SAFETY EVALUATION REPORT

REQUEST FOR ALTERNATE DISPOSAL APPROVAL AND EXEMPTIONS FOR SPECIFIC HEMATITE DECOMMISIONING PROJECT WASTE AT US ECOLOGY'S IDAHO FACILITY

January 15, 2014

Contributors:
John Hayes
Leah Parks
Karen Pinkston
Tom Pham
Gary Purdy
Chris Tripp

Table of Contents

Contents

1. INTRODUCTION 5
  1.1. Westinghouse Request 5
  1.2. USEI Facility 5
  1.3. Overview of NRC Review 6
  1.4. Additional Westinghouse Supporting Information 6
2. BACKGROUND 7
3. DOSE EVALUATION 9
  3.1. Types and Quantities of Material 9
    3.1.1. Characterization of Soil and Soil-Like Material 9
  3.2. NRC Evaluation of WEC's Material Characterization 10
    3.2.1. NRC Findings 10
  3.3. WEC Assessment of Doses 11
    3.3.1. Transportation and USEI Worker Doses 11
    3.3.2. Post-Closure Dose 13
    3.3.3. Inadvertent Intruder Dose 14
    3.3.4. Intruder Well-Driller Scenario 15
    3.3.5. Intruder Construction Scenario 16
  3.4. NRC Assessment of Doses 16
    3.4.1. Evaluation of Transportation and USEI Worker Dose 16
    3.4.2. NRC Evaluation of Post-Closure Dose 17
    3.4.3. NRC Evaluation of Intruder Doses 18
  3.5. Stability of the Disposal Facility Following Closure 19
    3.5.1. Westinghouse Assessment 19
    3.5.2. NRC Evaluation and Findings 20
4. HEALTH PHYSICS ASSESSMENT 21
  4.1. WEC's Soil and Soil-Like Material Characterization 21
    4.1.1. NRC Findings 21
  4.2. Quality Assurance and Contingency Plans 21
    4.2.1. WEC Quality Assurance and Contingency Plans 21
5. NUCLEAR CRITICALITY SAFETY 24
6. PHYSICAL SECURITY 34
  6.1. Assessment 34
  6.2. NRC Findings 35
7. POTENTIAL FOR RECONCENTRATON 36

7.1. Assessment 36
7.2. NRC Findings 36
8. MATERIAL CONTROL AND ACCOUNTING 37
9. LICENSE CHANGES 38
10. CONCLUSIONS 40
11. REFERENCES 41

List of Tables

Table 3-1. Expected Radionuclide Concentrations in Westinghouse Hematite Waste............... 10
Table 3-2: Job Function Scenario Assumptions 12
Table 3-3: Dose per Person for Individual Job Function* 13
Table 3-4: Cumulative Tc-99 Limits for the Previous §20.2002 Requests* 14
Table 3-5: Potential Cumulative Dose from Previous and Current §20.2002 Requests*............ 17
Table 3-6: Summary of Intruder Doses (mrem/yr)[1] 19
Table 4-1: Pre-Shipment Contingency Plans Proposed by WEC 22
Table 5-1: Chemical composition of bounding soil/sludge matrix materials............................... 26

List of Figures:

Figure 3-1: Intruder Scenario Waste Concentration Assumptions 15
Figure 5-1: Reactivity of uranium in matrix material versus concentration................................. 28

1. INTRODUCTION

1.1. Westinghouse Request

By letter dated May 28, 2013 (ADAMS Accession No. ML13149A291), Westinghouse Electric Company, LLC (WEC) requested that the U.S. Nuclear Regulatory Commission (NRC) approve an amendment to its Hematite license (SNM-33) to permit alternate disposal of licensed material in accordance with Title 10 of the Code of Federal Regulations (10 CFR) §20.2002. The disposal would involve low-activity radioactive materials generated by the Hematite Decommissioning Project (HDP) containing source, byproduct, and special nuclear material (SNM). The May 28, 2013 request includes a request for an exemption from NRC licensing requirements in 10 CFR §30.3 and 10 CFR §70.3 for byproduct material and SNM, respectively. Granting these exemptions would allow these materials to be disposed of at the US Ecology Idaho, Inc. (USEI) facility, even though USEI is not an NRC licensee. On June 5, 2013, USEI requested that it be considered a party to WEC's May 28, 2013, alternate disposal request and exemption request (ADAMS Accession No. ML13227A016). WEC did not request, nor does it need, an exemption for its proposed disposal of source material because the quantities involved are "unimportant" and are exempt from licensing under 10 CFR §40.13(a). The 0.05 weight % referenced in 10 CFR §40.13(a) translates to approximately 339 pCi/g for natural uranium (including U-234, U-235, and U-238, but omitting consideration of decay products). Enclosure 1 to WEC's May 28, 2013 submittal shows in Section 5.1 that the average total activity concentration (sum of all nuclides and progeny and not just uranium) for this waste is approximately 226 pCi/g. Therefore, the 10 CFR §40.13(a) exemption is applicable here.

Granting the May 28, 2013 request would allow WEC to ship the HDP waste to USEI's Resource Conservation and Recovery Act (RCRA) Subtitle C disposal facility in Idaho.

The May 28, 2013 request follows similar requests submitted by WEC (HEM-09-52) on May 21, 2009 (ADAMS Accession No. ML091480071) and by WEC (HEM-12-2) on January 16, 2012. (ADAMS Accession Nos. ML12017A188, ML12017A189, and ML12017A190). Those requests were approved on October 27, 2011 as Hematite License Amendment No. 58 (ADAMS Accession Nos. ML111441087, ML112560105, and ML112560193) and on April 11, 2013, as Hematite License Amendment No 60 (ADAMS Accession No. ML12158A384).

Various types and quantities of SNM are discussed below. SER Section 5 (Criticality Safety) and Section 8 (Material Control and Accountability) discuss SNM in quantities of 1 g or more of U-235. SER Section 6 (Physical Security) pertains to SNM enriched in the U-235 isotope, in quantities of approximately 45 Kg of U-235.

1.2. USEI Facility

The USEI facility is a RCRA Subtitle C hazardous waste disposal facility permitted by the Idaho Department of Environmental Quality (IDEQ), and is not an NRC licensee. On October 4, 2012, USEI submitted a letter (ADAMS Accession No. ML12313A014) to the NRC stating that it had worked with WEC in the preparation and submittal of WEC's alternate disposal request and supporting documentation.

The USEI RCRA facility is located near Grand View, Idaho in the Owyhee Desert. The HDP material would be disposed in Cell 15, which has an area of 88,220 m2 (21.7 acres) and a depth of 33.6 m. The most important natural site features that limit the transport of radioactive material are the low precipitation rate (i.e., 18.4 cm/y (7.4 in. per year)) and the long vertical distance to groundwater (i.e., 61-meter (203-ft) thick on average unsaturated zone below the disposal zone).

As is usual with a RCRA Subtitle C site, a number of engineered features are present to enhance confinement of contaminants over the long term. These features include an engineered cover, liners, and leachate monitoring systems. Operations at the site include a number of systems that minimize the potential for exposure of workers to any waste handled by the facility. These systems include a closed facility with filtered ventilation exhaust for transfer of incoming waste material from the shipping conveyance to trucks for transport to the cell, mechanized equipment for disposition of waste material in the cell, and the application of an asphaltic spray at the end of each day's operations. The site is permitted to receive non Atomic Energy Act material or exempted radioactive material that meets site permit requirements.

1.3. Overview of NRC Review

The NRC reviews §20.2002 requests from the standpoint of the safety implications of disposing of licensed material at disposal facilities that are not licensed by the NRC or an NRC Agreement State.

The NRC's review of a 10 CFR §20.2002 request for disposal of low-activity waste at a RCRA facility covers protection of individuals, inadvertent intruders, and the public. The period of performance is 1,000 years after the expected date of license termination of the facility, consistent with 10 CFR 20.1401 (the License Termination Rule in Subpart E of 10 CFR Part 20). While the 10 CFR Part 20 dose limit for individual members of the public is 1 mSv/yr (100 mrem/yr) (10 CFR §20.1301), the NRC's practice is to approve §20.2002 requests if calculations demonstrate that disposal would not result in a dose exceeding more than a few millirem per year

Because this 10 CFR §20.2002 disposal request includes SNM, the NRC's review must -- in addition to a dose limit analysis – evaluate nuclear criticality safety, material control and accounting, and physical security issues. .

The potential exists that the waste material approved for disposal by Amendment 58 and the material approved for disposal in this SER will be available for shipment to USEI at the same time. Therefore, this SER will discuss the cumulative impact of the alternative disposal of material from both requests.

1.4. Additional Westinghouse Supporting Information

The NRC's review of WEC's May 28, 2013, request resulted in a need for WEC to supplement its request. On July 10, 2013, the NRC made a request for additional information (RAI) (ADAMS Accession No. ML13183A049). WEC provided responses (HEM-13-101 and HEM-13-127) to that request in letters dated August 13, 2013 (ADAMS Accession No. ML13226A385) and November 5, 2013 (ADAMS Accession No. ML13310A625). The November 5, 2013, submittal resulted from the discussions which occurred in publicly noticed calls conducted on September 4, 2013 and October 2, 2013. A summary of those calls can be found at ADAMS Accession Nos. ML13269A235 and ML13317A712.

2. BACKGROUND

The Hematite site was used for the manufacture of low-enriched, intermediate-enriched, and high-enriched materials during the period of 1956 through 1974. In 1974, the production of intermediate- and high-enriched material was discontinued and all associated materials and equipment were removed from the facility. From 1974 to the cessation of manufacturing operations in 2001, the Hematite facility produced nuclear fuel assemblies for commercial nuclear power plants. In 2001, fuel manufacturing operations terminated and the facility license was amended to authorize only decommissioning operations.

Activities at the Hematite site generated a large volume of process wastes contaminated with uranium of varying enrichment. Based on historic documentation, 40 unlined pits were excavated and used for the disposal of contaminated materials generated by fuel fabrication processes at Hematite between 1965 and 1970. The May 2009 alternate disposal request and License Amendment 58 approval covers the disposal of material from these burial pits, other undocumented burial pits, and other soil associated with the remediation of the Hematite site. The January 16, 2012, request and License Amendment 60 approval covers the disposal of source, byproduct, and special nuclear materials contained in building slabs, asphalt, soils, buried piping and miscellaneous equipment associated with the HDP. The primary waste type covered by the May 28, 2013, alternate disposal request is soil and soil type material.

WEC plans to ship the material associated with the May 28, 2013, request to the USEI facility by rail if the material meets criteria established by WEC and approved by the NRC for this §20.2002 disposal request. Discrete quantities of highly enriched uranium (HEU) will not be shipped to the USEI facility. However, the proposed rail shipments may contain diffuse quantities of HEU spread throughout the waste materials, as discussed further in Section 6 below.

The May 28, 2013, request encompasses three actions. The first is that it addresses the fact that previous§20.2002 requests had underestimated the amount of material which would be excavated and would qualify for disposal at USEI. Therefore, the May 28, 2013, submittal requested that the amount of material which would be allowed to dispose at USEI be increased by an additional 22,000 m^3. Most of the additional material is soil except for the soil-like material identified below. Since this additional soil is characteristically the same as the previous §20.2002 requests, the dose contribution from the soil will be the same as previously calculated absent the contribution from Tc-99 which is excluded for the reasons noted in Section 3.2. Approval of this additional amount of material being shipped to and disposed at USEI would necessitate a revision to Hematite License Condition 17.

The second action requests approval for a type of material not previously identified as candidate material for shipment to USEI. WEC identified this material as soil-like material, specifically, dewatered sanitary sludge. The inclusion of dewatered sanitary sludge would necessitate staff review of the characterization of the material, criticality safety considerations and the dose consequences associated with the shipment and treatment of that specific material.
The third action involves the request for approval for the treatment of radioactive material containing Volatile Organic Compounds (VOCs) or hazardous chemicals at the USEI facility. The staff approved the Hematite Decommissioning Plan (DP) in Amendment No.57 (ADAMS Accession No. ML112101713). This approval affirmed WEC's intent to treat VOC contaminated

soil at the Hematite site using a soil vapor extraction (SVE) system. Soils which were contaminated both with VOCs and radioactivity would be treated in the SVE. Following treatment, those soils which were radioactively contaminated and which met WEC's criteria for waste shipment to USEI would be shipped to USEI. Subsequently, WEC decided not to install the SVE system. Instead, for that radioactive waste which met WEC's criteria for shipment to USEI, WEC proposed that if the waste was also contaminated with VOCs and other hazardous chemicals, the waste would be treated at USEI. In their previous §20.2002 requests, WEC's submittals had indicated that the waste material would not be treated at USEI but would be offloaded from the railcar and disposed into the burial cell without further action, i.e., treatment. Therefore, the staff had no criticality safety concerns associated with the actions at USEI. Criticality safety had been previously addressed for the loading of the railcars at the Hematite site. That assessment remained valid during shipment and offloading and burial of the material at USEI. Criticality safety with respect to the potential for SNM to accumulate when mixed with other buried waste in the burial cells had also been assessed. However, with WEC's intention now to have USEI treat VOC and hazardous chemically contaminated radioactive waste at USEI, it becomes necessary for the staff to assess the treatment methods at USEI to determine if such treatment methods pose criticality safety concerns.

3. DOSE EVALUATION

This SER section evaluates WEC's description of the types of material it plans to ship and its potential to generate radiological dose to various members of the public. WEC supplied information on the source material and a description of the job functions which permitted them to evaluate different possible exposures for various members of the public. These scenarios included the doses to the transportation workers and USEI workers and the post-closure dose to the general public, and to an intruder. For §20.2002 reviews, all the scenarios treat exposed individuals as members of the public because the material is proposed to be sent to a facility that is not licensed by the NRC or an NRC Agreement State. Therefore, the NRC's occupational dose criteria do not apply to workers at USEI.

3.1. Types and Quantities of Material

WEC estimates the volume of the waste that will be a candidate for disposal at USEI associated with the May 2013 request to be approximately 22,000 m^3 at a waste density of 1.69 g/cm^3 (i.e., approximately 41,000 tons). The waste covered by this request consists of soil and soil-like material (dewatered sanitary sludge), and contains low concentrations of source, SNM, and byproduct material contaminants. WEC determined the radionuclides of concern based on studies in the Hematite Historical Site Assessment (ADAMS Accession Nos. ML092870417 and ML092870418). This is summarized in Chapter 4 of the Hematite DP (ADAMS Accession No. ML092330136). The majority of the waste materials will be made up of soils, while only a small portion (approximately 30 m^3) of the total waste is estimated to contain soil-like materials. Density measurements performed by WEC indicated that the dewatered sludge has an average density of 0.99 g/cm^3 compared to the soil density of 1.69 g/cm^3. Since the dose assessment calculations assume a volume of 22,000 m^3 as a limit, it will be an upper bound on the amount of waste that WEC is permitted to send to USEI under this request. License Amendment 58 had approved for disposal approximately 23,000 m^3 at a waste density of 1.69 g/cm^3 (i.e., approximately 50,000 tons), and License Amendment 60 approved for disposal approximately 23,000 m^3 at a waste density of 1.5 g/cm^3 (i.e., approximately 38,700 tons). Therefore, the combined waste volume for all requests is approximately 68,000 m^3.

3.1.1. Characterization of Soil and Soil-Like Material

WEC provided characterization information on the waste to be shipped by rail to USEI in Section 5.0 (Material Description and Characterization) of HDP-TBD-WM-909, which was provided as Enclosure 1 (*Safety Assessment for Third Alternative Disposal Request for Transfer of Hematite Project Waste to USEI*) to the May 28, 2013, alternate disposal request. There, it was noted that the expected concentrations for the radionuclides are based on the information associated with WEC's May 21, 2009, submittal (approved as Amendment 58) (ADAMS Accession No. ML091480071)), except that the total amount of Tc-99 will not exceed the numerical limits identified in Table 4-1, which are unchanged from Amendment 60 (ADAMS Accession No. ML12158A384). The expected concentrations are reproduced below in Table 3-1.

Table 3-1. Expected Radionuclide Concentrations in Westinghouse Hematite Waste

Shipped Volume (m^3)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Tc-99 (pCi/g)	Ra-226 (pCi/g)	Th-232 (pCi/g)
22,000	113	5.5	18	27	1	1.2

* Multiply Ci by 3.7×10^{10} to obtain Bq

The characterization of site soils used to develop the values in Table 3-1 was previously accomplished in support of the May 21, 2009, and January 16, 2012, alternate disposal requests. The May 28, 2013, alternate disposal request represents additional soil (which is similar to that of the previous two alternate disposal requests), and a relatively small amount of soil-like materials (dewatered sanitary sludge). In Section 1.0 of HDP-TBD-WM-909, WEC indicated that "the additional volume of waste in this §20.2002 request is based on encountering more material during excavation that requires disposal than was accounted for by contingencies in the original estimates," and "the additional material is from areas that were previously characterized, but the volumetric extent of the contaminated material was underestimated." As such, it is appropriate to use the previous soil characterization performed in the development of WEC's previous 20.2002 requests that were approved on October 27, 2011, and April 11, 2013 to inform the current request.

In addition to relying on the previous characterization data, WEC provided a summary of the supplementary characterization of the material that has already been shipped to USEI as required under the previous approvals. As of August 31, 2013, WEC has shipped approximately 21,175 m^3 of material. WEC provided a summary of the characterization data of the material in Table 3 (Summary Data for Shipments to USEI as of August 31, 2013) of Revision 1 of HDP-TBD-WM-909, (ADAMS Accession No. ML13310A625). The average total concentration for material already shipped is below the expected concentrations presented in Table 3-1. The average Tc-99 concentration for the material already shipped is 8.3 pCi/g.

Additional sanitary sludge characterization results were provided as RAI responses in HEM-13-127 (ADAMS Accession No. ML13310A625) as an update to Table 4 (Sample Results from the Sanitary Sludge) of HDP-TBD-WM-909, Revision 1. WEC estimated that the total amount of Tc-99 in sludge was 2.5E-3 Ci, with a 95% Upper Confidence Limit (UCL) of 2.9E-3 Ci, and also estimated that the weighted average total activity of the sludge was 1,891 pCi/g.

3.2. NRC Evaluation of WEC's Material Characterization

Given that the source term values presented by WEC are an estimate, WEC continues its commitment to perform additional characterization of soils and soil-like material prior to shipment to verify amounts and to ensure adherence to the Tc-99 limits associated with License Condition 17 of the Hematite license. The adequacy of these future sampling plans is discussed in Section 4 of this SER. NRC staff evaluated the available characterization data, which was used to estimate the dose and help define the limits imposed under License Condition 17, and the findings are summarized below.

3.2.1. NRC Findings

The NRC has concluded that WEC has presented a reasonable explanation of the existing soil characterization data for their previous Amendment 58 and 60 requests. The NRC staff finds the use of the concentrations assumed in the May 2009 request to remain appropriate for the dose estimation because WEC has committed to further characterization of the Tc-99 concentrations to ensure the shipments remain within the previously established limits. While it may be ideal to have a more complete characterization of the material prior to approving a request for alternate disposal, it is not always realistic or necessary for making a safety case. Therefore, in this case, the staff's safety analysis relies on supplementary characterization and adherence to limits as described in the following sections. Also, the characterization of dewatered sanitary sludge, as provided in the updated Table 4 of HDP-TBD-WM-909, Revision 1, is adequate to describe the radiological status of soil-like materials and allows WEC to develop protocols for additional sampling to be performed prior to shipment to USEI.

3.3. WEC Assessment of Doses

3.3.1. Transportation and USEI Worker Doses

WEC analyzed the dose to USEI workers as well as the potential dose to a member of the public during transportation of the waste to USEI. The USEI workers included a gondola surveyor, an excavator operator, gondola cleanout worker, truck driver, stabilization operator, and cell operator. These dose assessments were similar to those provided by WEC in its previous alternate disposal requests. WEC estimated that 372 gondola railcars will be used to transport the waste from the Hematite site to USEI. The contents of the gondola railcar will be enclosed in wrappers meeting the U.S. Department of Transportation (DOT) Industrial Type-1 Package (IP-1) requirements, which preclude dispersal of waste to the air or loss of material during transport. Once the waste is received at the USEI site, the gondola railcar will be surveyed and then off-loaded into trucks for transport to the USEI disposal cell. Once the waste is off-loaded, USEI personnel will remove any residual material in the railcar using shovels and brooms. The truck is surveyed prior to being driven to the USEI disposal cell, where the waste is spread and compacted in the cell. The waste may contain hazardous constituents that require stabilization. The stabilization will be performed inside the USEI containment building prior to disposal.

Table 3-2 summarizes the job function scenario assumptions. The times assigned are the times for one person to perform each function once. In WEC's analysis, it is assumed that a specific number of workers per year will be available to carry out each of the job functions, and the total dose for the job function is divided equally among all workers within a job function group. Job functions are not shared among employees tasked as an excavator operator, truck driver, stabilization operator, or cell operator. These workers' responsibilities are not assumed to overlap. However, the groups performing tasks as gondola surveyors, gondola clean-out crews, and truck surveyors may involve the same individual employees.

Table 3-2: Job Function Scenario Assumptions

Job Function	Number of Workers in Group	Minutes to Perform Task	Type of Conveyance (count)
Gondola Surveyor	8	20	Gondola (372)
Excavator Operator	4	45	Gondola (372)
Gondola Cleanout	8	10	Gondola (372)
Truck Surveyor	8	5	Truck (1117)
Truck Driver	14	45	Truck (1117)
Stabilization Operator	6	45	Cube (372)
Cell Operator	2	15	Gondola (372)

The MicroShield 7.02 code was used to calculate the external doses for the workers. The parameters used to estimate the external dose for the gondola cleanout worker, truck surveyor, truck driver, and cell operator were identical to those used in the May 2009 Hematite §20.2002 request. The parameters used to estimate the external dose for the gondola surveyor, excavator operator, and stabilization operator are the same as those assumed in the January 2012 request, except that the soil density was assumed to be 1.69 g/cm^3. The method and parameters used by WEC to calculate the internal dose are the same as those used in both of the previously approved §20.2002 requests. The internal dose from the inhalation of contaminated dust was calculated based on an assumed concentration of dust in the building of 0.23 mg/m^3, an assumed inhalation rate of 1.2 m^3/hr, the concentrations of radioactivity in Table 3-2, and the FGR 11 Inhalation Dose Conversion Factors (DCFs). The assumed dust concentration was based on a study that found that the respirable dust concentrations at the USEI facility ranged from 0.17 to 0.23 mg/m^3. WEC did not take credit for the respiratory protection program at USEI, so the actual inhalation dose would likely be smaller than what was calculated. Unlike in the first approved §20.2002 request, an internal dose was not calculated for the gondola surveyor, truck surveyor, or the truck driver. WEC clarified that internal doses were not assigned to these workers because the truck bed and gondola railcar remains covered while they are being surveyed and the truck bed remains covered during the trip to the disposal cell, so these workers would not be expected to receive an internal dose. The dose to the public during transportation to USEI is bounded by the dose to the workers at USEI. WEC calculated that in order for the dose to the public during transportation to be higher than the dose to a USEI worker, an individual would have to spend more than 1,000 hours at a distance of 1 m from the waste or 790 hours at 1 foot from the waste, which is not a credible scenario. Therefore, WEC did not estimate an actual dose to the public during transportation.

Table 3-3: Dose per Person for Individual Job Function*

Job Function	*Internal Dose (mrem/worker)*	*External Dose (mrem/worker)*	*Total Dose (mrem/worker)*
Gondola Surveyor	NA	$4.0x10^{-2}$	$4.0x10^{-2}$
Excavator Operator	$3.8x10^{-1}$	$3.0x10^{-2}$	$4.1x10^{-1}$
Gondola Cleanout	$4.2x10^{-2}$	$1.3x10^{-2}$	$5.4x10^{-2}$
Truck Surveyor	NA	$2.4x10^{-2}$	$2.4x10^{-2}$
Truck Driver	NA	$1.4x10^{-1}$	$1.4x10^{-1}$
Stabilization Operator	$2.5x10^{-1}$	$3.2x10^{-2}$	$2.9x10^{-1}$
Cell Operator	$2.6x10^{-1}$	$1.1x10^{-1}$	$3.7x10^{-1}$

*multiply mrem/yr. by 0.01 to obtain mSv/y

3.3.2. Post-Closure Dose

The appropriateness of the RESRAD model for the USEI site was reviewed by USEI staff upon USEI purchasing the site from Envirosafe in 2001. The USEI staff concluded that the code was appropriate for the site conditions. In 2005, USEI hired consultants to review the input values used for RESRAD, and determine site-specific inputs that should be used with the code to more accurately reflect the site environmental conditions. Most of the site-specific parameters are explained in the 2005 report titled "Site-specific RESRAD Water Pathway Parameters for the Contaminated Soil, Vadose Zone, and Saturated Zone". This report was provided in WEC's December 29, 2009, RAI response to the May 2009 alternative disposal request noted as HEM-09-146 (ADAMS Accession No. ML100320540). For those parameters not described in the report, WEC provided additional justification with its March 31, 2010 (HEM-I0-38), submittal (ADAMS Accession No. ML100950397.)

Since Tc-99 is the primary contributing radionuclide and the dose is delivered through the groundwater, the total quantity of Tc-99 (as opposed to the concentration) will drive the dose consequences. RESRAD applies the concentration of Tc 99 and the volume of soil in the contaminated zone to determine the total quantity of Tc 99 that is available in uptake pathways. WEC will ensure that the total amount of Tc-99 will not exceed the previously approved limit in the 2012 request (ADAMS Accession Nos. ML12017A188, ML12017A189, and ML12017A190). Therefore, the prior post-closure dose remains valid since the dose will not be impacted by the additional volume of material.

WEC plans to treat the material identified in this request cumulatively with the material from the two previous requests. To ensure that the inventory calculated from the mean activity concentrations (derived from the mass-weighted concentrations of each stockpile) remains below the cumulative limit, WEC plans to sample the outgoing shipments of material. The sampling plan and associated contingency limits, which are discussed in Section 4 of this SER, will ensure that the limits established for the cumulative mean and 95th UCL of the mean will not be exceeded. WEC selected the UCL of the mean in order to maintain the dose at the UCL within the 'few mrem' criterion. Table 3-4 shows the Tc-99 mean and UCL inventory limits for the prior two requests, as well as the cumulative limit. Since WEC is ensuring that the total amount of Tc-99 remains within the previously approved limits, the cumulative action threshold for Tc-99 is not impacted by this additional request. The other radionuclides (besides Tc-99) contribute insignificant amounts to the overall post-closure dose. These radionuclides will become more concentrated (approximately doubled) in the USEI cell as a result of the additional material being sent. However, the impact of this is not significant (on the order of 10^{-4} mSv/yr (10^{-2} mrem/yr)).

Table 3-4: Cumulative Tc-99 Limits for the Previous §20.2002 Requests*

	2009 §20.2002 Request	2012 §20.2002 Request	Cumulative Action Threshold
Total Quantity ofTc-99 shipped to USEI (Mean)	1.0 Ci	0.3 Ci	1.3 Ci
Equivalent Dose for Mean	1.9 mrem/yr	0.8 mrem/yr	2.7 mrem/yr
95% UCL of the Mean of Tc-99 shipped to USEI	1.6 Ci	0.45 Ci	2.05 Ci
Equivalent Dose for the 95% UCL of the Mean	3 mrem/yr	1.2 mrem/yr	4.2 mrem/yr

*multiply mrem/yr by .01 to obtain mSv/y

WEC also performed a sensitivity analysis to evaluate the impact of a shorter project duration and therefore a decrease in the volume of non-Hematite waste that is available for mixing with Hematite waste. WEC analyzed a scenario in which the waste is sent over the shortest possible duration. Since 62% of the waste from the 2009 request had already been shipped as of March 31, 2013, at the shipping rate of 3.7 railcars/wk[1], the dose from that request is weighted accordingly. The nominal shipping rate dose is 1.9 mrem/yr, while the maximum shipping rate dose is 4.1 mrem/yr. The weighted dose from the May 2009 request is added to the maximum shipping rate dose contribution from the 2012 request (1.0 mrem), as shown in the equation below. The remaining 38% of the 2009 request, as well as all the full amount of the 2012 request are assumed to be sent at the faster shipping rate of 20 railcars/wk. Note that there is zero contribution to the post-closure dose sensitivity analysis associated with the current request.

Sensitivity Analysis Cumulative Dose =
0.62(1.9 mrem)+ 0.38(4.1 mrem)+(1.0 mrem) = 3.7 mrem

3.3.3. Inadvertent Intruder Dose

To calculate dose to the intruder post-burial, WEC used the methods from NRC Guidance NUREG/CR 4370, Volume 2 (ADAMS Accession No. ML100250917). Since the volume for this request is only slightly less than the volume for the May 2009 request and the assumed concentrations are the same, WEC relied on the their March 31, 2010, analysis performed in support of the May 2009 §20.2002 alternate disposal request (ADAMS Accession No. ML100950386).

The analysis from the May 2009 request is summarized in the following paragraphs for convenience. The analyses included variations on assumptions about the concentration of the material as it is shipped and the extent to which the shipping concentrations are diluted once it has been disposed of in the cell as detailed in Figure 3-1. WEC did not evaluate the Average Cell Concentration Scenario for material shipped at the Waste Acceptance Criteria (WAC) for all radionuclides because the volume of material and concentration limits for Tc-99 prevent WEC

[1] The number of railcars shipped in the 62 week period since the start of shipping under Amendment 58 through March 31, 2013 was 227, for an average of 3.7 railcars/week.

from shipping the total volume of waste under this request at the WAC. Instead, WEC analyzed the dose assuming that the total volume was shipped at the WAC containing uranium, but not containing Tc-99.

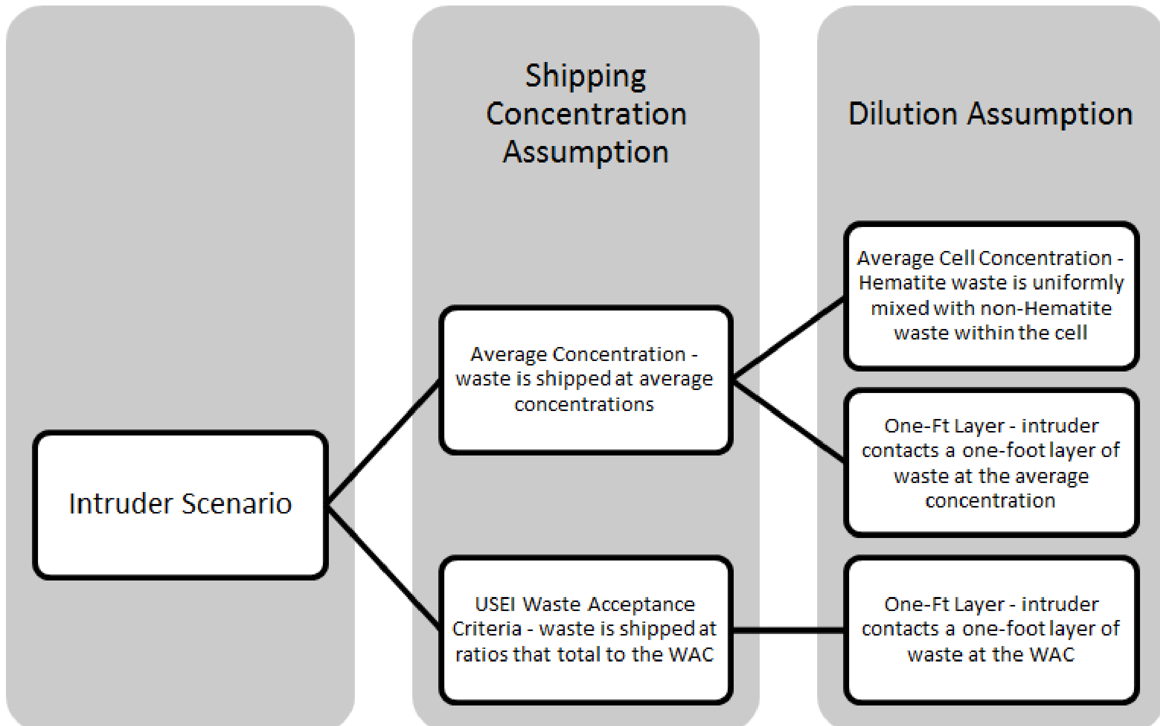

Figure 3-1: Intruder Scenario Waste Concentration Assumptions

3.3.4. Intruder Well-Driller Scenario

WEC evaluated two intruder well-driller scenarios (acute and chronic) as detailed below.

Acute Well-Driller	
Description	Intruder digs a well by drilling through the waste disposal cell to reach the underlying aquifer at a depth of 93.1 m. The total period of exposure is 40 hours, 8 of which occur during the drilling through the contaminated layer.
Concentration of Contaminated Layer	Concentration of the contaminated layer of Hematite waste, which is either the Average Cell Concentration, or the WAC Concentration as shown in Figure 3-1.
Additional Dilution of Contaminated Layer During Exhumation	Concentration of the contaminated layer multiplied by the ratio of 0.31/93.1 or 3.3×10^{-3}, which is the ratio of a 1-ft contaminated layer (0.31 m) to the total well depth (93.1 m).
Dose	0.029 mSv/yr (2.9 mrem/yr) based upon the intruder drilling through a 1-ft layer at the WAC.

Chronic Well-Driller	
Description	Intruder spreads the exhumed drill cuttings around the residence and grows a garden in soil containing the drill cuttings over the course of one year. His time for the year is spent either gardening (100 hours), outdoors (1,800 hours) or indoors (4,380 hours).
Concentration of the Waste	Maximum concentration resulting from the acute well-drilling (based on the soil disposed at the WAC in 1-ft layer).
Dose	3.0 mrem/yr based upon the intruder drilling through a 1-ft layer at the WAC.

3.3.5. Intruder Construction Scenario

WEC evaluated the intruder construction scenario as detailed below.

Construction Intruder	
Description	Intruder is assumed to excavate or construct a building on a disposal site following a breakdown in institutional controls. The intruder is exposed to dust particles through the inhalation pathway, and may also be exposed to direct gamma radiation resulting from airborne particulates and by working directly in the waste-soil mixture. The dose from the inhalation and from external gamma exposure is evaluated for duration of 500 working hours, or a construction period of 3 months.
Concentration of Waste to Which Intruder is Exposed	• Average Cell Concentration – Shipping concentration (either Average or WAC) multiplied by 0.053, which is calculated by taking the ratio of Hematite waste to total waste received (38,710 tons/ 725,000 tons). • 1-Ft Layer – Shipping Concentration (WAC) multiplied by a factor of 0.31 (12 in/39 in) to account for USEI's practice of layering waste into pits in 1-ft layers and an assumption that 1 meter (39 in) of waste is excavated.
Dose	Results range from 0.1 mrem - 16 mrem, with the highest value assuming the intruder encounters a 1 ft. layer at the WAC values.

3.4. NRC Assessment of Doses

3.4.1. Evaluation of Transportation and USEI Worker Dose

The NRC staff finds that the scenarios selected for the transportation and USEI worker dose assessment are consistent with the manner in which the waste will be transported to and handled at USEI. Additionally, the NRC staff finds that the parameter values selected appropriately represent the job functions and the site conditions at USEI. NRC staff performed independent calculations of the external doses using MicroShield and obtained similar results to those obtained by WEC. In addition, NRC staff performed independent calculations of the internal dose and obtained similar results to those obtained by WEC.

3.4.1.1. NRC Findings

Since the waste disposal covered by the approved 2009 and 2012 §20.2002 requests are still ongoing, there is some potential for the USEI workers to receive -- during the same year -- a dose both from those actions and the current May 2013, request. The potential cumulative dose was calculated by assuming that the workers are exposed to all of the waste from the previous requests that had not been shipped as of December 31, 2012 plus the waste from the current §20.2002 request during the same year. This corresponds to 58% of the waste from the 1st request and 100% of the waste from the 2nd request and the current request.

Cumulative dose = 0.58 * Dose from 1st request + Dose from 2nd request + Dose from current request

As seen inTable 3-5, the results of the dose assessment for the USEI workers indicate that the cumulative dose to these individuals will be within the "few millirem" criteria.

Table 3-5: Potential Cumulative Dose from Previous and Current §20.2002 Requests*

Job Function	§20.2002 Request Approved in Amendment 58 (mrem/worker)	§20.2002 Request Approved in Amendment XX (mrem/worker)	Current §20.2002 Request (mrem/worker)	Cumulative Dose Estimate for 2013 (mrem/worker)
Gondola Surveyor	1.1×10^{-01}	1.6×10^{-03}	4.0×10^{-02}	1.2×10^{-01}
Excavator Operator	4.7×10^{-01}	1.9×10^{-01}	4.1×10^{-01}	8.6×10^{-01}
Gondola Cleanout	5.9×10^{-02}	2.2×10^{-02}	5.4×10^{-02}	1.1×10^{-01}
Truck Surveyor	9.3×10^{-02}	2.1×10^{-03}	2.4×10^{-02}	8.0×10^{-02}
Truck Driver	4.9×10^{-01}	1.2×10^{-02}	1.4×10^{-01}	4.3×10^{-01}
Stabilization Operator	1.6×10^{-02}	6.3×10^{-03}	2.9×10^{-01}	3.0×10^{-01}
Cell Operator	3.8×10^{-01}	1.3×10^{-01}	3.7×10^{-01}	7.2×10^{-01}

*multiply mrem/yr by 0.01 to obtain mSv/y

3.4.2. NRC Evaluation of Post-Closure Dose

The staff finds that approval of the May 28, 2013, request will not yield a post closure long-term dose that is more than a few mrem/yr provided the total inventory of Tc-99 remains within the limits established by the previous requests as summarized in Table 3-4 . The staff finds this upper confidence limit to be acceptable because the dose resulting from the total inventory is also within a few mrem. A detailed discussion of the review of the sampling plan and contingency limits is contained in Section 4 of this SER.

Regarding cumulative post-closure doses, the staff agrees that it is acceptable in this case to treat the material cumulatively and to calculate a cumulative long term post-closure dose given that Tc-99 (through the groundwater pathway) is the primary contributor to dose. The staff finds the expected cumulative dose of 0.027 mSv (2.7 mrem) to be within the acceptable range of 'a few millirem'. The staff notes that WEC has analyzed the combined impacts of a faster shipping schedule for all 20.2002 alternate disposal requests. Because the cumulative 4.1 millirem dose in this scenario is still within a 'few millirem', the NRC staff finds the post-closure cumulative doses acceptable.

3.4.2.1. NRC Findings

NRC staff finds the parameter values and assumptions used in calculating the post-closure dose acceptable based on review of the USEI 2005 report and the RAI responses (HEM-09-146, HEM-10-38, and HEM-13-101). NRC staff performed independent assessments of WEC's calculations for post-closure dose and finds the post-closure doses submitted by WEC within the criteria of 'a few millirem'.

3.4.3. NRC Evaluation of Intruder Doses

The NRC staff considered the assumptions and pathways for the intruder scenarios to be reasonable based on comparison to the guidance in Appendix G of NUREG-0782 and NUREG/CR–4370, Volume 1.

Staff considers the dilution factor of 0.31 acceptable for the Construction One-Ft Layer scenario after reviewing the standard practices at USEI. Staff also considered the dilution factor of 0.53 acceptable for the Average Cell Concentration scenario after reviewing historical data for waste volumes sent to USEI. The staff notes the following conservatisms were presented in Section 7.2 of Enclosure 1 WEC's January 2012 submittal:

- No credit taken for the mixing of the waste with the cover material as noted in the RAI Response to Performance Assessment RAI No. 9, (ADAMS Accession No. ML100320540).
- USEI restriction of the emplacement of any radioactive waste to within 3.6 meters of the surface of the finished cap of the cell, which could rule out the construction scenario as not a feasible scenario.
- No credit taken for decay up to the intrusion event, for waste form, or solidification.

TTable 3-6 shows the cumulative intruder doses for various assumptions, which are simply the sum of the doses assumed for the prior and current request. The maximum dose assumes the intruder encounters a 1 ft layer of waste at the WAC concentrations. The NRC staff notes that assuming an arithmetic sum for the cumulative intruder dose is unrealistic given that the intruder is not likely to encounter a separate 1 ft layer of the waste at the WAC concentration from all three requests in the same location. The total expected average concentration is approximately 18 times less than the WAC concentration of 3,000 pCi/g. The intruder doses assuming the intruder encounters waste at the expected average concentrations yield doses that are within a few millirem.

Table 3-6: Summary of Intruder Doses (mrem/yr)[1]

	Intruder Scenario	Conc. Shipped	Dilution Conditions	May 2009 Request	Jan 2012 Request	May 2013 Request	Sum
Acute	Well Driller Intruder	Expected Average	Average Cell	0.1	0.0	0.1	0.2
Acute	Well Driller Intruder	Expected Average	1 Ft Layer	0.2	0.1	0.2	0.5
Acute	Well Driller Intruder	WAC	1 Ft Layer (dilution is 0.31/93.1)	2.9	2.9*	2.9	8.7
Chronic	Well Driller Intruder	Expected Average	1 Ft Layer (dilution is 0.1)	2	**	2	7
Chronic	Well Driller Intruder	WAC	Average Cell	**	3.0*	**	
3 months	Construction Intruder	Expected Average	Average Cell	0.05	0.1	0.05	0.2
3 months	Construction Intruder	Expected Average	1 Ft Layer	0.8	0.6	0.8	2.2
3 months	Construction Intruder	WAC	1 Ft Layer	10	16*	10	36

[1] multiply by 0.01 to convert mrem/yr to mSv/yr
*assumes entire WAC is attributed to uranium
**values for these scenarios were not submitted by WEC, but were independently evaluated by NRC staff to be within a few millirem

3.4.3.1. NRC Findings

The NRC staff finds the assumptions and pathways considered for the intruder scenarios to be reasonable based on comparison to the guidance in Appendix G of NUREG-0782 and NUREG/CR–4370, Volume 1. The NRC staff finds the intruder doses acceptable, given the conservative approach. The staff notes that the time for the intruder construction scenario was limited to 500 hours. The intruder construction scenario that WEC analyzed does not account for the chance that the intruder could subsequently live and grow food onsite due to the site's remote location and arid environmental conditions. The staff agrees with the technical basis for why intruder agricultural practices at the site are highly improbable. The NRC staff find the concentration assumptions for the WAC (that the 3,000 pCi/g is attributable fully to uranium and not Tc-99) in the sensitivity analyses performed by WEC acceptable because Tc-99 is not a significant radionuclide for the intruder scenarios and because uranium, through the air and direct gamma pathways, is the main contributor to dose for the intruder scenarios.

3.5. Stability of the Disposal Facility Following Closure

3.5.1. Westinghouse Assessment

Site-stability can be impacted by natural surface and subsurface processes, and is also impacted by the stability of the waste and engineered barriers of the disposal facility. In WEC's March 31, 2010, submittal associated with the May 2009 alternative disposal request, WEC provided a technical basis for the stability of the USEI site stating that the facility was "constructed in compliance with the RCRA standards and the applicable Minimum Technology Requirements (MTRs). These requirements provide conservative criteria for cell construction to insure long-term stability and are consistent with the erosion design requirements in 10 CFR Part 61, and the joint NRC/EPA guidance document with guidelines on drainage and processes impacting stability."

3.5.2. NRC Evaluation and Findings

The NRC has noted that site-stability can be impacted by natural surface and subsurface processes and by the stability of the waste and engineered barriers of the disposal facility. The NRC staff has evaluated WEC's technical basis for the stability of the USEI site. The NRC staff has concluded that construction of the USEI facility to RCRA standards and to the applicable MTRs are sufficient to provide long-term stability and to be consistent with the erosion design requirements in 10 CFR Part 61 as well as the joint NRC/EPA guidance document with guidelines on drainage and processes impacting stability.

4. HEALTH PHYSICS ASSESSMENT

4.1. WEC's Soil and Soil-Like Material Characterization

In Section 5.2 of HDP-TBD-WM-909, WEC indicated that they will subject soils, which may include spent limestone used as backfill, associated with this request to the same sampling plan, radiological controls, and programmatic elements that were detailed in the previous Amendment 58 alternate disposal request, and that the sample results will be compared to the combined contingency plan limits in Table 4-1. The previously approved soil sampling plan, that WEC has committed to follow, was provided in HEM-11 (ADAMS Accession No. ML110530155). This sampling plan was transmitted to the NRC in WEC's February 18, 2011, submittal and was previously approved by the NRC with the issuance of Amendment 58 to the Hematite license (ADAMS Accession No. ML112560105). Sampling protocols, detection capabilities, and activity limits for U-234, U-235, U-238, Th-232, Ra-226, and Tc-99 were provided by WEC in the aforementioned technical basis document and remain the same for the current request, with the exception of the Tc-99 limits. The overall limits on the quantity of Tc-99 shipped to USEI will be consistent with those approved for Amendment 60, which are 1.3 Ci total or a 95% upper confidence level of the mean of 2.05 Ci.

In the HEM-13-101 (ADAMS Accession No. ML13226A385) responses to NRC staff RAIs, WEC provided an updated sampling plan for soil-like materials in Section 5.2 of HDP-TBD-WM-909. This plan includes 12 samples to be taken from random locations within sludge dewatering containers (after dewatering occurs). Visual Sampling Plan software was used to determine the number of samples required, based upon Tc-99 sampling results from July 2013 (as provided in the updated Table 3 of HDP-TBD-WM-909). WEC also indicated that characterization of dewatered sludge and an evaluation of the results per the §20.2002 criteria would take place before commingling with soils or other waste. WEC intends to mix the dewatered sanitary sludge with soils prior to shipment to ensure adequate dryness is achieved. The resultant mixture will then be sampled using the soil sampling protocols described above.

4.1.1. NRC Findings

The NRC staff has reviewed WEC's plans for additional soil and soil-like material and finds that WEC's plans represent acceptable sampling protocols and frequencies to adequately characterize materials prior to shipment to USEI.

4.2. Quality Assurance and Contingency Plans

4.2.1. WEC Quality Assurance and Contingency Plans

WEC developed several quality assurance and contingency plans related to their Amendment 58 submittal, and these plans will apply to the current alternate disposal request. Sampling data quality objectives were provided as Appendix P in Revision 1 to HDP-TBD-WM-906. A detailed quality assurance plan for soils was described in HEM-11-16 and was approved as part of the staff's review and approval associated with Hematite License Amendment 58. It was noted in the plan that WEC intends to implement field duplicate samples, field blanks, and laboratory control samples throughout the excavation process at its Hematite site. WEC will collect field duplicates at a frequency of 1 per 20 samples and the results will be evaluated to determine the relative difference or relative percent difference between two data sets. WEC intends to utilize guidance from the Multi Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual to compare results to pre-determined warning and control limits. Field blanks will be collected at a frequency of 1 per 100 samples and these results will be used to evaluate bias. Laboratory control samples, matrix spikes (if applicable), and replicate counts will be performed at a frequency of 1 per 20 samples in order to assess overall laboratory performance.

WEC provided a table of contingency plans which included radiological action levels, monitoring strategies, and actions to be taken if limits are exceeded. This table is provided as Table 4-1 of this SER.

Table 4-1: Pre-Shipment Contingency Plans Proposed by WEC

Parameter	Action Level	How Monitored	Actions
Total Quantity of Tc-99 shipped to USEI (mean)	>1.3 Ci	Running total activity (both shipped and pending shipment), based on laboratory sample results prior to shipment	• Reanalyze composite sample and/or analyze individual aliquots used to create the composite sample; • Resample stockpile and re-evaluate; and • Ship material to alternate facility.
95% Upper Confidence Level of the mean Tc-99 shipped to USEI [UCL(0.95)]	>2.05 Ci	Running confidence interval (both shipped and pending shipment) based on laboratory sample data prior to shipment	• Reanalyze composite sample and/or analyze individual aliquots used to create the composite sample; • Resample stockpile and re-evaluate; and • Ship material to alternate facility.
Total activity contribution from all radionuclides within individual railcar	>3000 pCi/g > 40 μR/hr	Laboratory sample results for stockpile evaluated at 95% UCL prior to shipment Gamma radiation levels on railcars prior to shipment	• Analyze additional aliquot of composite sample; • Unload railcar (at HDP) and re-load with material containing lower concentration (either blended or alternate material from onsite waste stream); and • Ship material to alternate facility.
Unexpected Tc-99 results for stockpile samples (soil and dewatered sanitary sludge)	>99th percentile of the site wide dataset (573 pCi/g)	Laboratory sample results for stockpile evaluated prior to shipment	• Analyze additional aliquot of composite sample; • Resample stockpile and re-evaluate; • Blend with less contaminated material, resample stockpile and re-evaluate; and • Ship material to alternate facility.

Parameter	Action Level	How Monitored	Actions
Unexpected Tc-99 results for stockpile samples (concrete)	>99th percentile of the site wide dataset (1590 pCi/g)	Laboratory sample results for stockpile evaluated prior to shipment	• Analyze additional aliquot of composite sample; • Resample stockpile and re-evaluate; • Blend with less contaminated material, resample stockpile and re-evaluate; and • Ship material to alternate facility.
Unexpected Tc-99 results for stockpile samples (piping internal debris / residue)	>99th percentile of the dataset (162 pCi/g)	Laboratory sample results for stockpile evaluated prior to shipment	• Analyze additional aliquot of composite sample; • Resample stockpile and re-evaluate; • Blend with less contaminated material, resample stockpile and re-evaluate; and • Ship material to alternate facility.
Unexpected Tc-99 results for stockpile samples (piping average concentration)	>99th percentile of the dataset (125 pCi/g)	Laboratory sample results for stockpile evaluated prior to shipment	• Analyze additional aliquot of composite sample; • Resample stockpile and re-evaluate; • Blend with less contaminated material, resample stockpile and re-evaluate; and • Ship material to alternate facility.
Maximum average concentration of Ra-226 and Th-232 within individual railcar	Ra-226 >13 pCi/g Th-232 >16 pCi/g	Laboratory sample results for each railcar evaluated prior to shipment	• Analyze additional aliquot of composite sample; • Resample stockpile and re-evaluate; Blend with less contaminated material, resample stockpile and re-evaluate; and • Ship material to alternate facility.

4.3.2 NRC Assessment of WEC Quality Assurance and Contingency Plans

The staff has reviewed WEC's quality assurance/quality control programs, data quality objectives, and contingency plans. The staff has found them acceptable and their implementation should permit WEC to demonstrate that the NRC's alternate disposal dose requirement (of not more than "a few millirem per year" to any member of the public) can be met.

5. NUCLEAR CRITICALITY SAFETY

This section of the SER addresses those nuclear criticality safety (NCS) aspects of WEC's 10 CFR 20.2002 alternate disposal request dated May 28, 2013, which had not been addressed in previous requests. The first §20.2002 submittal, dated May 21, 2009, and the second §20.2002 submittal, dated January 16, 2012, covered the excavation of waste material from burial pits, and disposal at USEI of burial waste and contaminated soil, concrete/asphalt, subterranean piping and sewage/septic treatment equipment, and various demolition debris and equipment. Material shipped to USEI will be subject to a concentration limit of 0.1 g U-235/l to be considered NCS Exempt Material. Additionally, material with no more than 15 g U-235 within an enclosed volume of 5 liters may be aggregated with other waste as long as the average concentration does not exceed 0.1 g U-235/l. Material shipped to USEI that meets these criteria does not require any additional NCS controls, because the material will simply be received and buried. Received consignments may be subject to one of four stabilization methods, (chemical, chemical fixation (oxidation/reduction), macro-encapsulation, and micro-encapsulation), whose end goal is to reduce or immobilize contaminants and reduce the solubility and migration potential of contaminants associated with the waste. These methods stabilize the waste but do not concentrate contaminants, including fissile contaminants (here U-235), and no credible mechanisms for concentrating the waste sufficiently to constitute an NCS concern have been identified. .By letters dated February 26, 2013, and March 18, 2013, the NRC informed WEC that plans to dispose of dewatered sanitary sludge and VOCs could not be done under the previous two §20.2002 requests. Disposal of sanitary sludge was not authorized because this material was not specifically mentioned in the previous requests. Disposal of VOCs was not authorized because treatment of consigned waste was not discussed in the previous requests, and such treatment would contradict commitments that material received at USEI would be consigned to a waste cell without prior treatment. As a result, WEC submitted a third §20.2002 request by letter dated May 28, 2013, to cover the disposal of sanitary sludge and the removal of VOCs and/or hazardous chemicals from radioactive soil at the USEI facility. The request was also necessary because the volume of waste to be shipped was underestimated in the previous two request, due to WEC encountering more material during excavation than had been anticipated.

5.1 Dewatered Sanitary Sludge

5.1.1 WEC Criticality Assessment of Dewatered Sanitary Sludge

The disposal of sanitary sludge from the Hematite site at the USEI facility is mentioned in NSA-TR-HDP-11-11, Rev. 1, "Nuclear Criticality Safety Assessment of the US Ecology Idaho (USEI) Site for the Land Fill Disposal of Additional Decommissioning Waste from the Hematite Site," dated July 2012. The same limits that apply to contaminated soil and other bulk waste will be applicable to the disposal of sanitary sludge. NCS Exempt Material is that having an average uranium concentration at or below 0.1 g U-235/l(either as homogeneous waste or with discrete items containing less than 15 g U-235 within a contiguous 5 liter volume). NCS Exempt Material does not require any additional NCS controls, because it is sufficiently below the minimum critical concentration of 1.4 g U-235/l for an infinite sea of uranium in bounding soil (SiO_2), as well as the corresponding limit of 4 g U-235/l for uranium in nominal soil, as determined in NSA-TR-HDP-11-11. The above concentration limits are based on the widely-accepted studies in NUREG/CR-6505, Vol. 1, "The Potential for Criticality Following Disposal of Uranium at Low-

Level Waste Facilities: Uranium Blended with Soil," dated January 1997. These limits were determined based on sensitivity analyses in which the concentration of both uranium and water was varied. In general, the addition of water results in a decrease in k_{eff}, primarily due to the neutron poisoning effect of hydrogen. In an infinite system, large concentrations of soil will be sufficient to produce a fully thermalized neutron spectrum such that the addition of water or other hydrogenous materials will result in an over-moderated condition. (For comparison, the minimum critical concentration for a water-moderated system is 11.6 g U-235/l.)NUREG/CR-6505 examines hydrogeochemical transport phenomena to determine a maximum credible concentration factor for waste emplaced at USEI. NUREG/CR-6505 determined that the identified concentration mechanisms will not result in concentration of buried waste by more than a factor of 10 (actual derived concentration factors were substantially less than this, but a maximum concentration factor of 10 was conservatively used). NSA-TR-HDP-11-11 evaluated seven different criticality scenarios. Six of these involved exceeding concentration limits when the waste is packaged for shipment at Hematite, but Scenario 2.4.7, "Migration and Localized Concentration of U-235 in USEI Landfill Cells, Leachate System, and/or Evaporation Pond," involved concentration after burial. A minimum concentration factor of 14 is needed to reach the minimum critical concentration of 1.4 g U-235/l. In actuality, there will not be an infinite extent of the waste, not all of it will be at the regulatory limit, and the matrix material will not consist of pure SiO_2. Scenario 2.4.7 discusses the finite extent of the waste and the fact that a higher concentration factor is needed than for an infinite system. A concentration substantially in excess of what is considered credible given postulated migration mechanisms is therefore needed before criticality is realistically possible.

5.1.2 NRC Staff's Criticality Assessment of Dewatered Sanitary Sludge

Sanitary sludge is produced from a variety of sources at the WEC Hematite site, primarily non-fissile material locations in the facility (e.g., building lavatories). Concentrated solids from the sewage treatment system are expected to be a major component of this waste stream. Like soil, sanitary sludge does not have a well-defined composition, and therefore some nominal composition must be postulated so that the staff can compare its reactivity effects with those of soil. Described as "soil-like" in the submittals, this primarily biological waste is likely to include significant quantities of nitrogenous materials and other mineral elements, most of which are neutron poisons. The neutron spectrum in a sea of such material will be fully thermalized, and any neutron moderating or absorbing elements will only serve to reduce reactivity. The staff chose typical values from a report supported by the U.S. Department of the Interior, Geological Survey, and State Water Resources Research Center (Kelley et al., Bulletin 143, "Agricultural Use of Sewage Sludge: A Literature Review," Department of Agronomy, Virginia Polytechnic Institute and State University, 1984). Based on NUREG/CR-6505, Vol. I, and the above report, the median composition of nominal soil and sanitary sludge are compared below, together with the bounding SiO_2 soil:

Table 5-1: Chemical composition of bounding soil/sludge matrix materials

Constituent	Bounding (SiO_2) Soil 1.6 g/cm^3	Nominal Soil 1.6 g/cm^3	Sewage Sludge 0.72 g/cm^3
B			33 μg/g
C		4.29 wt%	30.4 wt%
N			3.3 wt%
O	53.257 wt%	49 wt%	*
Na		0.68 wt%	0.2 wt%
Mg		0.6 wt%	0.4 wt%
Al		7.1 wt%	0.4 wt%
Si	46.743 wt%	33 wt%	
P			2.3 wt%
S			1.1 wt%
K		1.36 wt%	0.3 wt%
Ca		1.37 wt%	3.9 wt%
Cr			890 μg/g
Mn			260 μg/g
Fe		2.6 wt%	1.1 wt%
Co			4 μg/g
Ni			82 μg/g
Cu			850 μg/g
Zn			1740 μg/g
As			10 μg/g
Mo			30 μg/g
Cd			16 μg/g
Ba			162 μg/g
Hg			5 μg/g
Pb			500 μg/g

*No abundance of oxygen was given for sludge in the report; however, the balance of the composition (~56 wt%) was assumed to consist of oxygen, which is conservative because it is nearly transparent to neutrons.

In the above table, moderators (i.e., those elements, other than fissionable ones, whose presence tends to increase k_{eff}) are shaded. The remaining, unshaded entries represent neutron absorbers (whose presence tends to decrease k_{eff}). Soil consisting of pure SiO2 is therefore seen to be the most conservative because this takes no credit for the presence of neutron poisons. Nominal soil and sludge are less reactive mainly because of the presence of such poisons. The exception is that both nominal soil and sludge contain significant quantities of carbon, which is a neutron moderator. However, since the concentration limits were based on an infinite medium, the other light nuclides present (among them silicon, for nominal soil, and oxygen) already provide for a fully thermalized neutron spectrum. The staff's calculations for these matrix media produced an energy of average lethargy causing fission (EALF) in the range of 0.05 to 0.08 eV. The neutron spectrum tends towards a roughly Maxwellian distribution, and when that has occurred, the presence of additional moderator—including carbon—can have no additional benefit, and acts essentially as a neutron poison. All the remaining constituents in the nominal soil and sludge are neutron absorbers and as such only serve to reduce reactivity. The importance of each constituent is a function of its macroscopic absorption cross section, which depends on both its energy-dependent microscopic cross section and relative abundance. Those constituents for which abundance is given in terms of µg/g may be considered as trace constituents whose effect on system reactivity is generally minor. Thus while boron (especially B -10) has a large absorption cross section, its overall importance is reduced because it occurs in trace amounts.

The staff performed a series of sensitivity calculations using the SCALE 6.0 computer package, to first confirm the results of calculations in NUREG/CR-6505, Vol. I, for SiO_2 and nominal soil, and then to compare these results to waste with sanitary sludge as the matrix material. The staff varied the concentration of U-235 to verify the adequacy of the 0.1 g U-235/l limit for each of the matrix materials, and to determine the amount of safety margin in this limit. The safety margin was represented by the maximum safe concentration factor, which was taken to be the concentration at which k_{eff} exceeds 0.95 divided by the concentration limit of 0.1 g U-235/l. The staff also varied the concentration of water, although in general adding water to the waste material resulted in a net decrease in k_{eff}. The waste material was modeled as infinite in all three dimensions by applying mirror boundary conditions on a cuboid filled with a homogeneous mixture of waste consisting of the matrix material, fully-enriched uranium, and water. Because soil and sludge are highly porous materials, uranium and water were assumed to fill up the voids in the matrix material, so that the density of the matrix medium remained unchanged as uranium and water were added to it. (This maximizes the overall bulk density, though in an infinite system k_{eff} is insensitive to the bulk density.) For the sludge, certain isotopes were not represented in the SCALE Standard Composition Library (e.g., zinc and mercury, and only the As-75 and Ba-138 isotopes could be used). These trace materials were neglected, and the relative abundance of oxygen increased so the weight percent of all species totaled to 100%. The graph below shows the change in k_{eff} thus determined as a function of uranium loading, with no water present:

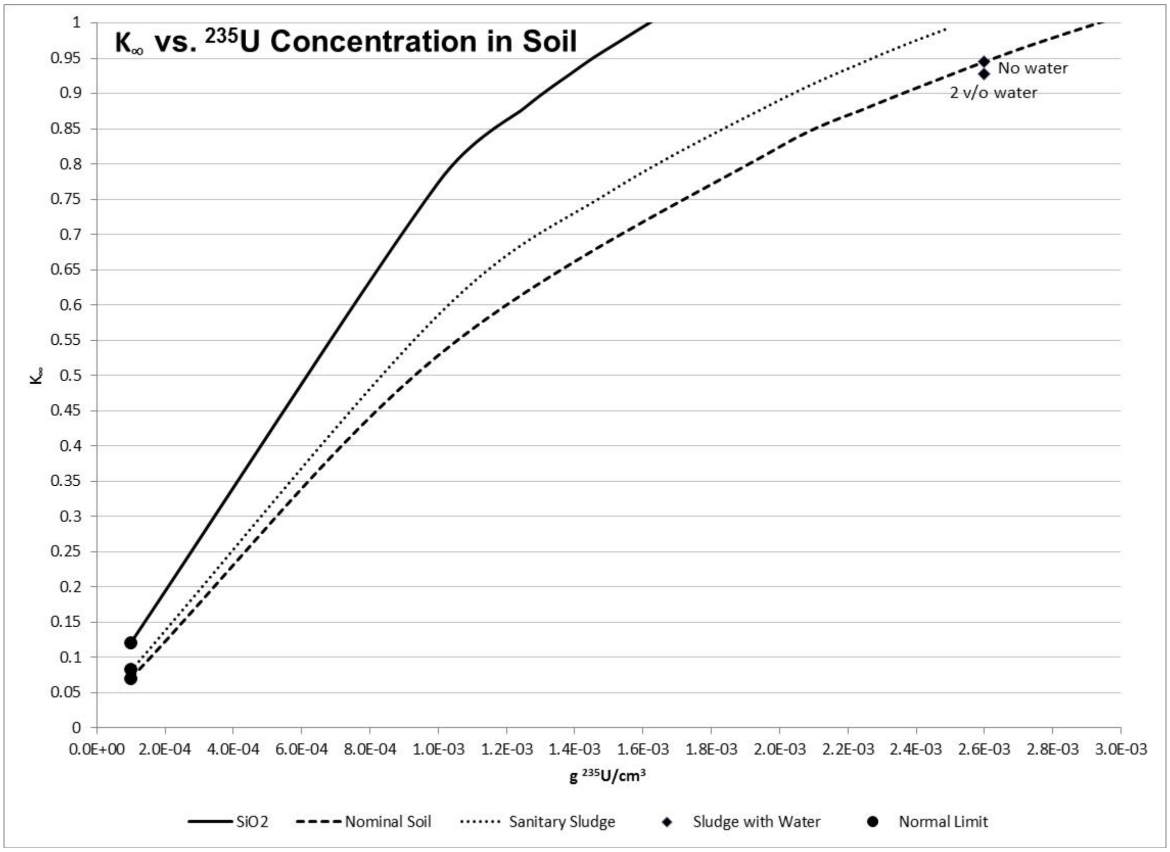

Figure 5-1: Reactivity of uranium in matrix material versus concentration

The staff's calculations showed that, over the whole range of uranium concentrations, SiO_2 is still the bounding matrix medium, and sanitary sludge (as modeled) is slightly more reactive than nominal soil. While the sludge contains more neutron poisons, its density is lower than soil (0.72 g/cm^3 instead of 1.6 g/cm^3). Thus, at the same uranium concentration, uranium will have a higher relative concentration (in terms of g U-235/g waste) in sludge than in soil. Also shown are results for the sludge calculation closest to k_∞ = 0.95 with no water present and with 2 v/o (volume percent) water. This shows that the addition of water results in a slight decrease in reactivity, so dry waste is the most bounding. The circles represent the case in which uranium concentration is at its normal limit of 0.1 g U-235/l, or 10-4 g U-235/cm^3. The results show that for SiO2 soil, it would require the concentration to increase to 14.5 times its normal limit before criticality is possible. For nominal soil, the factor is 26.3 times the normal limit, while for the sanitary sludge, the factor is 22.7 times the normal limit.

These concentration factors are the lowest such factors for which criticality is possible, based as they are on homogeneous mixtures infinite in all directions. In NSA-TR-HDP-11-11, using the results of NUREG/CR-6505, WEC demonstrated that an even higher concentration is needed given the finite extent of the landfill cells. Tables C-1 and C-2 of NUREG/CR-6505, Vol. 1, give k_∞ values and (when an infinite medium is critical) safely subcritical slab thicknesses, cylinder diameters, and sphere diameters, for various concentrations of uranium and water in SiO_2 and nominal soil. At a concentration of 0.006 g U-235/cm^3 (used as a typical value in NUREG/CR-6505), a slab that is infinite in two dimensions attains a k_{eff} that exceeds 0.95 at an areal density of 0.86 g U-235/cm^2, corresponding to a thickness of ~143 cm. The same mixture in an infinitely long cylinder attains a k_{eff} that exceeds 0.95 at an areal density of 1.27 g U-235/cm^2, which necessitates a diameter of ~270 cm. The same mixture in a sphere exceeds 0.95 at an areal density of 1.53 g U-235/cm^2, which necessitates a diameter of ~382 cm. (For comparison, the minimum critical areal density for U-235 is given as 0.4 g U-235/cm^2 in ANSI/ANS-8.1-1998.) Thus, for a given concentration factor, a slab geometry attains criticality with the lowest areal density. Cylinders and spheres require higher areal densities, which means they must be larger, and therefore greater migration or concentration over a larger total volume. Criticality can also be achieved at a lower concentration (as long as it exceeds the minimum concentration of .00145 g U-235/cm^3 for a uranium-SiO_2 mixture), but this requires a larger areal density and therefore more extensive migration. Thus, in all cases, attaining a critical condition requires both concentration by more than a factor of ten, and migration over a significant area. Such migration is extremely unlikely due to the arid conditions, leachate monitoring, and waste stabilization efforts.

The staff also performed a sensitivity analysis using the TSUNAMI-1D module in the SCALE computing package. The results showed that all constituents of the sludge had negative integral sensitivity coefficients—indicating their role as neutron poisons—with the exception of the fissile isotope, U-235, carbon, and oxygen. Of the remaining neutron poisons, the ones with the highest negative reactivity worth were nitrogen, boron, cadmium, calcium, and iron (and phosphorus, potassium, and sulfur also had a measurable neutron poisoning effect).
The results indicated that dilute waste containing sanitary sludge as a matrix medium will be adequately bounded by a uranium-SiO_2 mixture, whose limits were based on NUREG/CR-6505. This conclusion is valid for the bounding case of dry waste as well as for wet waste. For all three types of postulated matrix media (SiO_2 soil, nominal soil, and sanitary sludge), the concentration factor necessary before criticality is possible exceeds a factor of 10, which is the maximum considered credible in NUREG/CR-6505 for in situ concentration. Therefore, the staff concludes that there is no safety concern with the disposal of waste containing sanitary sludge at USEI, provided all the existing limits are adhered to.

5.2 Volatile Organic Compounds (VOCs)

5.2.1 WEC Criticality Assessment of VOCs

The previous 20.2002 requests, and the discussion above concerning concentration of waste in the landfill cells at USEI, relied on the applicant's commitment that waste would be received and buried but would undergo no treatment at USEI. The staff determined that the WEC's stated intention to treat contaminated soil for the removal of hazardous chemicals and VOCs was inconsistent with that commitment, as documented in the NRC's letter dated March 18, 2013. NSA-TR-HDP-11-11 stated as an assumption that the treatment for removal of VOCs would not result in the significant concentration of uranium. This NCS assessment did not describe the specific chemicals designated as VOCs or the treatment method to be used, and did not justify the assumption that significant concentration of uranium will not occur. NSA-TR-09-14, Rev. 6, "Nuclear Criticality Safety Assessment of the US Ecology Idaho (USEI) Site for the Land Fill Disposal of Decommissioning Waste from the Hematite Site," dated July 2012, contained the same assumption. The cover letter transmitting this NCS assessment stated that Rev. 4 of the assessment addressed the treatment of waste, and the staff's SER accompanying Amendment 58 considered treatment of waste, for removal of VOCs. The staff reviewed this information and determined that there had been no detailed submittal or review of the criticality safety basis for treatment for VOCs at USEI. The staff therefore requested additional information on this topic. WEC provided additional information in a November 5, 2013 submittal (ADAMS Accession No. ML13310A625. Specific information of interest was provided in HEM-13-MEMO-090, Rev. 1, “Stabilization of Soil Comprising Chemical Constituents Received from the Hematite Site for Treatment at US Ecology Idaho (USEI),” (ADAMS Accession No. ML13310A582). Further clarifying information was provided in a November 19, 2013 WEC email (ADAMS Accession No. ML13330B678).

5.2.2 NRC Staff’s Criticality Assessment of VOCs

The staff’s review of criticality analyses NSA-TR-HDP-11-11 and NSA-TR-09-14 indicated that treatment of waste for the removal of VOCs is mentioned, but is not described in sufficient detail to permit the staff to conclude that there is reasonable assurance that criticality will not occur. The staff therefore posed additional questions to the applicant in a publicly noticed telephone call on October 2, 2013 (ADAMS Accession No. ML13). In that phone call WEC indicated that the main constituents of the VOCs are expected to be trichloroethylene and vinyl chloride, plus perchloroethylene, cis-1,2-dichloroethylene, and trans-1,2-trichloroethylene. WEC stated that these additional constituents would be added to the discussion in the completed revision of HDP-TBD-WM-909, “Safety Assessment for Third Alternative Disposal Request for Transfer of Hematite Project Waste to USEI,”.

WEC also clarified that USEI will not filter or chemically separate the contaminants, but will merely decompose them in place. Waste will be batched to treatment containers or tanks, sampled, and treated with reagents as appropriate to dissociate the hazardous contaminants. The specific treatment agents will vary according to the sampling results, and may include chemicals such as potassium permanganate, calcium hypochlorite, or bleach (e.g., sodium hypochlorite). After a residence time of 3-5 hours, the tanks will be resampled to verify that the contents meet RCRA limits. Sampling will not be done to verify fissile content either before or after chemical treatment. USEI may also add water to aid the chemical reactions and materials such as clay to absorb any free liquids prior to stabilization and ultimate disposal.

The addition of water, clay, and various chemical reagents is expected to primarily reduce the uranium concentration through dilution with non-fissile constituents. The addition of water has been shown (see Section 5.1.2) to reduce reactivity at low concentration in an infinite medium (though in a finite geometry this may not always be the case). The chemical reagents above (potassium permanganate, calcium and sodium hypochlorite) and clay contain mainly the same neutron absorbing elements as the soils and sludge considered above. The latter two reagents, as well as the VOCs themselves, also contain chlorine, which has a fairly large thermal neutron cross section. While the reactivity worth of these neutron absorbing elements cannot be readily quantified, due to the fact that their relative abundance will vary from batch to batch, they are expected to have a net negative reactivity impact on reactivity of the soil or sludge material.

While the reactivity effect of these chemicals is expected to either be negligible or reduce the overall reactivity, some of these chemicals have the potential to cause uranium leaching. The potential concentration of uranium due to the reaction of contaminated soil or sludge with these chemicals was addressed in document HEM-13-MEMO-090. In this evaluation, the WEC stated that it may add between 1 and 50% chemical reagents by weight to the contaminated soil. The WEC then performed a dilution calculation in which it assumed that all the U-235 present in a given volume of soil (assuming an initial concentration of 0.1 g U-235/l) would be dissolved by the reagent. The concentration of U-235 was therefore assumed to increase by a factor equal to the ratio of the volume of soil to the volume taken up by the solvent. The largest resulting concentration corresponds to the smallest volume of solvent, 6.67 g U-235/l for 1 wt% chemical reagents. Although this exceeds the minimum critical concentration of 4 g U-235/l in nominal soil, the WEC determined that criticality was not credible because it would require optimum conditions in terms of enrichment, absorption, and separation of solvent from the soil matrix. This is in addition to the assumption that the solvent would dissolve 100% of the uranium present.

The staff recognized the conservative nature of this dilution calculation, and determined that the more appropriate limit was the minimum critical concentration of uranium in water, 11.6 g U-235/l, once the uranium is separated from the soil matrix. Based on this limit, the concentration would never exceed a subcritical value under the assumptions of the dilution calculation. However, the staff questioned whether some of the chemical reagents used in the treatment for VOCs could result in chemical transformation and subsequent concentration through mechanisms such as precipitation. The WEC's analysis did not address this eventuality. In response to staff's questions, the WEC's provided supplemental information in their November 19, 2013 email. The WEC's submittal stated that the treatment bins are rectangular, flat-bottomed bins to ensure the treatment agents are thoroughly mixed with the soil; any excess solution or precipitate will be taken up by the clay that is also thoroughly mixed into the waste.

The staff determined that the geometry and mixing significantly reduced the potential for any aqueous solution to become separated from the waste material and accumulate near the bottom of the bin. The WEC also stated that it will limit the maximum mass in an individual railcar to no more than 700 g U-235. This will be ensured using the sampling protocol reviewed and approved as part of Amendment 58. The WEC further stated that USEI will not perform treatment for VOCs on more than one railcar's contents in a treatment bin at a time. For comparison, the highest amount measured in a single railcar to date has been 443 g U-235, and ordinarily only the contents of a single transfer truck (approximately 1/3 of a railcar) are treated in a treatment bin at a time. The mass limit of 700 g U-235 per treatment batch is less than the minimum critical mass, and is therefore sufficient to preclude criticality while in the treatment bin. The homogenization by mixing and subsequent stabilization of the waste further reduces the potential for criticality following disposal. The staff noted that the above information is not included in the WEC's criticality assessments or in its decommissioning plan, and therefore added the following to License Condition No. 17:

> Any waste material which will be chemically treated at the US Ecology Idaho facility in Grand View Idaho will be shipped in a rail car and total U-235 content per rail car will be limited to 700 grams or less. In addition, Westinghouse will ensure that any chemical treatment which occurs at US Ecology Idaho is limited so that no treated batch contains more than the contents of one railcar.

With this addition, the staff has reasonable assurance of safety involving the treatment of waste shipped to USEI for the removal of VOCs.

5.3 Excavation of Waste Materials at Hematite

The excavation of contaminated soil and other bulk waste from the Hematite site involves dual in-situ radiological surveys and visual inspections to identify potential non-conforming items (so-called Non-NCS Exempt Material). The radiological surveys typically use portable NaI (sodium iodide) gamma probes to identify items with potential masses exceeding 350 g U-235. Any such items identified by the surveys, and any items identified by the complementary visual inspection, will be containerized and characterized using more precise drum counters prior to packaging and shipment to USEI. The survey method utilizes the widely-accepted Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM) protocol to identify such Non-NCS Exempt Material, and relies on multiple independent administrative controls to ensure a high degree of reliability. The NRC staff had previously reviewed the NCS controls applied to excavation and characterization during the first 20.2002 request, and similar controls for the removal of specific waste materials (e.g., removal of concrete/asphalt and subterranean piping) during the second 20.2002 request. Similar methods would be used for the removal of materials covered by this third 20.2002 request. The controls reviewed previously had appeared to provide for criticality safety, and in particular to provide for independence in accordance with the double contingency principle.

Two events occurred during review of this third 20.2002 request which called into question the adequacy of controls associated with waste excavation in general, however. On August 20, 2013 (Event Notice (EN) #49292), a crushed container was discovered that had been removed from the burial pits and set aside without the necessary criticality controls being in place. The in-situ radiological survey and visual inspections had failed to identify the item as exceeding the 15 g U-235 threshold for being Non-NCS Exempt Material. Upon more thorough characterization, the container was determined to contain approximately 22 g U-235. The radiological survey appears to have been impeded by the presence of a significant quantity of shielding material. On August 22, 2013, EN #49292 was updated due to the discovery of a second undetected container that was later found to exceed the 15 g U-235 threshold. This container was essentially empty, containing only 3 g U-235, but soil adhering to its outer surfaces contained approximately 21 g U-235, for a total of 24 g U-235 associated with this item. While the masses involved in these two occurrences were substantially less than a minimum critical mass, they were in excess of the analytical limit of 15 g U-235 and should have been handled as Non-NCS Exempt Material. Subsequent discussions with the applicant indicated that there is no simple correlation between mass and count rate, and that the presence of significant quantities of shielding material can cause the radiological survey to fail to identify such material. Thus, in the presence of significant shielding, the only controls in place were the dual independent visual inspections, which had also failed to identify the containers as non-conforming items.

Following these events, the NRC performed the special inspection 70-36/2013-004, exiting on September 25, 2013 with several potential violations. As part of its corrective actions following the inspection, the licensee revised its procedure for conducting the gamma walkover surveys, HDP-PR-HP-601, Rev. 21, “Remedial Action Support Surveys,” dated October 1, 2013. The procedure specifies that the surveys shall be conducted by two different technicians using two different instruments. The instruments to be used are 2×2 sodium iodide (NaI) detectors set at a threshold of 75 keV in the window out position. The detectors are considered safety-related equipment and must be calibrated so as to account for variation in uranium distribution, particle size, and attenuation due to shielding. The Region III inspectors indicated that the difficulties with the two improperly detected containers appeared to stem from a recent switch to a higher resolution lanthanum-bromide (LaBr) detector instead of the previously used NaI detector. The licensee used the LaBr detector with a narrow window in an effort to discriminate the gamma signature from U-235 from the general background, to obtain a more accurate mass estimation.

However, the use of a narrow energy window apparently allowed the U-235 signature to be masked by the shielding material present. As a result of the inspection findings, the licensee returned to its original technique of using NaI detectors with an open energy window in Revision 21 of procedure HDP-PR-HP-601.

The Region III inspectors examined the licensee's corrective actions and concluded that they appeared adequate to detect a safe mass of uranium (the limit for a Field Container being 350 g U-235). However, the staff noted that the limits for NCS Exempt Material occur at a much lower threshold (a concentration of 0.1 g U-235/l, or no more than 15 g U-235 in any 5-liter volume), and the ability to detect such small quantities is strongly dependent on both the distribution of fissile material and the amount of shielding present. In addition, the utility of an open energy window to detect high-energy gammas is significantly reduced at high enrichments, due to the reduced yield of high-energy gammas primarily from 238U. To address these concerns, and because the license did not prevent the use of alternate methods (e.g., LaBr) that proved ineffectual, the staff recommends imposing the following license condition:

18. The licensee SHALL evaluate the impact of any change to its methods or procedures for performing surveys or visual inspection of buried or exhumed waste and/or contaminated soil, whether *in situ* or *ex situ*, on its ability to comply with the applicable criticality safety mass and concentration limits and associated controls established in a nuclear criticality safety assessment/evaluation or in Condition 14. If, based upon this evaluation, the licensee determines that the change has the potential to increase or decrease the effectiveness or efficiency of the licensee's methods for complying with these limits, then the licensee SHALL provide the NRC a copy of the procedure and the evaluation within 48 hours after its approval.

The requirement to use two different individuals with two different instruments ensures that at least two contingencies must occur before a safe mass can be exceeded. The requirement for two visual inspections is to account for items whose size and shielding may render the gamma scan ineffectual. The calibration requirement is to ensure that the methods used are sufficiently sensitive to provide assurance that all action levels can be complied with. In the event that the licensee chooses to use some other method than that specified in the license condition, the 14 day notification will provide time for the NRC to assess the proposed methods and determine whether additional review and approval is necessary.

5.4 NRC Staff Findings

The staff determined that the excavation and disposal of soil-like material composed in part of sanitary sludge is bounded by the excavation and disposal of contaminated soil under previous NRC approvals (with the addition of proposed License Condition 18 to resolve the observed deficiencies in in-situ characterization). Sanitary sludge containing uranium is less reactive than uranium in an SiO_2 soil matrix, and therefore the controls and limits currently in place will remain valid. With regard to treatment for the removal of VOCs at USEI, the applicant has not provided sufficient details with regard to the chemicals involved or the processes for removing them for the staff to verify assertions that the treatment of waste will not result the in the significant concentration of uranium.

6. PHYSICAL SECURITY

6.1. Assessment

This section of the SER addresses the physical security aspects of WEC's May28, 2013 request. As noted previously, this material is nearly identical to the material proposed for alternate disposal in the May 2009 20.2002 request and approved in Hematite Amendment No. 58. The exception is that this material also includes dewatered sanitary sludge. In Amendment No. 58, the transportation of the materials to USEI and their disposal at USEI were previously assessed in accordance with the physical security requirements of 10 CFR Part 73. Those aspects of the May 28, 2013 requests which have not been previously assessed included the dewatered sanitary sludge being shipped, treated and disposed at USEI and the treatment of the May 28, 2013 and previous 20.2002 alternate disposal wastes at USE for removal of VOCs.

Section 5.1 of Enclosure 1 to WEC's May28, 2013 request states that approximately 0.1 Ci of U-235 in total would be shipped to USEI for disposal. This curie amount equates to approximately 45 Kg of U-235.

The physical security issues associated with Amendment 58 remain relevant,withregard to: (1) rail shipment of waste that may contain SNM of average enrichment less than 10% U-235 to USEI; (2) transferring such SNM from the gondola cars to trucks for transport to the USEI burial cell; and (3) disposal of the SNM in the burial cells. From a physical security standpoint, any assessment needs to consider the concentration and the enrichment of the SNM being shipped to USEI and handled there, the attractiveness of the form of the SNM being disposed, and the ability of an adversary to efficiently and timely segregate such material after disposal.

In License Amendment 58, the average concentration of U-235 estimated to be shipped to USEI was 5.5 pCi/g. For the May 28, 2013 request, the average expected U-235 concentration is expected to be the same as the concentration in Amendment No. 58.. The volume of waste associated with the disposal in Amendment 58 and this §20.2002 request is about the same, about 22,000 m^3.

While some of the SNM going to USEI will be HEU, WEC will not be shipping to USEI any HEU that is in a discrete form. Rather, the HEU will be dispersed throughout the waste material being shipped.

In terms of the attractiveness of the SNM for malicious use and its form, the SER for Hematite Amendment No. 58 bounds the analysis here. In neither case is the SNM in a useful form, because it is mixed with dirt. Thus, the timely and efficient removal of the SNM by an adversary for unauthorized purposes is improbable. The combination of the existing physical security at the USEI site and the effort to identify SNM under such conditions would effectively prevent any opportunities for extracting SNM from its disposal cell.

6.2. NRC Findings

The NRC staff finds that, from a physical security perspective, the physical security section (Chapter 7) of the SER associated with Hematite Amendment No. 58 presents a bounding analysis for the May 28, 2013, request. The elements of that conclusion are presented below as well as the relationship of the present request to the request associated with Amendment 58.

The NRC staff has reviewed the physical security aspects of the May 28, 2013, request. The staff has concluded that there are no physical security concerns associated with the disposal of the Hematite material at the USEI facility. The average U-235 activity levels are low. While SNM will be disposed at USEI, WEC has committed to removing discrete forms of HEU. The SNM will be dispersed throughout the waste material, thereby not lending itself for efficient and timely removal for unauthorized purposes.

7. POTENTIAL FOR RECONCENTRATON

7.1. Assessment

The staff assessed the potential for reconcentration of U-235 in the leachate system at the USEI facility given the half-lives of the SNM and the impact of leachate control system.

In 2008, USEI's permit was modified by the Idaho Department of Environmental Quality (IDEQ) to authorize receipt of specified quantities of SNM, provided that the SNM was made exempt from NRC regulations and licensing requirements. The potential for the generation of leachate is minimized by the site's acceptance requirement that any incoming waste contain no free liquids. Further reducing the potential for leachate generation is the site's location in a desert environment that averages approximately 7.3 inches of precipitation per year with an evaporation rate of approximately 42 inches per year.

The potential to generate leachate is further reduced by the USEI facility's design to completely encapsulate the waste in a low permeability (1 x 10-7 cm/sec) cover system. Requirements for the construction of a waste cell include a base layer of compacted clay three-feet thick overlain by a composite liner with a sump to collect any leachate that might be generated. The composite liner is overlain by a 30-inch soil layer as a protection barrier for the liner. Waste placed in the cell is compacted to minimize the potential for future subsidence and when the cell is full is overlain by a low permeability multi-layer cap 11.8 feet thick that includes nine feet of non-radiological material.

7.2. NRC Findings

As a result of design features such as a low permeability cover, the base layer of compacted clay with a composite liner as an overlay and the compaction of the waste upon burial, the staff has concluded that reconcentration in the leachate system should not be an issue with respect to the disposal of the SNM at USEI.

8. MATERIAL CONTROL AND ACCOUNTING

8.1 Westinghouse Assessment

This section of the SER addresses the material control and accounting (MC&A) aspects of WEC's May 28, 2013, request. The staff conducts such a review due to the general reporting and recordkeeping requirements of subpart B of 10 CFR Part 74, which are applicable to those who possess SNM of 1 g or more of U-235.

WEC Hematite maintains an overall MC&A program in accordance with the NRC-approved Fundamental Nuclear Material Control Plan (FNMCP) per 10 CFR Part 74, Material Control and Accounting of Special Nuclear Material. The FNMCP contains the reporting requirements of 10CFR § Part 74.15 associated with DOE/NRC Form 741, Nuclear Material Transaction Reports, for the WEC Hematite facility.

WEC's May 28, 2013, request is similar to its May 21, 2009, alternate disposal request. The only difference between the two requests is that the May 28, 2013, request includes dewatered sanitary sewage sludge. Other than that, the type of material~~;~~ and the concentration of radionuclides are, for all intents and purposes, identical. The May 21, 2009, request involved soil with an average concentration of U-235 of 5.5 pCi/g. The average U-235 in the dewatered sanitary sludge is expected to be 81 pCi/g.

It was indicated in WEC's submittal that the proposed waste to be disposed of at USEI is diffuse material as defined in Hematite's February 18, 2011, FNMCP. WEC's submittal indicated that it will continue to meet 10 CFR Part 74.15 requirements to document the transfers of 1 gram or more of SNM to the disposal facility through use of DOE/NRC Form 741, and that USEI will report SNM receipts using its existing account with the Nuclear Materials Management and Safeguards System (NMMSS).

8.2 NRC Evaluation and Findings

As noted above WEC will continue to use DOE/NRC Form 741 to document all transfers of 1 gram or more of SNM to NMMSS and USEI will report all SNM receipts, including SNM contained in waste, to NMMSS. Once all of the WEC material is received and disposed of below ground at the USEI facility, USEI may request that its NMMSS account be de-activated, as previously approved. Based upon the above-noted WEC and USEI commitments, the staff has concluded that WEC's alternate disposal request is acceptable with regards to MC&A.

9. LICENSE CHANGES

Approval of WEC's May 28, 2013, request will be effectuated by amending the Hematite License. Amendment No. 63 to the Hematite License includes the following changes to the Hematite License Conditions.

The first change to the Hematite license revises License Condition 15 to list the documents referenced in this SER.

The second change revises License Condition 17 to include the total volume of waste material that WEC is authorized to ship to USEI for disposal there. This includes the 22,809 m^3 of soils and associated debris covered by the approval of WEC's May 2009 alternate disposal request; the 23,000 m^3 of concrete/asphalt, piping, soil and miscellaneous equipment covered by the approval of WEC's January 16, 2012, request; and the 22,000 m^3 covered by this approval of the May 2013 alternate disposal request. Consistent with the criticality safety review, this License Condition also limits the amount of U-235 which may be contained in any one railcar to 700 grams or less.

The third change involves the addition of License Condition 18. License Condition 18 was added to address the August 20, 2013, events which resulted in Westinghouse not identifying greater than 20 grams of U-235 while performing gamma walkover surveys in the burial pit areas of the Hematite site. These events are discussed in more detail in Section 5.3.

Therefore, the revisions to License Conditions 15 and 17 and the addition of License Condition 18 would result in the following license changes:

15. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The NRC's regulations shall govern unless the statements, representations, and procedures in the licensee's application and the following correspondence are more restrictive than the regulations.

    A. Westinghouse HEM-11-96, "Final Supplemental Response to NRC Request for Additional Information on the Hematite Decommissioning Plan and Related Revision to a Pending Licensing Action", July 5, 2011 except for Attachment 18. (ADAMS Accession Nos. ML111880290 and ML111880292)

    B. Documents identified in Chapter 1 of NRC Decommissioning Plan SER ADAMS Accession No. (ML112101630).

    C. Westinghouse HEM-11-56, "*Evaluation of Technetium-99 Under the Process Buildings*", May 5, 2011. (ADAMS Accession No. ML111260624).

D. Documents identified in the NRC's 10 CFR 20.2002 SERs associated with Amendment Nos. 58, 60, and 63. (ADAMS Accession Nos. ML111441087, ML12158A401, and ML13280A368)

E. Westinghouse HEM-12-101, "Special Nuclear Material License Application for the Hematite Decommissioning Project", August 16, 2012. (ADAMS Accession No. ML12233A362)

17. Pursuant to 10 CFR 20.2002, the licensee may dispose of solid materials [consisting of a total of 44,809 m^3 of soils, soil-like material (dewatered sanitary sludge) and associated debris and 23,000 m^3 of concrete/asphalt, piping, soil and miscellaneous equipment] provided the total inventory of Tc-99 based on the average concentration and total mass shipped remains below 1.3 Ci or 2.05 Ci based upon the 95th upper confidence limit as waste at the U.S. Ecology Idaho facility in Grand View, ID. Pursuant to 10 CFR 30.11 and 10 CFR 70.17, this material is exempt from the requirements in 10 CFR 30.3 and 10 CFR 70.3. Any waste material which will be chemically treated at the US Ecology Idaho facility in Grand View Idaho will be shipped in a rail car and total U-235 content per rail car will be limited to 700 grams or less. In addition, Westinghouse will ensure that any chemical treatment which occurs at US Ecology Idaho is limited so that no treated batch contains more than the contents of one railcar.

18. The licensee SHALL evaluate the impact of any change to its methods or procedures for performing surveys or visual inspection of buried or exhumed waste and/or contaminated soil, whether *in situ* or *ex situ*, on its ability to comply with the applicable criticality safety mass and concentration limits and associated controls established in a nuclear criticality safety assessment/evaluation or in Condition 14. If, based upon this evaluation, the licensee determines that the change has the potential to increase or decrease the effectiveness or efficiency of the licensee's methods for complying with these limits, then the licensee SHALL provide the NRC a copy of the procedure and the evaluation within 48 hours after its approval.

10. CONCLUSIONS

On May 28, 2013, WEC requested that the NRC approve alternate disposal, in accordance with 10 CFR §20.2002, of specified low-activity radioactive materials from the HDP. These waste materials total approximately 23,000 m^3 of concrete/asphalt, piping, soil and miscellaneous equipment, and contain low concentrations of source, SNM and byproduct material contaminants. WEC plans to ship these materials by rail to USEI RCRA Subtitle C disposal facility near Grand View, Idaho.

Activities and potential doses associated with transportation, waste handling and disposal have been evaluated in reviewing this 10 CFR §20.2002 application. The staff has determined that WEC has provided an adequate description of the waste to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal.

The staff has determined that WEC's proposed statistical evaluation, sampling plan, QA/QC program, and contingency plans are acceptable, and demonstrate that its proposed disposal will not result in a dose to individual members of the public exceeding a few millirem per year.

Independent review of the post-closure and intruder scenarios using RESRAD estimated that the maximum projected dose per year over a period of 1,000 years is within "a few millirem". A conservative bounding analysis conducted by the staff yielded doses less than the Part 20 annual dose limit of 1.0 mSv/yr (100 mrem/yr) to members of the public. The projected doses to individual USEI workers have been conservatively estimated and demonstrate that the proposed disposal will not result in a dose to members of the public exceeding a few millirem per year.

In addition, because this 10 CFR §20.2002 application involves SNM, nuclear criticality safety, material control and accounting, and physical security assessments were performed.
The staff finds that this proposed action will not significantly impact the annual cumulative dose from all exempted and naturally occurring radioactive material at the USEI disposal facility. This finding is based upon the dose evaluations discussed in Section 3 above.

Further, in accordance with the provisions of 10 CFR §30.11 and 10 CFR §70.17, the NRC may, upon application by an interested person or upon its own initiative, grant such exemptions from the requirements of the regulations in those parts of Title 10, Chapter 1 of the Code of Federal Regulations as it determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest. Based on the above analyses, the staff concludes that: (1) this material authorized for disposal poses no danger to public health and safety; (2) the authorized disposal does not involve activities that could potentially impact the common defense and security of the United States; and (3) it is in the public interest to dispose of wastes in a controlled environment, such as that provided by the US Ecology Idaho facility located in Grand View, ID. Therefore, to the extent that the waste authorized for disposal contains byproduct material and SNM that would otherwise be licensable, the staff concludes that the receipt and possession of this material by USEI is exempt from NRC licensing requirements in 10 CFR §30.3, and §70.3, respectively.

11. REFERENCES

For convenience, the references have been organized according to their WEC, LLC identification number.

HDP-TBD-WM-906. “Characterization Data Summary in Support of Additional USEI Alternate Disposal Request, Revision 0, Westinghouse Electric Company LLC, Hematite Decommissioning Project. January 19, 2012. (ADAMS Accession No. ML12017A188)

HDP-TBD-WM-906. “Characterization Data Summary in Support of Additional USEI Alternate Disposal Request, Revision 1, Westinghouse Electric Company LLC, Hematite Decommissioning Project. July 24, 2012. (ADAMS Accession No. ML12209A201)

HDP-TBD-WM-908. “Safety Assessment for Additional Hematite Project Waste at USEI, Revision 2,” Westinghouse Electric Company LLC, Hematite Decommissioning Project October 17, 2012. (ADAMS Accession No. ML12293A029)

HDP-TBD-WM-909. “Safety Assessment for Additional Hematite Project Waste at USEI, Revision 1”. August 2013, (ADAMS Accession No. ML13310A625)

HEM-09-94. “Decommissioning Plan and Revision to License Application,”. Westinghouse Electric Company LLC, Hematite Decommissioning Project. August 12, 2009. (ADAMS Accession No. ML092330136)

HEM-09-52. “Westinghouse Electric Company, LLC - Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste,”. . Westinghouse Electric Company LLC, Hematite Decommissioning Project, May 21, 2009. (ADAMS Accession No. ML091480071)

HEM-09-94. Hematite Decommissioning Project Report DO-08-005, Rev. 0, “Historical Site Assessment.,” Westinghouse Electric Company LLC, Hematite Decommissioning Project. July 2009. (ADAMS Accession Nos. ML092870417 and ML092870418)

HEM-11-16. “Revised Technical Basis for Characterization of Decommissioning Soils Waste That is Subject to the Alternate Disposal Request for U.S. Ecology Idaho, Inc.” February 18, 2011. (ADAMS Accession No. ML110530155)

HEM-12-2. “Request for Additional Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste at US Ecology Idaho,” Westinghouse Electric Company LLC, Hematite Decommissioning Project, January 16, 2012. (ADAMS Accession Nos. ML12017A188, ML12017A189, ML12017A190)

HEM-12-67. “Partial Response to NRC Requests for Additional Information Dated May 1, 2012 on the January 16, 2012 Hematite 20.2002 Alternate Disposal Request. Westinghouse Electric Company LLC, Hematite Decommissioning Project. June 19, 2012. (ADAMS Accession No. ML121740265)

HEM-12-88. “Final Responses to NRC Requests for Additional Information Dated May 1, 2012 on the January 16, 2012 Hematite 20.2002 Alternate Disposal Request.” Westinghouse Electric Company LLC, Hematite Decommissioning Project. July 24, 2012. (ADAMS Accession Nos. ML12209A200 and ML12209A201)

HEM-12-121. “Further Information for the Final Response Dated July 24, 2012 to NRC Requests for Additional Information Dated May 1, 2012 on the January 16, 2012, Hematite Alternate Disposal Request,” October 17, 2012. (ADAMS Accession No. ML12293A029)

HEM-13-71. “Westinghouse Hematite Decommissioning Project: Request for Third Alternate Disposal Approval and Exemptions for Waste Transferred to US Ecology Idaho”. May 28, 2013. (ADAMS Accession No. ML13149A291)

HEM-13-101. "Westinghouse Hematite Decommissioning Project: Response to N RC Request for Additional Information dated July 10, 2013, on the May 28, 2013, HOP 20.2002 Alternate Disposal Request". August 13, 2013, (ADAMS Accession No. ML13226A385)

HEM-13-127. “Westinghouse Hematite Decommissioning Project: Second Response to NRC Request for Additional Infonnation dated July 10, 2013, on the May 28, 2013, HDP 20.2002 Alternate Disposal Request”. November 5, 2013. (ADAMS Accession No. ML13310A625)

HDP-TBD-WM-901. “Scaling Factors for Radioactive Waste Associated with the Above Slab Portion of the Process Buildings. Westinghouse Electric Company LLC Hematite Decommissioning Project. March 28, 2012. (ADAMS Accession No. ML12090A191)

HEM-09-146. “WEC Response to Request for Additional Information - Alternate Waste Disposal,” Westinghouse Electric Company LLC, Hematite Decommissioning Project, December 29, 2009. (ADAMS Accession No. ML100320540)

HEM-I0-38. “Additional Information for Alternate Waste Disposal Authorization and Exemption,” Westinghouse Electric Company LLC, Hematite Decommissioning Project, March 31, 2010 (ADAMS Accession No. ML100950397)

Nuclear Criticality Safety Associates, NSA-TR-09-08, Rev. 1, “NCSA of the Sub-Surface Structure Decommissioning at the Hematite Site”, November 2011. (ADAMS Accession No. ML12293A029)

Nuclear Criticality Safety Associates, NSA-TR-HDP-11-11, Rev. 1, “Nuclear Criticality Safety Assessment of the US Ecology Idaho (USEI) Site for the Land Fill Disposal of Additional Decommissioning Waste from the Hematite Site”, July 2012. (ADAMS Accession No. ML12209A200)

U. S. Environmental Protection Agency, Federal Guidance Report No. 11, “Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion,” September 1988.

U.S. Nuclear Regulatory Commission, NUREG/CR-6505, Vol. 1, “The Potential for Criticality Following Disposal of Uranium at Low Level Waste Facilities.” June 1997.

U.S. Nuclear Regulatory Commission, NUREG/CR-0782, Volume 4, “Draft Environmental Impact Statement on 10 CFR Part 61 Licensing Requirements for Land Disposal of Radioactive Waste: Appendices G-Q,” September 1981. (ADAMS Accession No. ML052590354)

U.S. Nuclear Regulatory Commission, NUREG/CR-4370, “Update of Part 61 Impacts Analysis Methodology, Vol. 2”. January 1986. (ADAMS Accession No. ML100250917)

U.S. Nuclear Regulatory Commission, Hematite Amendment No.57. “US NRC Safety Evaluation Report Request on Westinghouse Amendment Request for Approval of Hematite Decommissioning Plan and Associated Supporiting Documents”. October 13, 2011 (ADAMS Accession No. ML112101713)

U.S. Nuclear Regulatory Commission, Hematite Amendment No. 58. “US NRC Safety Evaluation Report Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste at US Ecology’s Idaho Facility,” October 27, 2011. (ADAMS Accession No. ML111441087)

U.S. Nuclear Regulatory Commission, Hematite Amendment No. 60. “US NRC Safety Evaluation Report Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste at US Ecology’s Idaho Facility,” April 11, 2013. (ADAMS Accession No. ML12158A384)

U.S. Nuclear Regulatory Commission, “Hematite Amendment No. 58 Transmittal Letter and License,” October 27, 2011. (ADAMS Accession Nos. ML112560105 and ML112560193)

U.S. Nuclear Regulatory Commission, SECY-07-0600, “Basis and Justification for Approval Process for 10 CFR 20.2002 Authorizations and Options for Change,” March 27, 2007. (ADAMS Accession No. ML070220045)

U.S. Nuclear Regulatory Commission, NUREG-1757, Vol. 1, Rev. 2 “Consolidated Decommissioning Guidance: Decommissioning Process for Material Licensees,” September 2006. (ADAMS Accession No. ML070390074)

U.S. Nuclear Regulatory Commission, NUREG-1757, Vol. 2, Rev. 1 “Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria,” September 2006

U.S. Nuclear Regulatory Commission, “D. Richardson Letter Requesting Additional Information on Hematite 20.2002 Alternate Disposal Request,” July 10, 2013. (ADAMS Accession No. ML13183A049)

U.S. Nuclear Regulatory Commission, “NRC Request for Additional Information during 6/21/10 Teleconference between NRC and WEC Regarding Westinghouse Electric Corporation Hematite Project 20.2002 Soil Exemption Request,” Westinghouse Electric Company LLC, Hematite Decommissioning Project, Jun 25, 2010. (ADAMS Accession No. ML110560334)

U.S. Nuclear Regulatory Commission, “Summary of September 4, 2014 Publicly Noticed Call between the NRC and Westinghouse Hematite” October 9, 2013. (ADAMS Accession No. ML13269A235)

U.S. Nuclear Regulatory Commission, “Summary of Octoberr 2, 2014 Publicly Noticed Call between the NRC and Westinghouse Hematite” November 20, 2013. (ADAMS Accession No. ML13317A712)

U.S. Ecology Idaho, “Request for Exemptions under 10 CFR 30.11 and 10 CFR 70.17 for Alternate Disposal of Wastes from Hematite Decommissioning Project under 10 CFR 20.2002,” October 4, 2012. (ADAMS Accession No. ML12313A014)

U.S. Ecology Idaho**, “**Request for Exemptions under 10 CFR 30.11 and 10 CFR 70.17 for Alternate Disposal of Wastes from Hematite Decommissioning Project under 10 CFR 20.2002”. June 5, 2013. (ADAMS Accession No. ML13227A016)

Westinghouse, “November 14, 2013 Email from Kevin Davis Westinghouse Hematite on Average U-235 Concentration in Dewatered Sanitary Sludge Sample,” November 14, 2013. (ADAMS Accession No. ML13322A431)

Westinghouse, “November 19, 2013 Email from Kevin Davis Westinghouse Hematite on Chemical Treatment of Hematite Waste at US Ecology Idaho and Criticality Safety,” November 19, 2013. (ADAMS Accession No. ML13330B678)