

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

DOE Supplemental Guidance NA-1 SD G 1027, *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"*

AOP 94-12, *Technical Work Document Processing System*

AOP 94-19, *Records Requirements*

AOP 99-09, *Information Management Procedures*

AOP 99-10, *Disposal Request Custodian Procedures*

ESH100.2.SB.2, *Nuclear Criticality Safety Program*

FOP 00-02, *Waste Handling*

FOP 09-11, *Open Container Operations*

Longley, J. M., Radioactive Material Inventory in Open Container Operations (Memo of Record), Segmentation and Cat Roll-ups, February 2005

NCS-PDD-2016, *Nuclear Criticality Safety (NCS) Program Description Document*

PLA 10-09, *Software Quality Assurance Project Plan*

PRG 00-01, *Training Program*

PRG 00-02, *Operations Training Program*

Qualitative Analysis of RMWMF Segmentation

Sansone, K., Drum Sample Acceptance Criteria for RPSD 6921 Laboratory, Segmentation and Cat Roll-ups, June 2004

SBDC-013-01, *Hazard Categorization Calculations Using ICRP 68, 72*

SS-R89727, *Specific Use Specification, Sandia Software Quality Assurance Program*

Weston Qualification and Training Program

ATTACHMENT 1 – Criticality Safety at the Radioactive and Mixed Waste Management Facility (RMWMF)

1.0 Radiological Facility Classification

DOE-STD-1027-92, Supplemental Guidance NA-1 SD G 1027, and SBDC-013-1 provide guidance and radionuclide threshold values for determining the hazard category of a particular facility. NA-1 SD G 1027 states, "If the facility has a final categorization of less than Hazard Category 3, it is a radiological facility." Each RMWMF segment and each Manzano Storage Bunker is classified as a sub-category 3 (i.e., less than Hazard Category 3 or "radiological") facility.

The RMWMF compound has been divided into segments to provide greater flexibility in operations, storage, and processing of radioactive and mixed waste in accordance with the *Qualitative Analysis of RMWMF Segmentation*. The radionuclide inventory of each of these segments must be managed to stay below 90 percent of the Hazard Category 3 threshold values presented in NA-1 SD G 1027 and SBDC-013-1.

2.0 Criticality Safety Requirements

ESH100.2.SB.2, *Nuclear Criticality Safety Program*, specifies criticality safety requirements at Sandia National Laboratories (SNL). Table 1 of NCS-PDD-2016 provides a list of fissile radionuclides and their criticality safety threshold mass limits.

For operations when fissile inventories are below criticality safety threshold limits, ESH100.2.SB.2 and NCS-PDD-2016 require the facility manager to establish administrative controls to ensure that threshold limits are not exceeded. This procedure specifies the administrative controls used by the Department to meet this requirement for storage operations not in a CSI array. Specifically, the Department limits fissile mass in individual segments to 700 g U-235 FEM. This is equivalent to the sum-of-fractions method specified in NCS-PDD-2016, "Apply Threshold Limits."

ATTACHMENT 1 – Criticality Safety at the Radioactive and Mixed Waste Management Facility (RMWMF) *(cont'd)*

3.0 Calculations

The Department controls criticality safety using U-235 FEM limits for storage areas that do not apply CSI arrays. U-235 FEM is computed for each segment as specified below. Initially, the uranium enrichment of each parcel is evaluated as the mass ratio U-235/$U_{Total(234, 235, 236, and 238)}$. If the mass ratio exceeds 0.00711 (ref. Nuclear Chemical Engineering), the uranium is enriched, and the threshold limits for U-234 and U-235 apply. If the ratio is less than or equal to 0.00711, the uranium is natural or depleted, and the threshold limit for natural or depleted uranium, 1.8E7 g, applies to uranium isotopes (234, 235, 236, and 238). The segment U-235 FEM inventory is calculated as specified below

$$S_{U-235n} = \sum \frac{\frac{A_i}{SA_i}}{FT_i} \; x \; 700$$

where,

$S_{U\text{-}235n}$ is the U-235 FEM inventory for segment n (g).

A_i is the activity of nuclide i (Ci).

SA_i is the specific activity of nuclide i (Ci/g).

FT_i is the fissile threshold for nuclide i (g).

700 is the fissile threshold for U-235 (g).

The summation is performed for all nuclides listed in Table 1 of NCS-PDD-2016 and for all parcels located in the segment.

The value of $S_{U\text{-}235}$ must be less than or equal to 700 g U-235 FEM for each of the RMWMF segments and for each of the Manzano Storage Bunkers not implementing CSI arrays. Any Manzano Storage Bunker managed as a CSI array is not subject to the 700 g U-235 FEM limit. RMWMF Segment 1 also includes a CSI storage array in Room 100. The U-235 FEM limit for storage in RMWMF Segment 1 does not include material that is stored in the CSI array. Refer to FOP 00-02, *Waste Handling*, and FOP 09-11, *Open Container Operations*, for CSI array management procedures.

ATTACHMENT 2 – Change History

Change from Revision 08a to Revision 9. Changes address the following:

- Updating the new Department name (i.e., Life Cycle Material Management Department).
- Removing eliminated titles (i.e., Information Custodian, Waste Handler) adding new titles (i.e., Radioactive Field Technician), and listing roles.
- Updating the title of ESH100.2.SB.2, *Nuclear Criticality Safety Program*, and adding NCS-PDD-2016, *Nuclear Criticality Safety (NCS) Program Description Document*