

U.S. NUCLEAR REGULATORY COMMISSION
DOCKET 40-8989
ENVIROCARE OF UTAH, INC.
SAFETY EVALUATION REPORT
REGARDING THE REVISION TO EXEMPTION FROM
REQUIREMENTS OF 10 CFR PART 70
January 14, 2003

1. INTRODUCTION

Envirocare of Utah, Inc. (Envirocare) operates a low-level waste disposal facility in Clive, Utah. This facility is licensed by the State of Utah, an Agreement State, under a 10 CFR Part 61 equivalent license (UT 2300249). The U.S. Nuclear Regulatory Commission (NRC) transmitted an Order to Envirocare on May 24, 1999, that exempted it from the licensing requirements in 10 CFR Part 70. The Order was published in the Federal Register on May 21, 1999, (64FR27826). The Order contained nine conditions that were required to maintain safety and a low risk of inadvertent criticality of special nuclear material (SNM). The Order became effective when the conditions of the Order were incorporated into Envirocare's State of Utah radioactive material license. To support the Order, NRC staff prepared a Safety Evaluation Report (SER) and Environmental Assessment (EA).

Conceptually, the conditions of the 1999 Order are:

- SNM isotope concentration limits (Condition 1);
- bulk chemical limits (Condition 2);
- unusual moderator limits (Condition 3);
- soluble uranium limits (Condition 4);
- mixed waste processing limits (Condition 5);
- waste characterization and certification requirements (Condition 6); and
- waste receipt sampling condition (Condition 7).

The basic approach is the specification of four sets of technical criticality safety limits, conditions 1 through 4; then the provision in condition 6 for a certification and waste characterization assuring that these limits will not be exceeded. The waste sampling plan of Condition 7 provides for detection of erroneous shipment of waste not complying with the concentration limits. Condition 5 limits mixed waste processing activities to those currently used by Envirocare.

In a letters dated July 3, 2002, and July 29, 2002, Envirocare request that certain conditions of the 1999 Order be modified. Specifically, Envirocare requested the following: (1) include stabilization of liquid waste streams containing SNM; (2) include the thermal desorption process; (3) change the homogenous contiguous mass limit from 145 kg to 600 kg; (4) change the language and SNM limit associated with footnotes "c" and "d" of Condition 1 to reflect all materials in Conditions 2 and 3; and (5) omit the confirmatory testing requirements for debris waste. Additional description of these requests are provided in the Evaluations Section below.

2. PROPOSED ACTION

Envirocare proposes to amend the Order transmitted to Envirocare on May 24, 1999, that exempted it from the licensing requirements in 10 CFR Part 70, to include the following: (1) stabilization of liquid waste streams containing SNM; (2) the thermal desorption process; (3) change the homogenous contiguous mass limit from 145 kg to 600 kg; (4) change the language and SNM limit associated with footnotes "c" and "d" of Condition 1 to reflect all materials in Conditions 2 and 3; and (5) omit the confirmatory testing requirements for debris waste.

3. EVALUATIONS

In evaluating the safety of the proposed action, staff used the 1999 SER as a primary basis. In addition, the NRC staff had refined some of its earlier analyses in preparing the SER for a similar exemption for Waste Control Specialists, LLC (WCS). Additional analyses and evaluations, as described below, were performed.

3.1 Stabilization of Liquid Waste Streams Containing SNM

Envirocare's State of Utah license was recently amended to allow processing (solidification) of aqueous and non-aqueous liquids. Because this is a deviation from waste processing activities evaluated in 1999, Envirocare requested the Order be modified in accordance with Condition 9 of the Order. The July 3, 2002, request stated that containers for liquids would be limited to 400 gallons. However, in a email dated October 17, 2002, Envirocare requested that the liquids be received in containers up to tanker-size (e.g., 4000 gallons). Prior to treatment, liquids would not be separated from any solids, and the entire contents of the container would be treated at one time.

The staff used criticality calculations presented in two studies prepared by Oak Ridge National Laboratories (ORNL), NUREG/CR-6505 Volumes 1 and 2 as the criticality model for low-level waste. In the ORNL studies, silicon dioxide (SiO_2) was used to represent the waste matrix. The system of SiO_2 and SNM does not provide a realistic model for liquid waste. The staff conducted analyses using polyethylene (CH_2) as a surrogate for the various liquid waste. The results using polyethylene are slightly more reactive than using water as the matrix material. The staff used infinite media calculations in NUREG/CR-5342. Using infinite media calculations is considered realistic considering the size of the storage containers. These calculations indicate that concentration limits developed for solid mixed waste will be adequate to ensure safety of liquid waste containing SNM.

However, the staff has concerns with several aspects of storing and treating liquids containing SNM. First, the liquid waste will be stored in containers that are not continuously stirred. Therefore, if the SNM is present in a solid phase, then settling of the SNM on the bottom of the container could occur, and averaging the concentration over the entire volume of the container would not be appropriate. An analysis was performed to modeling the settling of SNM into a infinite slab geometry to model the effects of SNM settling to the bottom of a tank. In addition, an optimization feature of the SCALE code was used to verify that intermediate concentration within the tank, due to matrix density differences, would not be a concern. The SNM in the liquid waste was assumed be at the maximum concentration allowed in Condition 1, and the container height was limited to that allowed by the maximum areal density from the infinite slab

calculations. Based on the above approach, a limiting container height of 12 feet was calculated.

Second, because SNM could be in a solid phase within a liquid matrix, it will be difficult to verify that the homogeneity criteria of Condition 1 is maintained. Even if the container size was limited in height as discussed above, the potential mass of SNM could be significant in large containers even at the concentration limits in Condition 1. Because the SNM could not be assured of being homogeneously distributed in a liquid matrix, maintaining the concentration limits could not be assured.

Third, if a waste stream contained both solid and liquid phases and the liquid phase was removed with the solid phase, then the effective concentration of SNM would increase in either the solid or liquid phases (depending which phase the SNM is located). The effective concentration could exceed the limits in Condition 1.

Therefore, additional conditions are need to be imposed in order to limit the risk of a criticality. The staff considers limiting the SNM mass to the maximum mass allowed using the homogeneity criteria in Condition 1 to be appropriate. This condition would bound the concerns with SNM settling, and therefore, the container height does not need to be specifically limited. In addition, staff considers not allowing waste containing free liquids and solids to be separated during transfer and treatment to be appropriate. Staff has modified Condition 5 to reflect these requirements.

3.2 Thermal Desorption Process

Thermal separation uses a combination of temperature, vacuum, and carrier gases to remove volatile and semi-volatile organics. Liquids are added in this process, and heat is applied to facilitate the separation of the organics. In this process, the effective gram of SNM per gram of waste could be increased by removing the liquid. Therefore, this processes could be a criticality safety concern. While the batch size of the thermal desorption process is small enough not to be a criticality concern (i.e., the concentration limits are based on infinite media calculations), this could be a concern for larger volumes of processed waste that might exceed the concentration limits following treatment.

Therefore, Condition 5 includes a requirement for Envirocare to verify that the limits in Condition 1 have not been exceed following the thermal processes. In the event that an SNM concentration limit is exceed on a batch, inert material should be added to that batch such that the SNM concentration is below the limit prior to storing the waste and the NRC should be notified.

3.3 Homogenous Contiguous Mass Limit

The homogeneity criteria established for the 1999 Order was based on one-eighth the minimum critical mass under optimal conditions. In developing a similar exemption for WCS, staff determined that this approach may be overly conservative. The approach used in the WCS exemption was based on one-fourth of the minimum critical mass for SNM in an silicon dioxide

matrix. Envirocare requested that the homogeneity criteria be revised to the values in the WCS exemption Order. Because this is an appropriate approach, staff has modified Condition 1 to reflect this change.

3.4 Changes to Condition 1

Envirocare requested that the footnotes for Condition 1 be revised to specify any of the materials listed in Conditions 2 and 3 rather than specifying only certain materials (i.e., beryllium and magnesium oxide). Envirocare also requested that the limit associated with footnote "d" remain the same and that the percentage of material be revised as necessary.

The staff performed additional criticality calculations and determined that the limits associated with footnotes "a" and "b" were appropriate. However, the limit associated with footnote "c" would need to be lowered from 67 pCi/g to 26 pCi/g to allow for a heavy water matrix. Because this limit is very low, the staff also evaluated the possibility of establishing another limit for ten percent enriched uranium in addition to 100 percent enriched uranium. However, because the heavy water thermalizes the neutrons very rapidly, the neutron capture by uranium-238 in the ten percent enriched uranium was not effective. Therefore, the above limit would apply to both ten percent enriched uranium and 100 percent enriched uranium. The staff has modified Condition 1 to reflect these changes.

3.5 Confirmatory Testing Requirements for Debris Waste.

As discussed in the 1999 SER, periodic confirmatory sampling of the SNM concentration in waste by Envirocare added to the assurance that the concentration limits in Condition 1 would not be exceeded. Due to the difficulty in obtaining a representative sample and inaccuracies of sample analysis, Envirocare requested that the confirmatory sampling currently required by Condition 7 not apply to debris waste (e.g., broken concrete, steel pieces, rebar).

The staff recognizes the difficulty in sampling and testing debris. However, if confirmatory sampling were not performed, the level of assurance and defense in depth approach used in the 1999 Order would be diminished. In evaluating other approaches that could be used, staff considered guidance on establishing concentrations for waste in its Waste Concentration Averaging Branch Technical Position (BTP). The BTP states that concentrations within a factor of ten are reasonable for manifesting waste. Using the approach, confirmatory testing by Envirocare could be eliminated for waste with SNM concentrations a factor of ten less than those in Condition 1. Envirocare would still be required, in accordance with Condition 6, to review the methods used by the generator to determine the SNM concentration and the generator would still be required to certify the waste meets the conditions of the Order. The staff has modified Condition 7 to reflect these changes. The State of Utah has accepted this approach.

4. SUMMARY AND CONCLUSION OF SAFETY EVALUATION

Based on its analysis, the staff concludes that modifications requested by Envirocare, as modified by the staff are generally acceptable. The staff has revised the conditions of the 1999 Order to incorporate the modifications requested by Envirocare, subject to additional staff conditions to ensure sufficient protection of health, safety, and the environment. With these conditions, the exemption presents an acceptable alternative to the definition of a critical mass

as defined in 10 CFR 150.11, thereby assuring the same level of protection. These conditions would be included in an Order to Envirocare and would be incorporated by the State of Utah into its RML.

5. REVISED EXEMPTION CONDITIONS

The Order is contingent on Envirocare complying with the following the conditions:

1. Concentrations of SNM in individual waste containers must not exceed the following values at time of receipt:

Radionuclide	Maximum Concentration (pCi/g)	Measurement Uncertainty (pCi/g)
U-235 ^a	1900	285
U-235 ^b	1190	179
U-235 ^c	26	10
U-235 ^d	680	102
U-233	75,000	11,250
Pu-236	500	75
Pu -238	10,000	1,500
Pu-239	10,000	1,500
Pu-240	10,000	1,500
Pu-241	350,000	50,000
Pu-242	10,000	1,500
Pu-243	500	75
Pu-244	500	75

- a - for uranium below 10 percent enrichment and a maximum of 20 percent of the weight of the waste of materials listed in Condition 2
- b - for uranium at or above 10 percent enrichment and a maximum of 20 percent of materials listed in Condition 2 of the weight of the waste of materials listed in Condition 2
- c - for uranium at any enrichment with unlimited quantities of materials listed in Conditions 2 and 3
- d - for uranium at any enrichment with sum of materials listed in Conditions 2 and 3 do not exceeding 45 percent of the weight of the waste

The measurement uncertainty values in column 3 above represent the maximum one-sigma uncertainty associated with the measurement of the concentration of the particular radionuclide.

The SNM must be homogeneously distributed throughout the waste. If the SNM is not homogeneously distributed, then the limiting concentrations must not be exceeded on average in any contiguous mass of 600 kilograms of waste.

2. Except as allowed by notes a, b, c, and d in Condition 1, waste must not contain "pure forms" of chemicals containing carbon, fluorine, magnesium, or bismuth in bulk quantities (e.g., a pallet of drums, a B-25 box). By "pure forms," it is meant that mixtures of the above elements such as magnesium oxide, magnesium carbonate, magnesium fluoride, bismuth oxide, etc. do not contain other elements. These chemicals would be added to the waste stream during processing, such as at fuel facilities or treatment such as at mixed waste treatment facilities. The presence of the above materials will be determined by the generator, based on process knowledge or testing.
3. Except as allowed by notes c and d in Condition 1, waste accepted must not contain total quantities of beryllium, hydrogenous material enriched in deuterium, or graphite above one percent of the total weight of the waste. The presence of the above materials will be determined by the generator, based on process knowledge, physical observations, or testing.
4. Waste packages must not contain highly water soluble forms of uranium greater than 350 grams of uranium-235 or 200 grams of uranium-233. The sum of the fractions rule will apply for mixtures of U-233 and U-235. Highly soluble forms of uranium include, but are not limited to: uranium sulfate, uranyl acetate, uranyl chloride, uranyl formate, uranyl fluoride, uranyl nitrate, uranyl potassium carbonate, and uranyl sulfate. The presence of the above materials will be determined by the generator, based on process knowledge or testing.
5. Waste processing of waste containing SNM will be limited to stabilization (mixing waste with reagents), micro-encapsulation, macro-encapsulation using low-density and high-density polyethylene and thermal desorption.

When waste is processed using the thermal desorption process, Envirocare shall confirm the SNM concentration following processing and prior to returning the waste to temporary storage.

Liquid waste may be stabilized provided the SNM concentration does not exceed the SNM concentration limits in Condition 1. For containers of liquid waste with more than 600 kilograms of waste, the total activity (pCi) of SNM shall not exceed the SNM concentration in Condition 1 times 600 kilograms of waste. Waste containing free liquids and solids shall be mixed prior to treatment. Any solids shall be maintained in a suspended state during transfer and treatment.

6. Envirocare shall require generators to provide the following information for each waste stream:

Pre-shipment

1. Waste Description. The description must detail how the waste was generated, list the physical forms in the waste, and identify uranium chemical composition.
2. Waste Characterization Summary. The data must include a general description of how the waste was characterized (including the volumetric extent of the waste, and the number, location, type, and results of any analytical testing), the range of SNM concentrations, and the analytical results with error values used to develop the concentration ranges.
3. Uniformity Description. A description of the process by which the waste was generated showing that the spatial distribution of SNM must be uniform, or other information supporting spatial distribution.
4. Manifest Concentration. The generator must describe the methods to be used to determine the concentrations on the manifests. These methods could include direct measurement and the use of scaling factors. The generator must describe the uncertainty associated with sampling and testing used to obtain the manifest concentrations.

Envirocare shall review the above information and, if adequate, approve in writing this pre-shipment waste characterization and assurance plan before permitting the shipment of a waste stream. This will include statements that Envirocare has a written copy of all the information required above, that the characterization information is adequate and consistent with the waste description, and that the information is sufficient to demonstrate compliance with conditions 1 through 4. Where generator process knowledge is used to demonstrate compliance with Conditions 1, 2, 3, or 4, Envirocare shall review this information and determine when testing is required to provide additional information in assuring compliance with the conditions. Envirocare shall retain this information as required by the State of Utah to permit independent review.

At receipt

Envirocare shall require generators of SNM waste to provide a written certification with each waste manifest that states that the SNM concentrations reported on the manifest do not exceed the limits in Condition 1, that the measurement uncertainty does not exceed the uncertainty value in Condition 1, and that the waste meets Conditions 2 through 4.

7. Sampling and radiological testing of waste containing SNM must be performed in accordance with the following: one sample for each of the first ten shipments of a waste stream; or one sample for each of the first 100 cubic yards of waste up to 1,000 cubic yards of a waste stream, and one sample for each additional 500 cubic yards of waste following the first ten shipments or the following the first 1,000 cubic yards of a waste stream. Sampling and radiological testing of debris waste containing SNM (that is exempted from sampling by the state of Utah) can be eliminated if the SNM concentration is lower than one tenth of the limits in Condition 1.

8. Envirocare shall notify the NRC, Region IV office within 24 hours if any of the above conditions are not met, including if a batch during a treatment process exceeds the SNM concentration of Condition 1. A written notification of the event must be provided within 7 days.
9. Envirocare shall obtain NRC approval prior to changing any activities associated with the above conditions.

6. REFERENCES

Envirocare of Utah, Inc., Letter to John Greeves, Nuclear Regulatory Commission, "Request to amend U.S. Nuclear Regulatory Commission Order, dated May 24, 1999, Docket No. 40-8989, Envirocare of Utah, Inc., Special Nuclear Material (SNM) Exemption," July 3, 2002

Envirocare of Utah, Inc., Letter to John Greeves, Nuclear Regulatory Commission, "Request to amend U.S. Nuclear Regulatory Commission Order, dated May 24, 1999, Docket No. 40-8989, Envirocare of Utah, Inc., Special Nuclear Material (SNM) Exemption," July 29, 2002

Oak Ridge National Laboratory, Letter to Timothy E. Harris, Nuclear Regulatory Commission, "Letter Report: Parametric Studies for Liquid Mixed Waste Disposal and Solid Waste Disposal,," October 31, 2002

U.S. Nuclear Regulatory Commission, Letter to Charles A. Judd, President, Envirocare of Utah, Inc., "Exemption from Licensing Requirements in 10 CFR Part 70, Docket No. 40-8989," May 24, 1999

U.S. Nuclear Regulatory Commission, Letter to William P. Dornsife, Vice President, Waste Control Specialists, LLC, November 21, 2001

SUBJECT: U.S. Nuclear Regulatory Commission, Docket 40-8989, Envirocare of Utah, Inc., Safety Evaluation Report Regarding the Revision to Exemption from Requirements of 10 CFR Part 70

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