

**Intentional Mixing of Special Nuclear Materials  
to Meet Waste Acceptance Criteria - 11387**

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**ABSTRACT**

As part of decommissioning a former nuclear fuel manufacturing site, there are soil and debris with residual enriched uranium. Enriched uranium falls under the category of Special Nuclear Materials (SNM) for disposal at a low-level radioactive waste landfill, which restricts the concentration of uranium 235 (U-235) for nuclear criticality safety. In order to ensure that decommissioning waste materials will meet the disposal facility Waste Acceptance Criteria (WAC), a request for intentional mixing in accordance with NRC regulations and guidance was submitted and approved. The NRC has indicated that this is an acceptable practice as described in Commission Paper SECY-04-0035, Result of the License Termination Rule Analysis of the Use of Intentional Mixing of Contaminated Soil. The intentional mixing process will follow the guidance provided by the NRC in NUREG-1757 Volume 1 Revision 2, Section 15.13. In addition, since uranium is not listed in Table 1 or 2 of 10 CFR 61.55, it is classified as "Class A" waste. Therefore intentional mixing of uranium wastes will not change waste classification since it will always be Class A waste.

**INTRODUCTION**

Intentionally mixing waste was proposed in order to meet waste acceptance criteria at off-Site disposal facilities. The NRC has indicated that this is an acceptable practice as described in Commission Paper SECY-04-0035, Result of the License Termination Rule Analysis of the Use of Intentional Mixing of Contaminated Soil. This process will follow the guidance provided by the NRC in NUREG-1757 Volume 1 Revision 2, Section 15.13. Since uranium is not listed in Table 1 or 2 of 10 CFR 61.55, it is classified as "Class A" waste. Therefore intentional mixing of uranium wastes will not change waste classification since it will always be Class A waste. The following describes the process, materials, equipment, radiological surveys and sampling in order to meet the WAC for off-Site disposal.

In order to dispose of decommissioning low level radioactive waste at an off-Site disposal facility, the materials need to meet the WAC for the facility. It is anticipated that low level radioactive waste (LLRW) generated during decommissioning will be sent to EnergySolutions disposal facility in Clive, Utah. WAC for this facility is a combination of regulatory and license specific requirements. In addition, this disposal facility has an exemption from 10 CFR Part 70 so waste containing SNM has additional requirements including exemption certification. Specified limits for waste containing SNM in the WAC include SNM isotope concentration limits, spatial distribution requirements, bulk chemical limits, unusual moderator limits and soluble uranium limits. In addition, waste will need to meet the Department of Transportation

(DOT) regulation (49 CFR 173.453) for the management and transportation of radioactive material. For transportation, SNM can be exempt from classification as “fissile” if the material meets a specific ratio of fissile to non-fissile material mass.

There are limited amounts of materials identified during characterization that will not meet Fissile Exempt criteria or WAC during decommissioning operations. From the current data set, less than 1% of the U-235 results exceed Fissile Exempt and WAC concentrations. Intentional mixing of waste is anticipated for the following scenarios: mixing soil or soil-like materials, mixing soil or soil-like materials containing small debris, or mixing large debris with soil or soil-like materials. Characterization data along with radiological surveys and sampling during decommissioning operations will be utilized to identify materials that will require intentional mixing for off-Site disposal. Waste generated during decommissioning activities will consist of low activity residues in soil, sediment, debris and building materials. There is no known product or stock material remaining.

## **METHODS OF INTENTIONAL MIXING**

Intentional mixing of soil or soil-like material will be conducted using the simplest approach possible. The waste streams are not homogenous with respect to uranium concentrations and intentional mixing will not attempt to achieve homogeneity. Intentional mixing will be done to the level necessary in order to meet the Fissile Exempt and WAC for off-Site disposal. In this regard, material that has been intentionally mixed will not be significantly different than other wastes generated during decommissioning operations. Heterogeneity of waste will be addressed by additional radiological surveys and sampling in order to demonstrate that Fissile Exempt and WAC have been met.

There are several options for proposed methods of intentional mixing of soil or soil-like material. The first is mixing elevated materials during excavation / removal operations with adjacent low concentration material. This option does not require additional equipment and is simply mixing of material as it is excavated and placed into a container. Elevated and low concentration materials can be mixed by excavating small amounts of each and then combining them with the excavator bucket prior to placing into a container. The second is to mix contents from one container (higher concentration) with material from another (lower concentration) into an additional container.

An example of this scenario is a region with localized areas of soil with elevated uranium surrounded by soil with low concentration uranium. Excavation of soils in this area will be conducted such that a small quantity of soil from the elevated areas will be excavated with an excavator, backhoe or other excavation equipment and placed in a container, and then a small quantity of low concentration soil will be excavated and placed in the same container. These materials may be further mixed inside the container. The process would be repeated until the container is filled. This excavation would be executed in such a way that the ratio of higher concentration to low concentration soil meets Fissile Exempt and WAC.

In some areas, there may be small pieces of debris mixed with soil or soil-like material which could require intentional mixing. In this case, debris may be too small to be readily separable

from soil. Representative surveys and sampling of the debris and soil mixture will be evaluated prior to mixing in order to verify that intentional mixing will meet Fissile Exempt and WAC. Similar to soil or soil-like materials, proposed methods for intentional mixing include mixing during excavation / removal operations with adjacent material or mixing contents from one container with another utilizing mechanical or hand tools. Heterogeneity of waste will be addressed by additional radiological surveys and sampling in order to demonstrate that Fissile Exempt and WAC have been met.

An example of this scenario is an area with small pieces of debris mixed with the soil and the amalgamation will be removed as part of remediation. Since the small pieces of debris are not easily separated from the soil, the mixture will be sampled and compared to WAC. In the event that the U-235 concentration does not meet Fissile Exempt and WAC, some lower concentration soil from another area could be mixed at an appropriate ratio with the material from the area into another container in order to meet Fissile Exempt and WAC. The operation would be conducted similar to the operation described above.

In other areas, there may be larger pieces of debris which could require intentional mixing with soil or soil-like material. Here, the debris is large and may contain significantly elevated concentrations of uranium, such as a section of pipe. In this case, the debris would be broken apart in order to facilitate mixing with soil or soil-like material. Proposed methods for intentional mixing include mixing contents from one container of soil or soil-like material into another containing debris utilizing mechanical or hand tools. Heterogeneity of waste will be addressed by additional radiological surveys and sampling in order to demonstrate that Fissile Exempt and WAC have been met.

An example of this scenario is sewer line sections. There is potential for elevated uranium sediment inside the pipe sections that does not meet Fissile Exempt and WAC. In this case, the sediment would be removed from the pipe section and mixed at an appropriate ratio with lower concentration soil from another area. Due to residual surface contamination on the pipe section, it will also need to be disposed as LLRW and it can be included in the container with the soil and sediment provided it meets WAC for debris sizing.

Radiological surveys and sampling will be performed in conjunction with intentional mixing. Pre-remediation surveys and sampling will be performed to verify characterization data as well as to support nuclear criticality safety, and SNM accountability. Areas will be identified that require intentional mixing. These areas will be then be evaluated for intentional mixing options. The preferred option is mixing with deeper soil or soil from adjacent areas. If mixing with deeper or immediately adjacent soils will not meet Fissile Exempt and WAC, then mixing with lower concentration soil from other portions of the Site will be necessary. The appropriate low concentration LLRW will be determined from the available waste inventory.

After intentional mixing, waste containers will be radiologically surveyed to determine radiation levels and a preliminary indication of homogeneity. Removable contamination levels will also be measured. Radiation and removable levels will be compared to DOT transportation requirements for radioactive materials.

Volumetric samples will be collected after intentional mixing. Representative samples will be collected from each container of intentionally mixed waste. In addition, waste may be quantified by direct in-situ methodologies, such as gamma spectroscopy utilizing ISOCS. If the results do not indicate that SNM is homogeneously distributed, then they will be evaluated to ensure that Fissile Exempt and WAC concentration limits for U-235 are not exceeded on average in any contiguous mass of 360 kilograms of waste.

Nuclear criticality safety during intentional mixing operations will be implemented in similar fashion to that used during decommissioning operations. This is a combination of concentration and mass criteria for U-235. No criticality safety controls will be required if volumetric concentrations of U-235 are less than 70 Bq/g (1,900 pCi/g) with less than 10% enrichment or less than 44 Bq/g (1,190 pCi/g) with greater than 10% enrichment. In addition, no criticality controls will be required if the mass of U-235 in the intentional mixing operation is less than 350 grams. As described in the DP, concentration, enrichment and U-235 gram weight are determined prior to significant disturbance of suspect material. This was successfully implemented during previous decommissioning operations and will be followed for the remaining areas. Therefore in the interest of safety, consistency and simplicity of intentional mixing operations, batches will be constrained to the above criteria.

WAC for SNM will be achieved as part of intentional mixing, primarily for U-235 concentration criterion and spatial distribution requirements. Other SNM WAC include bulk chemical limits, unusual moderator limits and soluble uranium limits. The primary chemical and physical form of uranium at the site is metal oxides as a solid. Uranium oxides are not soluble as defined in the WAC and NRC Safety Evaluation Report. Since nuclear fuel production operations were terminated more than ten years ago and characterization has not identified any significant amounts of bulk chemical of concern in the WAC, this criterion will not be of concern for intentional mixing or disposal of decommissioning wastes. No significant quantities of unusual moderators have been identified during previous decommissioning activities or characterization of the remaining areas so this criterion will not be of concern for intentional mixing or disposal of decommissioning wastes.

## **SUMMARY**

Intentional mixing of waste is anticipated for the following scenarios: mixing soil or soil-like materials, mixing soil or soil-like materials containing small debris, or mixing large debris with soil or soil-like materials. Intentional mixing of soil or soil-like material will be conducted using the simplest approach possible. The waste streams are not homogenous with respect to uranium concentrations and intentional mixing will not attempt to achieve homogeneity. Intentional mixing will be done to the level necessary in order to meet the Fissile Exempt and WAC for off-Site disposal. Intentional mixing of waste with residual SNM is an effective solution to ensure that waste materials will meet WAC for off-Site disposal and reduce potential schedule delays during decommissioning activities.

Intentional mixing of waste to meet WAC is an acceptable practice by the NRC and the submitted information follows NRC guidance in this area. The combination of these changes

will allow decommissioning activities to finish in a timely and efficient manner and achieve license termination for unrestricted use.