Attachment 6

Nuclear Criticality Safety Assessment of the US Ecology Idaho (USEI) Site for the Land Fill Disposal of Decommissioning Waste from the Hematite Site, Rev. 2." NSA-TR-09-14. December 2011

(75 pages)

Nuclear Criticality Safety Assessment of the US Ecology Idaho (USEI) Site for the Land Fill Disposal of Decommissioning Waste from the Hematite Site

Revision 2

December 2011

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NuclearSafety Associates

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Revision History

Rev. #	By	Significant Changes
0	R. S. Maurer	Original issue
1	B. A. Matthews & D. Mann	Document revised to update the following items: • Deletion of TBV1; The finalized water treatment system design report (Ref. 10) is referenced in this revision of the NCSA. • Modified DinD Control 01 to recognize that it is normal for some pooling of water to occur within open excavations during remediation operations. • Modified DinD Controls 02, 03, and 04 to reflect that radiological survey and/or sampling and analysis may be used to determine ^{235}U content, and to relax some of the action limit requirements. • Modified DinD Control 05 and associated DinD Safety Feature 01 to reflect that CDs will only be used for containerization of *non-NCS Exempt Material.* • Adjusted the text throughout the document to reflect the abovementioned changes. • Other minor changes. • Added a discussion to Section 1.5.1 to address screening of bulky objects and/or metallic items at the excavation area, and captured this new operational flexibility in notes to Administrative CSC 06.
2	B. A. Matthews	Document revised to implement minor changes to the wording of controls for clarity.

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Glossary of Acronyms, Abbreviations, and Terms

Acronym/Term	Definition
'	Foot (12")
"	Inch (2.54 cm)
ACM	Asbestos Containing Material
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
AESOP	Work Order Supplement and associated electronic database
Bq	One radioactive disintegration per second
BWCSR	Buried Waste and Contaminated Soil Remediation
cc	Cubic centimeter
CFR	Code of Federal Regulations
Ci	Curie (equivalent to 3.7×10^{10} Bq)
cm	Centimeter
cpm	Counts per minute
CSC	*Criticality Safety Control*
Cut Depth	Maximum permitted thickness of a layer of buried wastes/contaminated soils that is permitted to be exhumed following implementation of in-situ radiological survey and visual inspection procedures and removal of identified *Non-NCS Exempt Material.*
DCGL	Derived Concentration Guideline Levels
D&D	Decontamination and Decommissioning
DinD	Defense-in-Depth
Field Container	Limited volume container used to package *Hot Spots*.
Fissile Material	Material containing fissile nuclides (e.g., ^{235}U).
FSS	Final Status Survey
g	Gram
GAC	Granular Activated Carbon
gallon	3.785 L
gpm	gallons per minute
GUNFC	Gulf United Nuclear Fuels Corporation
HDP	Hematite Decommissioning Project
HEU	Highly Enriched Uranium
HPT	Health Physics Technician
HRGS	High Resolution Gamma Spectrometer
IX	Ion exchange
keV	Kilo Electron Volt
kg	Kilogram
L	Liter
LLW	Low Level Waste
μ	Micro (1.0×10^{-6})
m	Meter

MAA	Material Assay Area - area used to assay *Non-NCS Exempt Material* in order to determine its ^{235}U mass content.
MARSSIM	Multi Agency Radiation Survey and Site Investigation Manual
mg	Milligram
mil	One thousandth
NCS	Nuclear Criticality Safety
NCSA	Nuclear Criticality Safety Assessment
NCS Exempt Material	Material containing an insufficient quantity/concentration of fissile nuclides (e.g., ^{235}U) to require NCS controls/oversight
Non-Conforming Item	An object recovered from an HDP Remediation Area undergoing waste exhumation operations that exhibits certain characteristics. The qualifying characteristics include objects that protrude into material residing beneath the maximum permitted Cut Depth, and/or objects that are inconsistent with the calibration basis of the radiological survey equipment used (e.g., metallic items). In the latter case, an exception to this rule concerns objects that were not identified as containing a Hot Spot, have no hidden interior spaces, and clearly do not have any potential for containing Hot Spots. All Non-Conforming Items recovered from HDP Remediation Areas are classified as Non-NCS Exempt Material until proved otherwise by waste evaluation and/or assay.
Non-NCS Exempt Material	Material that has a fissile nuclide concentration greater than the limit established for NCS Exempt Material, or materials that comprise un-assayed Intact Containers or Non-Conforming Items recovered during HDP Remediation Area waste exhumation operations. These materials are controlled to ensure their safe handling, packaging, processing, and storage.
p	Pico (1.0×10^{-12})
PCE	Perchloroethylene
Survey Area	Clearly delineated area of land subject to in-situ radiological survey, and for which excavation activities are planned.
SNM	Special Nuclear Material - material containing fissile nuclides (e.g., ^{235}U)
SSC	System, Structure, and Component
TCE	Trichloroethene
U	Uranium
UNC	United Nuclear Corporation
vol. %	Percentage by volume
Waste Container	Containers used to hold materials classified as *NCS Exempt Material* following operations in a WEA and/or MAA.
WHA	Waste Holding Area – area used to stage solid wastes generated from site remediation activities that have been categorized as *NCS Exempt Material.*
WEA	Waste Evaluation Area – area used to evaluate *Non-NCS Exempt Material* for fissile nuclide content.
WTS	Water Treatment System

wt. %	Percentage by weight
yd	Yard (36")

1.0 INTRODUCTION

This Nuclear Criticality Safety Assessment (NCSA) is provided to demonstrate that a criticality accident is not credible at the US Ecology Idaho (USEI) site due to the burial of waste received from the Hematite site. The USEI activities include the receipt and burial of waste collected during final decommissioning of the Hematite site whereas the Hematite operations include the exhumation of the waste, limited waste treatment, waste characterization, and shipping preparation.

USEI is currently receiving uranium that is not enriched, whereas the waste shipped from the Hematite plant will involve low and high enriched uranium. Therefore, the purpose of this NCSA is to demonstrate that the risk of a criticality is not credible based on the process conditions at the Hematite site, very low concentrations of uranium in the waste, and the disposal activities at the USEI Site.

This NCSA is organized as follows:

- **Section 1** introduces the waste treatment and shipping preparation activities at the Hematite site as well as the waste receipt and disposal activities at the USEI site. An overview of the specific equipment to be used as well as the activities to be performed is also provided.
- **Section 2** provides the risk assessment of the waste burial operations outlined in Section 1.
- **Section 3** summarizes the important facility design features, equipment and procedural requirements identified in the criticality safety assessment provided in Section 2.
- **Section 4** details the conclusions of the NCSA for burial of Hematite decommissioning waste at the USEI site.

1.1 Description of the Hematite Site

The Westinghouse Hematite site, located near Festus, MO, is a former nuclear fuel cycle facility that is currently undergoing decommissioning. The Hematite site consists of approximately 228 acres, although operations at the site were confined to the "central tract" area which spans approximately 19 acres. The remaining 209 acres, which is not believed to be radiologically contaminated, is predominantly pasture or woodland.

The central tract area is bounded by State Road P to the north, the northeast site creek to the east, the union-pacific railroad tracks to the south, and the site creek/pond to the west. The central tract area currently includes former process buildings, facility administrative buildings, a documented 10CFR20.304 burial area, two evaporation ponds, a site pond, storm drains, sewage lines with a corresponding drain field, and several locations comprising contaminated limestone fill.

1.2 Hematite Site History

Throughout its history, operations at the Hematite facility included the manufacturing of uranium metal and compounds from natural and enriched uranium for use as nuclear fuel. Specifically, operations included the conversion of uranium hexafluoride (UF_6) gas of various ^{235}U enrichments to uranium oxide, uranium carbide, uranium dioxide pellets, and uranium metal. These products were manufactured for use by the federal government and government contractors and by commercial and research reactors approved by the Atomic Energy Commission (AEC). Research and Development was also conducted at the facility, as were uranium scrap recovery processes.

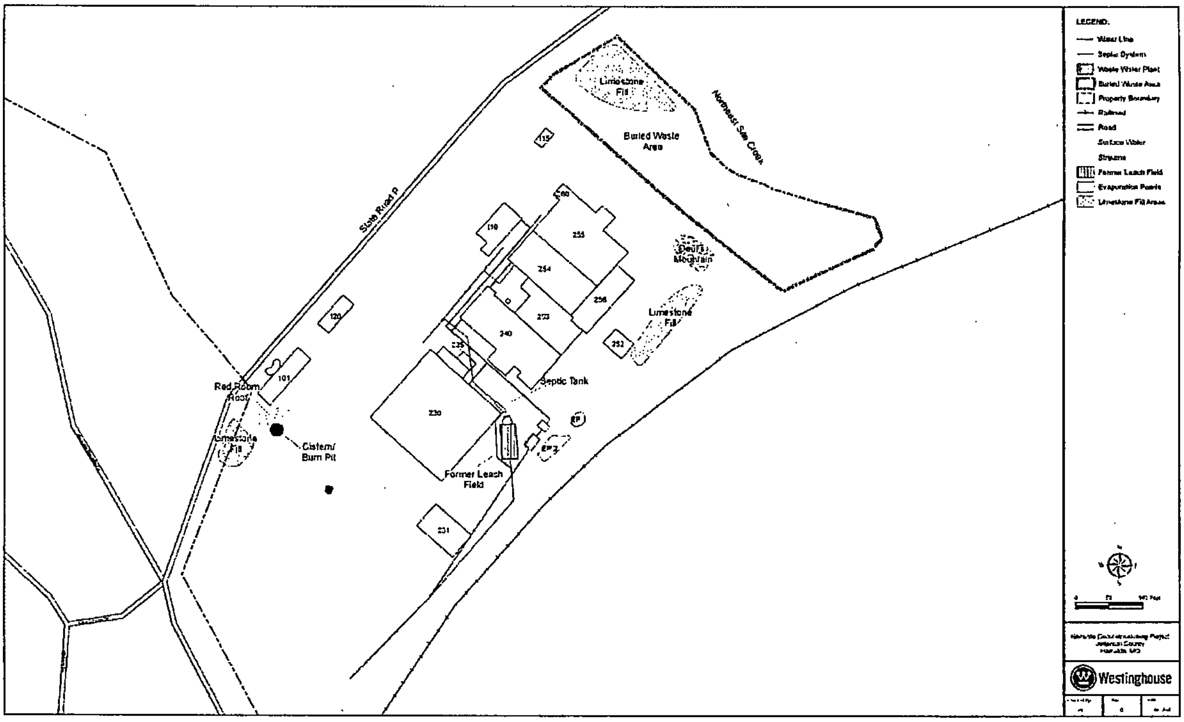
The Hematite facility was used for the manufacture of low-enriched (i.e., ≤ 5.0 wt.% ^{235}U), intermediate-enriched (i.e., >5 wt.% and up to 20 wt.% ^{235}U) and high-enriched (i.e., > 20 wt.% ^{235}U) materials during the period 1956 through 1974. In 1974 production of intermediate and high-enriched material was discontinued and all associated materials and equipment were removed from the facility. From 1974 to cessation of manufacturing operations in 2001, the Hematite facility produced nuclear fuel assemblies for commercial nuclear power plants. In 2001, fuel manufacturing operations were terminated and the facility license was amended to reflect a decommissioning scope. Accountable uranium inventory was removed and Decontamination and Decommissioning (D&D) of equipment and surfaces within the process buildings was undertaken. This effort resulted in the removal of the majority of process piping and equipment from the buildings. At the conclusion of that project phase, the accessible surfaces of the remaining equipment and surfaces of the buildings were sprayed with fixative in preparation for building demolition. More recently, the former process buildings at the Hematite site have undergone demolition, with the majority of the building demolition debris shipped off-site. However, the building slabs remain and will be remediated as part of the pending site-wide remediation operations.

1.3 Historic Operations

Historic operations at the Hematite site resulted in the generation of a large volume of process wastes contaminated with uranium of varying enrichment. Records indicate that as early as 1958, facility process wastes were consigned to unlined burial pits situated in the North East corner of the sites central tract.

1.3.1 Documented Burials

Based on historic documentation (Ref. 2), 40 unlined pits were excavated northeast of the plant buildings and southwest of "Northeast Site Creek" and were used for the disposal of contaminated materials generated by fuel fabrication processes at Hematite between 1965 and 1970. The documented burial area perimeter is outlined in Figure 1-1. Based on best available information, it is believed that the burial pits are nominally 20' × 40' and 12' deep.



Source: Ref. 2

Figure 1-1 Documented Burial Pit Area

Consignment of waste to the burial pits was reported to be in compliance with AEC regulation 10 CFR 20.304 (1964; Ref. 3). Facility operating procedures (Ref. 4) described the size and spacing requirement for the burial pits, in addition to the required thickness of the overlying soil cover (4'), and the quantity of radioactive material that could be buried in each pit. The procedures in place at the time of operation of the burial pits required that buried waste be covered with approximately 4' of soil following completion of pit filling operations. However, it is possible that the soil cover thickness may have been modified over time as the area where the burial pits are located was re-graded on several occasions.

United Nuclear Corporation (UNC) and Gulf United Nuclear Fuels Corporation (GUNFC) maintained detailed logs of burials for the period of July of 1965 through November of 1970. The Burial Pit log books (Ref. 5) contain approximately 15,000 data entries listing the date of burial, pit number, a description of the particular waste consignment, the uranium mass associated with the subject waste, and miscellaneous logging codes. Some logbook entries also list percent enrichment for the uranium. On-site burial of radioactive material ceased in November 1970.

The information recorded in the Burial Pit log books indicates that the waste consignments comprised a wide variety of waste types. This is further supported by interviews with past employees (Ref. 6). A schedule of the types of waste materials that may be present in the Burial Pits is provided in Table 1-1. The primary waste types expected to be encountered are trash, empty bottles, floor tile, rags, drums, bottles, glass wool, lab glassware, acid insolubles, and filters. Buried chemical wastes include hydrochloric acid, hydrofluoric acid, potassium hydroxide, trichloroethene (TCE), perchloroethylene (PCE), alcohols, oils, and waste water.

Table 1-1 Buried Waste Characteristics

Process Metals and Metal Wastes	
• High enriched uranium (93-98%) • Depleted and natural uranium • Beryllia UO_2 • Beryllium plates • Uranium-aluminum • Uranium-zirconium • Thorium UO_2	• UO_2 samarium oxide • UO_2 gadolinium • Molybdenum • Uranium dicarbide • Cuno filter scrap that included beryllium oxide • Niobium pentachloride
Chemical Wastes	
• Chlorinated solvents, cleaners and residues (perchloroethylene, trichloroethylene) • Acids and acid residues • Potassium hydroxide (KOH) insoluables • Ammonium nitrate • Oxidyne • Ethylene glycol	• Ammonium bichloride • Sulfuric acid • Uranyl sulfate • Acetone • Methyl-alcohol • Chlorafine • Pickling solution • Liquid organics
Other Wastes	
• Tiles from Red Room floor • Process equipment waste oils • Oily rags • TCE/PCE rags • Used sample bottles • Green salt (UF_4) • Calcium metal	• Contaminated limestone • UO_2 THO_2 Paper Towels • Pentachloride from vaporizer • Used Magnorite • $NbCl_5$ vaporizer Cleanout • Item 51 Poison equipment • Asbestos and Asbestos Containing Material (ACM)

Source: Adapted from Ref. 2

The recorded total uranium mass associated with the waste consignments range from 178 g^{235}U to 802 g^{235}U per burial pit with a maximum amount associated with any single waste consignment (i.e., burial item) of 44 g^{235}U (Ref. 5). The uranium enrichment of waste items consigned to the burial pits ranged from 1.65 wt. % to 97.0 wt. % ^{235}U/U. According to the Burial Pit log books, the five most frequent waste consignments comprised:

- Acid insolubles (2,050 entries);
- Glass wool (2,080 entries);

- Gloves and liners (900 entries);
- Red Room trash (570 entries); and
- Lab trash (515 entries).

The waste consignments representing the highest recorded ^{235}U content included:

- Wood filters (4 entries ranging from 22 to 44 g^{235}U);
- Metal shavings (one entry at 41 g^{235}U);
- Leco crucibles (4 entries ranging from 29-31.6 g^{235}U); and
- Reactor tray (one entry at 40.4 g^{235}U).

Historic consignment of contaminated materials to the burial pits was conducted under a controlled program requiring documentation of each waste consignment. Contaminant controls at the time of disposal (e.g., containerization, bagging, etc.) in conjunction with the documented low surface contamination levels minimize the potential for significant migration of any radiological contaminants by ground water. There were no documented fissile liquid waste consignments (e.g., uranyl nitrate, etc.), possibly due to the inherent risk of contaminating ground water that could migrate offsite.

Quarterly sampling data (see, for example, ^{235}U data excerpted in Appendix B) from wells both within the burial pit area and around the site periphery consistently indicates minimal fissile contaminant presence in the ground water. The quarterly well samples show little to no ^{235}U presence, with results indicating a few pCi/L. The worst-case contamination was noted in some of the leachate for the pits where up to 340 pCi/L ^{235}U (~0.157 mg/L*) was noted (Ref. 10). The following data excerpted from Reference 10 (compiled from water sampling data) provides the basis for the waste water treatment system design.

Table 1-2: Burial Pit Leachate Uranium Data

Radioisotope	Min.	Max.	Units
Uranium 233/234	24	7,900	pCi/L
Uranium 235	1	340	pCi/L
Uranium 238	24	449	pCi/L

Source: Adapted from Ref. 10

* Conversion of pCi to mg:

Specific activity of $^{235}U = 2.16107 \times 10^{-6}$ Ci/g,

$$\frac{3.40 \times 10^{-10}\, Ci/L}{2.16107 \times 10^{-6}\, Ci/g} = 0.15733\ mg/L$$

1.3.2 Undocumented Burials

It is assumed (Ref. 2) that additional, undocumented, burial pits may exist within the area between the former process buildings and the documented burial pit area. Based on interviews with former site employees (Ref. 6), it is possible that on-site burials other than burials conducted under 10CFR20.304 (1964; Ref. 3) may have occurred as early as 1958 or 1959. Specifically, three or four burials may have been performed each year prior to 1965 for disposal of general trash and items that were lightly contaminated by then current radiological free release standards (Ref. 8). Based on this information, it is estimated that a total of 20-25 burial pits may exist for which there are no records. Waste consignments to these burial pits (i.e., prior to 1965) were not documented (logged) as they were not considered to contain significant quantities of SNM (Ref. 7). No specific information has been found to indicate the explicit nature of the waste consignments associated with these undocumented burials.

1.4 Current State

The burial pits are currently in a quiescent state, although the pits may have been subjected to disturbances in the past, including characterization sampling initiatives (Ref. 10). The results of sampling activities indicate a maximum ^{235}U concentration of 53.5 pCi/g, corresponding to a ^{235}U concentration of approximately 2.5 µg/g(waste matrix). Based on this sample data and the original burial logs, the burial pits are believed to contain only small quantities of ^{235}U (i.e., less than 1 kg^{235}U per burial pit). The findings of more recent (May 2008) extensive site sampling initiatives further support this expectation (refer to Section 1.2.2 of Ref. 19 for further details).

1.5 Waste Material for burial at USEI

Waste shipped from the Hematite site may include the following low level sources:

1. Exhumed burial waste from the Hematite burial pits and contaminated soils and backfill material associated with the Hematite burial pits and other remediation areas at the Hematite site; and
2. Solids recovered from the Water Treatment System (i.e., used filter media, IX beds, solids in the holding tanks, etc.).

The process for extracting each of these wastes is discussed in the following sub-sections.

1.5.1 Burial waste and contaminated soil

Unless exempted by an NCSA, prior to removal of soil/waste from a remediation area of the Hematite site, comprehensive in-situ radiological survey and visual inspection of a clearly defined survey area (i.e., the area to be exhumed) is undertaken to identify *Non-NCS Exempt Material*.

The in-situ radiological survey will typically use NaI scintillator probes to provide gamma ray measurements of the surface area of interest. The survey technique that may be routinely performed is the Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM) protocol which involves walking straight parallel lines over an area while moving the detector in a serpentine motion, 2 inches to 4 inches above the surface. Employing the MARSSIM protocol provides a high degree of assurance that all areas will be properly characterized prior to exhumation. Other in-situ radiological survey equipment and survey techniques may be employed provided that they meet procedural requirements. Other radiological survey equipment may include, but is not limited to, the use of High Resolution Gamma Spectrometers (HRGS). Examples of other survey techniques may include, but is not limited to, the use of motorized equipment.

The objective of the in-situ radiological surveys is to identify *Hot Spots*. From an NCS perspective, *Hot Spots* are defined as a distinct in-situ location where detector radiation measurements indicate the presence of an elevated quantity of ^{235}U (whether one object, a group of objects, or a cluster of material) when compared to the quantity of ^{235}U in the surrounding area. Any item or region of soil/waste with an average fissile nuclide concentration exceeding 0.1 $g^{235}U/L$ is defined as a *Hot Spot*. The 0.1 $g^{235}U/L$ threshold provides a high degree of assurance that any items with elevated (i.e., non-trivial) levels of ^{235}U contamination would be identified. The in-situ radiological surveys are complemented by visual inspection of the survey area with the aim of identifying:

1) Items that resemble *Intact Containers*;
2) *Non-Conforming Items* (i.e., any items with the potential to contain *fissile material* (e.g., a process filter); bulky objects with linear dimensions exceeding the permitted *cut depth*; and thick metallic items*.

Hot Spots, *Intact Containers* and *Non-Conforming Items* are designated as *Non-NCS Exempt Materials* and must be identified and removed from any HDP Remediation Area undergoing remediation prior to the exhumation of *NCS Exempt Materials*.

Items that resemble *Intact Containers* are designated as *Non-NCS Exempt Materials* because they could potentially contain materials that are inconsistent with the calibration basis of the instruments used for the in-situ radiological surveys, or their dimensions may preclude effective in-situ radiological survey of their content. This is especially important in the event that large containers are encountered (e.g., 55-gallon drums, etc.) because of their large linear dimensions and the possibility that their content could comprise dense and/or high atomic number material (e.g., items or fragments constructed of steel), which could provide more attenuation than accounted for in the in-situ radiological survey equipment calibration basis.

Non-Conforming Items include bulky objects with significant linear dimensions, and metallic items or other dense materials that could provide significant photon attenuation. All *Non-Conforming Items* are designated as *Non-NCS Exempt Materials* for the same reasons discussed above for items that resemble *Intact Containers*.

* The concern with metallic items is that their properties may not be consistent with the calibration basis of the in-situ radiological survey equipment. For example, their high atomic number and/or density could provide more photon attenuation than accounted for in the calibration basis of the in-situ radiological survey equipment.

Any *Non-NCS Exempt Materials* identified from the results of the radiological survey and visual inspection are carefully removed, and will not be shipped to USEI unless distributed within low concentration material to reduce the average concentration of the bulk waste materials to no greater than 0.1 $g^{235}U/L$, or if more detailed characterization later confirms that the *Non-NCS Exempt Materials* actually qualify as *NCS Exempt Material* on the basis of low average ^{235}U concentration or low ^{235}U mass content (specifically, a total mass content not exceeding 15 $g^{235}U$ for items packaged in a container with a volume of atleast 5 liters). A second independent radiological survey/assay measurement will also be performed to provide an additional safety barrier to ensure that the *NCS Exempt Materials* consigned to the USEI site do not comprise an average concentration greater than 0.1 $g^{235}U/L$.

Once Non-NCS Exempt Materials have been removed from a surveyed area, the remaining portion(s) of the surveyed area, to a depth not exceeding the maximum permitted *cut depth* represents material not of interest from a NCS perspective. These *NCS Exempt Materials* are exhumed and transferred to a suitable material stockpile in a WHA* and will be eventually be shipped to the USEI site.

1.5.2 Solids Recovered from the Water Treatment System

During excavation and recovery of contaminated solid wastes from the burial pits a considerable amount of water is expected to intrude into the open excavations, including ground water seepage and rainwater. This water will be evacuated from the excavations to allow recovery of the buried wastes. Water removed during this process will be treated to remove entrained and soluble contaminants prior to release to the site water outfall.

Water will be generated from the following sources:

- Ground water associated with buried waste (leachate);
- Ground water that may seep into the excavation from surrounding soil;
- Precipitation that falls directly into an excavation; and
- Precipitation that falls onto waste and adjacent outside waste-processing areas.

Treatment of the water collected from, in, and around the burial pit excavations involves a number of collection and treatment stages:

- Collection of leachate, ground, and storm water from an excavation or draw-down cavity;
- Settling of course solids in holding tanks;
- Filtration and volatiles adsorption; and
- Filtration and ion exchange polishing.

* An overview of WHA operations is not provided in this NCSA because operations in WHAs are not subject to NCS controls or oversight. WHAs are used to stage and accumulate exhumed wastes and impacted soils in preparation for waste consolidation and shipment from the site in large gondola rail cars.

These treatment processes result in the following solid wastes that must be removed: sediments in the tanks, filter bags, filter media, and treatment media. The collection of these waste materials is discussed below.

1.5.2.1 Collection of Sediments from Tanks

A drum vacuum will be used to remove wet sediments from the bottom of the WTS Holding tanks. As operationally necessary, the water in a tank to be cleaned will first be emptied using a portable sump pump. The sediments will be radiologically surveyed and/or sampled and analyzed for fissile contamination before removal from the holding tank and at least once a month during tank operations. If the radiological survey and/or sample assay results indicate that the subject solids contain an average concentration exceeding 0.1 $g^{235}U/L$ then the subject solids are designated as *non-NCS Exempt Material* and must be recovered* directly into Collared Drums (CDs) pre-loaded with absorbent material (e.g., an immobilizing compound) to soak up any residual water associated with the sediments. Each loaded drum will be lidded, transferred to a WEA/MAA, and subject to a primary evaluation/assay measurement and a secondary independent evaluation/assay measurement, both of which will be independently verified to determine radiological content. In order to be shipped to the USEI site for burial, the evaluation/assay results must demonstrate that the content of the drum(s) does not comprise greater than 0.1 $g^{235}U/L$. In the event that the drum content is established to meet *NCS Exempt Material* criteria at the Hematite site, the materials will be aggregated with other bulk waste streams.

1.5.2.2 Filtration and Treatment Media Change-Outs

Periodically, the filtration and treatment media, such as Granular Activated Carbon (GAC) and Ion Exchange (IX) media, will require removal and replacement. The following sub-sections discuss the handling activities for these solid waste materials.

1.5.2.2.1 Filter Bags

The polypropylene filter bags (or similar material) will likely require frequent replacement (need for replacement is determined by measurement of the head pressure required to pump water through the filter). Prior to the replacement of a bag filter, its enclosure/vessel pair is radiologically surveyed. If the survey results indicate that the subject bag filter contains an average concentration exceeding 0.1 $g^{235}U/L$ then the bag filter is designated as *non-NCS Exempt Material* and must be directly loaded into an awaiting CD that is pre-loaded with absorbent material, as necessary, to soak up any residual water associated with the filter media. The loaded CD is then transferred to a WEA/MAA, and subject to a primary evaluation/assay measurement and a secondary independent evaluation/assay measurement, both of which will be independently verified to determine radiological content. In order to be shipped to USEI for burial, the evaluation/assay results must demonstrate the filter(s) do not contain an average ^{235}U concentration greater than 0.1 $g^{235}U/L$. In the event that the filter is established to meet *NCS Exempt Material* criteria at the Hematite site, the filter media will be aggregated

* The sediment recovery process will be achieved by opening the access hatches to the tank and guiding the vacuum suction hose intake to recover the designated *non-NCS Exempt Material.*

with other bulk waste streams.

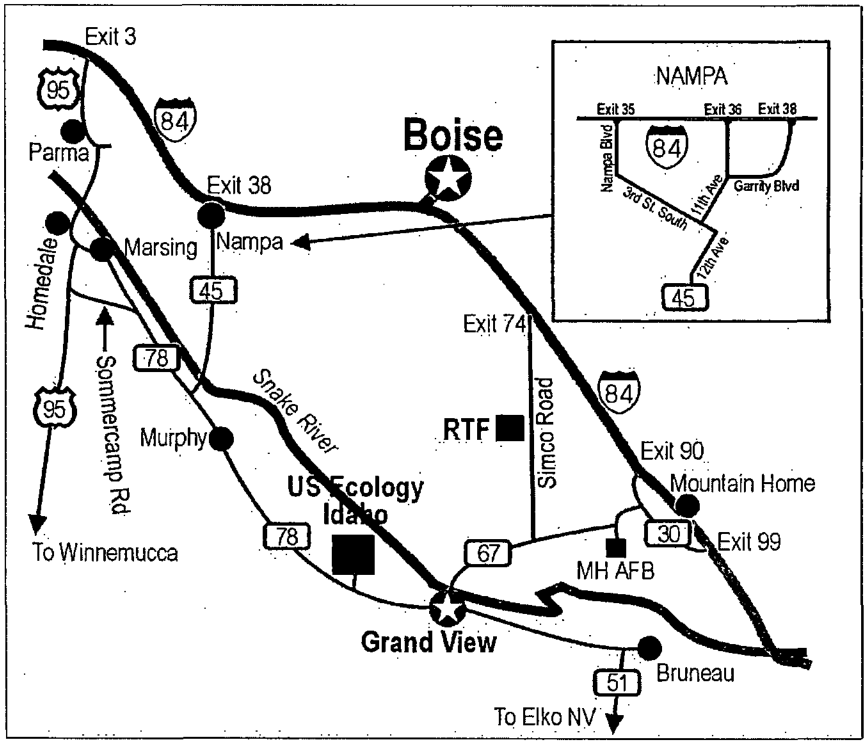
1.5.2.2.2 Treatment Media

The treatment beds (GAC and IX) will require periodic changing (need for changing is determined by measurement of the head pressure required to pump water through the respective treatment vessel). Unlike the bag filters, the GAC units will be backwashed to break up the carbon bed and remove entrained solids that are plugging or blinding the carbon bed. Treated effluent water from a tank will be used as backwash water. Water will be pumped from the tank backwards (up) through the GAC vessel being backwashed. The system is designed so that one set of two (2) GAC absorbers can be taken off-line for servicing or backwashing while the system runs at capacity (50 gpm) with only the second set of two (2) GAC units on-line. Backwash water from the GAC vessel being backwashed flows under pressure back to the inlet of storage tank T-3 for removal of suspended solids from the backwash water.

Prior to any replacement of the GAC media, the GAC vessel is valved out of service and the treatment media blown down with a portable air compressor, as necessary, to effectively dry the media. Samples of the media are extracted via the access ports on the media vessel and analyzed for fissile contamination at least once a week during operation to further ensure no significant *fissile material* concentration accumulates. However, it is noted that radiological survey of the vessels may be performed in lieu of sampling and analysis provided that it is performed with at least the same frequency. In the event that the radiological survey and/or sample assay results indicate that the solids to be removed contain an average concentration exceeding 0.1 $g^{235}U/L$, then the subject solids are designated as *non-NCS Exempt Material* and must be recovered directly into CDs pre-loaded with absorbent material, as necessary, to soak up any residual water associated with the solids. The loaded CDs are then transferred to a WEA/MAA, and subject to a primary evaluation/assay measurement and a secondary independent evaluation/assay measurement, both of which will be independently verified to determine radiological content. In order to be shipped to USEI for burial, the evaluation/assay results must demonstrate the drum(s) do not contain an average ^{235}U concentration greater than 0.1 $g^{235}U/L$. In the event that the drum content is established to meet *NCS Exempt Material* criteria at the Hematite site, the drum content will be aggregated with other bulk waste streams

1.6 USEI Site Description

US Ecology Idaho (USEI), Inc., owns and operates a hazardous waste treatment, storage, and disposal facility located approximately 10.5 miles west of Grand View, Idaho. (See Figure 1-2.) The USEI facility lies far from population centers in an arid climate with low annual rainfall and a high evaporation rate. The 160-acre site in Owyhee County is located on more than 1,000 contiguous acres of land owned by USEI. These factors, in combination with thick sub-surface layers of highly impermeable silts, clays, and sediments, make the site ideally suited for the secure treatment and disposal of hazardous and industrial wastes. USEI manages hazardous waste under a Resource Conservation and Recovery Act (RCRA) Part B Operating Permit (IDD073114654) issued on November 12, 2004 by the State of Idaho.

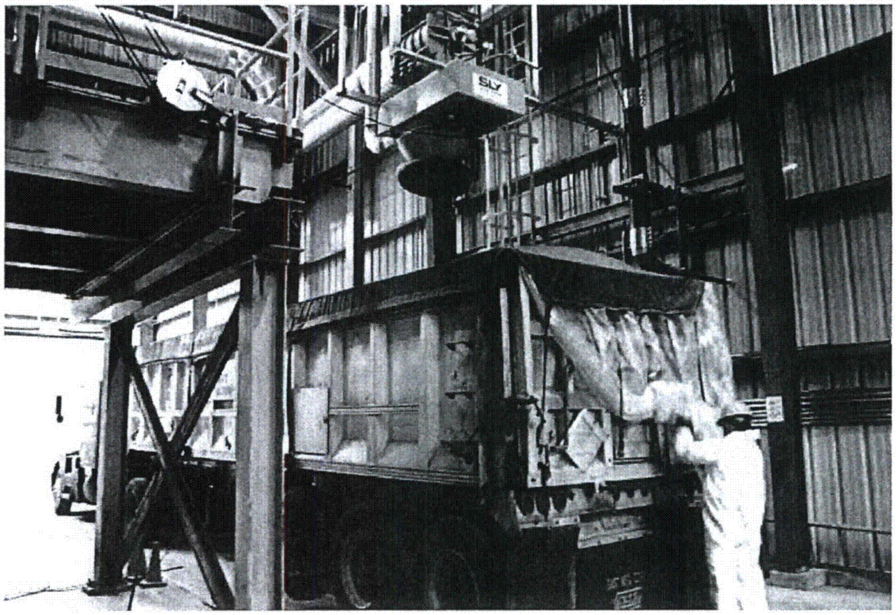


Source: Ref. 21

Figure 1-2 USEI Location Map

The USEI facility received a state permit to accept an expanded range of low-activity radioactive materials in 2001, and the permit has been amended several times since then. The facility's state RCRA Part B Operating Permit was renewed for a 10-year period in 2004. USEI is fully permitted to manage RCRA, Toxic Substances Control Act (TSCA), and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) wastes, and NRC-exempted radioactive waste. The facility provides waste management services including chemical stabilization of organic and inorganic solids, sludges and liquids, along with landfill disposal, aqueous evaporation treatment, debris treatment, and PCB management and disposal.

USEI offers rail transportation service to the facility from all points in the continental United States (refer to Figures 1-3 and 1-4). Nearly 2,000,000 tons of wastes have been received at the Rail Transfer Facility in the last three years, demonstrating an ability to handle large environmental remediation projects.



Source: Ref. 21

Figure 1-3 USEI Rail Transfer Facility Interior

Source: Ref. 21

Figure 1-4 USEI Rail Transfer Facility Exterior

1.7 USEI Site History

The USEI site was originally constructed as a U.S. Air Force Titan 1 Missile Complex and eventually decommissioned by the U.S. Air Force in 1965. In 1973, the State of Idaho permitted Western Containment, Inc. (Wes-Con) to dispose industrial waste at the site. Wes-Con received and disposed industrial and PCB wastes in trenches and in portions of the abandoned Titan Missile silos. In 1980, Wes-Con submitted a Part A notification under the Resource Conservation and Recovery Act (RCRA) for hazardous waste disposal. Envirosafe Services of Idaho, Inc. (ESII) purchased the site in 1981 and was granted RCRA interim status the same year. ESII obtained a RCRA Part B Operating Permit on December 15, 1988, and a TSCA Storage and Disposal Permit on November 29, 1991. The facility was purchased by American Ecology Corporation in January 2001, and renamed US Ecology Idaho, Inc. in May 2001.

The history of construction at the USEI site is summarized below:

- 1984: The first double-lined landfill cell constructed.
- 1988: Outdoor Stabilization Facility constructed.
- 1990: Phase I of the second double-lined cell (Cell 14) constructed.
- 1993: Phase II of Cell 14 completed.
- 1994: Debris Handling Facility completed.
- 1998: New Containment Building housing the stabilization units completed.
- October 2003: USEI's newest landfill, Cell 15, completed and disposal operations commenced.
- 2005: Cell 15 Phase II expansion completed.
- 2007: Cell 15 Phase III expansion completed.

1.8 Facility Description

1.8.1 Geography

The USEI facility is located off Highway 78 approximately 10.5 miles west of the town of Grand View, in Owyhee County, Idaho. Grand View has a population of 350. The nearest residence is 1 mile southwest of the site.

The site is situated on a one-mile wide plateau that slopes from south to north. Maximum surface relief on the facility is 90 feet and the mean surface elevation is 2600 feet above sea level. The site is located in a desert environment with an average rainfall of 7.26 inches per year and an average evaporation rate in excess of 42 inches per year.

Castle Creek, the nearest surface water, is an intermittent creek located one-half mile west of the site that lies topographically 150 feet below the facility. The Snake River, the largest surface water source near the site, lies approximately 2½ miles north and 350 feet in elevation below the facility. EPA site evaluations indicate little possibility of site flooding due to a number of factors, primarily low rainfall, high evaporation, and location of the facility outside the 100-year flood plain.

The facility is located within seismic zone 2 and therefore does not require a seismic standard demonstration under 40 CFR Part 264 Appendix IV.

Currently, USEI has eighteen (18) Piezometers and thirty-nine (39) monitoring wells screened within two aquifers below the site. In accordance with USEI Part B R and TSCA permits, pH, specific conductivity, and a custom list of 28 VOCs are sampled semi-annually. Sampling for PCB analysis is performed each year. Groundwater sampling is performed in accordance with the requirements of USEI's current operating permit. Analysis is completed by a certified contract laboratory. The results of the semi-annual groundwater sampling and analysis activities are submitted to IDEQ semi-annually, in accordance with the requirements of USEI's RCRA Part B Permit, and to U.S. EPA Region 10 each year, in accordance with the requirements of USEI's TSCA permit.

Runoff due to rain is managed through an engineered drainage collection and containment system. The system directs runoff from the interior of the site into one of three on-site RCRA Surface Impoundments. A run-on diversion system prevents run-on from entering the facility.

Site drainage and run-off controls are designed to contain and control run-off from a 25-year, 24-hour storm (1.75 inches of precipitation). Active waste disposal, storage, and treatment operations are segregated from uncontaminated areas by a series of diversion berms and channels. The control system consists of drainage swales, engineered grades, drainage conduits, flumes, riprap, and surface impoundments.

A system of interceptor channels collects and conveys run-off from the active waste handling areas to the rain water Surface Impoundments/Collection Ponds. Runoff from clean areas to the active area is prevented by a series of dikes and channels around active units. Run-off may be transferred from Collection Ponds 1, 2, and 3 and routed to the Evaporation Pond for solar evaporation.

Runoff from the active areas of Cells 5, 14 and 15 are collected within the unit and transferred to storage tanks and treated as multi-source leachate. Once the leachate has been treated to below Land Disposal Restrictions (LDRs) leachate is routed to the primary Evaporation Pond (also a RCRA Surface Impoundment) for solar evaporation.

1.8.2 Landfill Cells

Two RCRA/TSCA landfills are actively used to dispose of containerized solids, bulk solids, and electrical equipment (i.e., small capacitors, transformer carcasses, etc.).

Construction of Cell 15 was initiated on March 1, 2003 and the cell was in operation by October 2003. Phase I of Cell 15 provided about 1,000,000 cubic yards of cell space. When all phases are complete Cell 15 is designed to contain over 3.6 million cubic yards of material (refer to Figure 1-5). Second phase construction was completed in 2005, and third phase construction was completed in 2007.

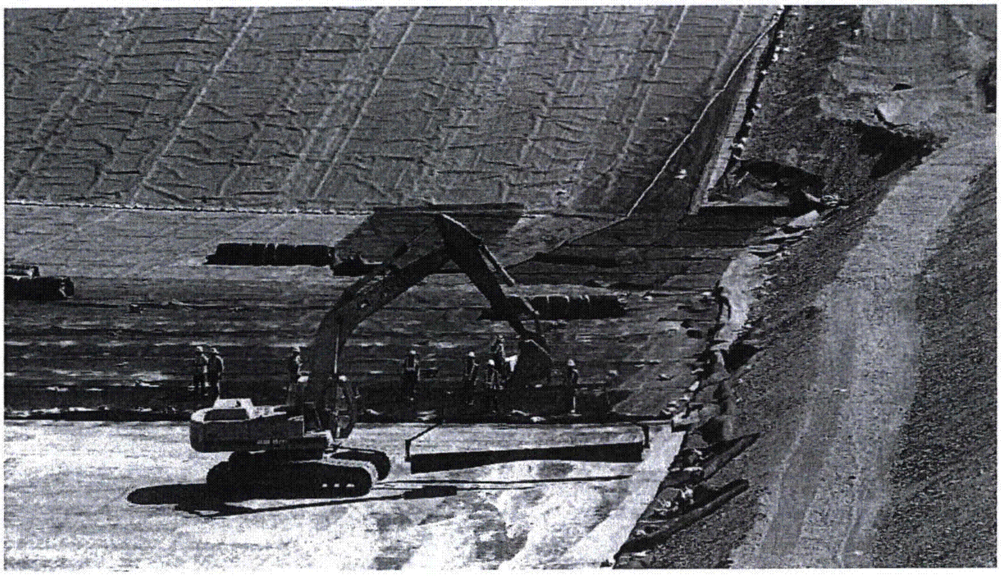
Source: Ref. 21

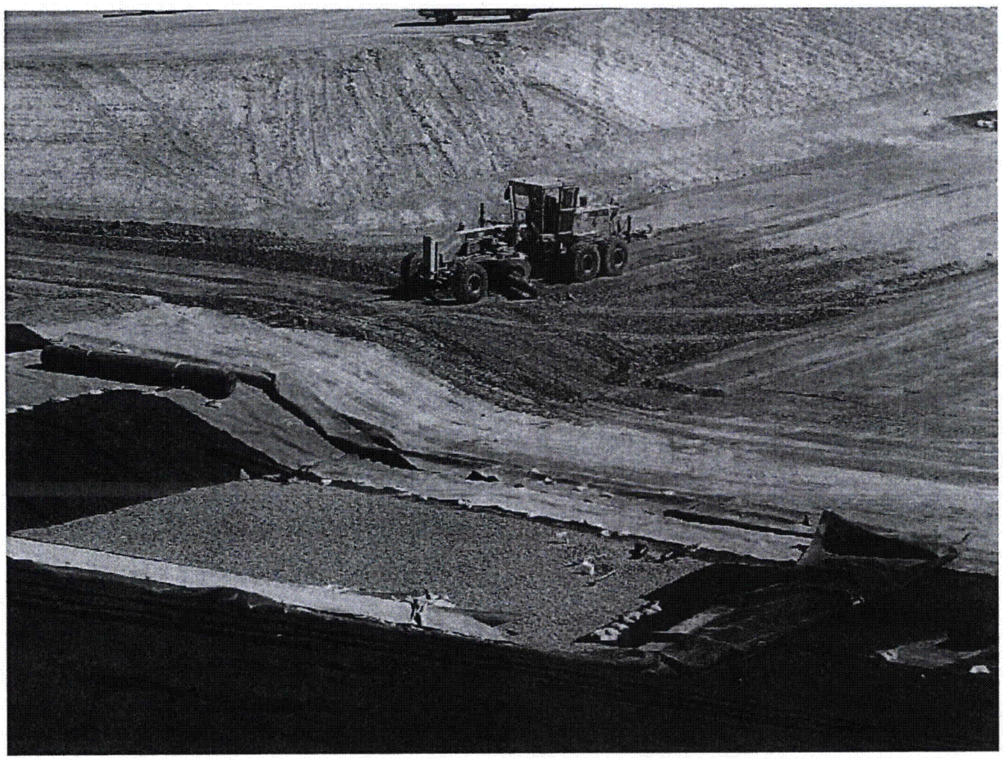
Figure 1-5 First Load of Waste in Cell 15

1.8.2.1 Landfill Cell Liner System

USEI's landfill liner system for cells 14 and 15 consists of a dual composite liner with a leak detection system overlying the primary liner. See Figure 1-6 for a schematic depiction. The liner system was constructed from bottom to top as indicated:

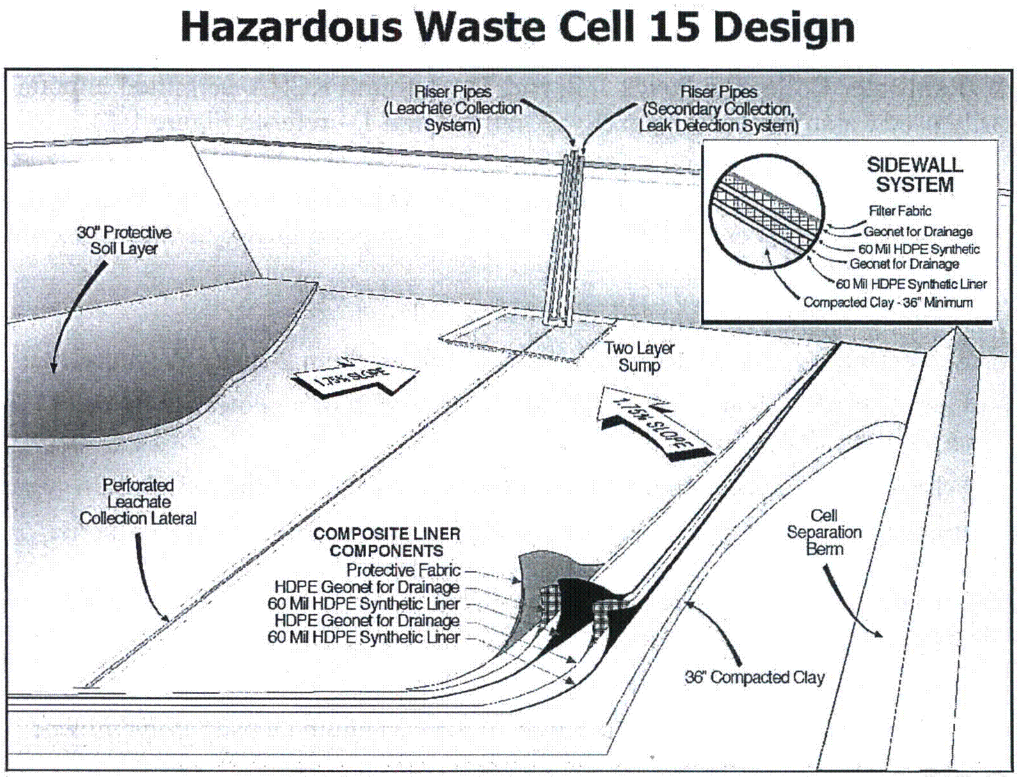
- Subgrade: In-situ compacted silty, sandy soil.
- Secondary Soil Liner: Minimum 36-inches of recompacted clay with a permeability of less than 1×10^{-7} cm/sec.
- Secondary Flexible Membrane Liner: 60 or 80-mil high density polyethylene.
- Leak Detection Zone: Composite layer consisting of a synthetic drainage net, geotextile fabric, 12-inches of stone, and a secondary geotextile fabric.
- Primary Flexible Membrane Liner: 60 or 80-mil high density polyethylene.
- Primary Leachate Collection Zone: Composite layer consisting of a synthetic drainage net, geotextile fabric, 12-inches of sand, and a second geotextile fabric.
- Protective Layer: 12-inches of compacted soil.





Source: Ref. 21

Figure 1-6 Cell 15 Liner Installation



Source: Ref. 21

Figure 1-7 Schematic of Cell 15 Design

1.8.2.2 Leachate Collection, Inspection and Treatment

The leachate collection system drains and traps moisture and liquids percolating through the landfill. The leachate collection system is protected from clogging by a geotextile filter and protected from physical disturbance by 6-inches of soil. Cells are graded so that liquids drain towards the leachate collection system. The sumps are pumped according to a Leachate Management Schedule outlined in USEI's operating permits.

Leachate levels are checked weekly in the primary leachate systems and daily in the secondary leak detection collection and removal system. Both sumps are checked in the event the facility receives more than ½ inch of rainfall in a 24-hour period. Leachate is pumped and removed in accordance with action levels established in the Part B Permit. Records are maintained for each pumping event. Pumping records indicate leachate levels before and after pumping, the volume pumped, and the on-site dispensation of the leachate.

The leachate is managed in accordance with 40 CFR Part 268.7, using a carbon absorption system. The treated leachate is stored until the required testing is completed. Upon passing the required parameters, the leachate is disposed in the solar evaporation pond.

1.8.3 Surface Impoundments

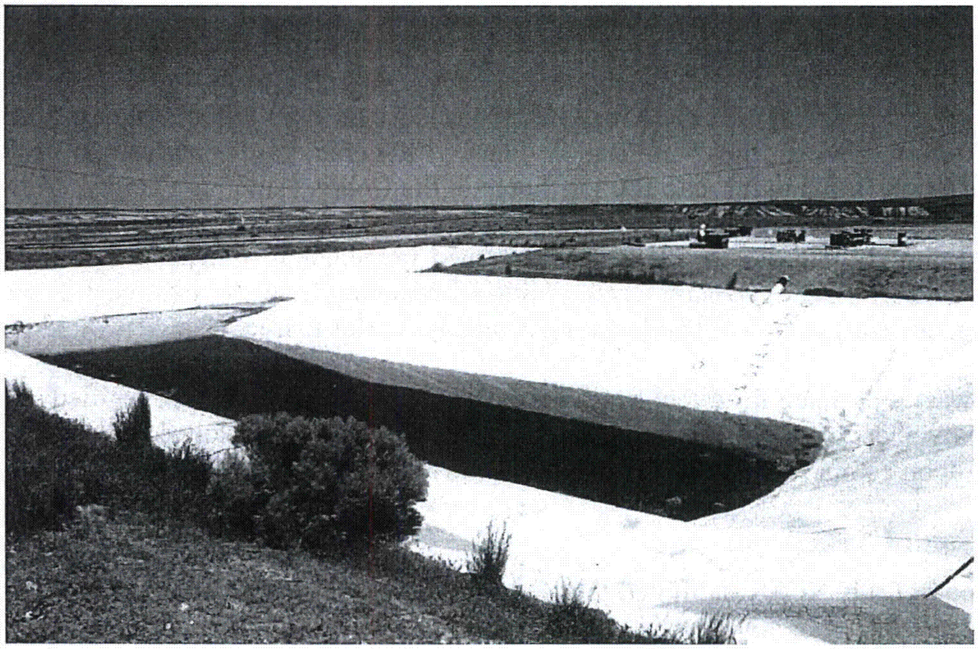
USEI has three RCRA-permitted surface impoundments for the collection of storm water runoff (Rainwater Collection Ponds 1, 2, and 3). A fourth RCRA-permitted impoundment is primarily used for solar evaporation (Evaporation Pond 1 – refer to Figure 1-8).

USEI's Surface Impoundments are constructed with dual synthetic liner systems and associated leak detection capabilities. The Storm-water pond liner systems are constructed as indicated from bottom to top:

- Subgrade: In-situ compacted silty, sandy soil.
- Secondary Flexible Membrane Liner: 40-mil Medium Density Polyethylene.
- Leak Detection Zone: Composite layer consisting of a geotextile fabric, 12 inches of sand, and a collection pipe.
- Primary Flexible Membrane Liner: 60-mil High Density Polyethylene.
- Protective layer: 12 inches of sand, geotextile fabric and 6 inches of stone.

The Evaporation Pond liner system is constructed in a slightly different fashion to place a flexible membrane liner on the surface:

- Subgrade: In-situ compacted silty, sandy soil.
- Secondary Flexible Membrane Liner: 40-mil Medium Density Polyethylene.
- Leak Detection Zone: Composite layer consisting of a geotextile fabric, 12 inches of sand, and a collection pipe.
- Primary Soil Liner: 12 inches of compacted clay with permeability of less than 1×10^{-6} cm/sec.
- Primary Flexible Membrane Liner: 80-mil High Density Polyethylene.



Source: Ref. 21

Figure 1-8 Evaporative Surface Impoundment

1.9 Managing Wastes for Treatment and Disposal

The Receiving Department enters all waste management information into the Company's American Ecology Standard Operating Platform (AESOP) system (i.e., weights, reagents, constituents, concentrations, disposal locations, etc.). Depending on the waste in question, wastes received at USEI may be placed in temporary storage, or sent to one of the stabilization units, the debris handling facility, or directly land-filled. In regards to the Hematite waste, approximately 95% of the wastes will be directly land-filled (i.e., no treatment), with the remaining 5% expected to require stabilization for RCRA regulated metals. Upon final waste placement, three-dimensional disposal coordinates are recorded on a Work Order Supplement and associated electronic database (AESOP).

1.9.1 Processing Containerized Waste

Waste streams with similar waste codes, characteristics and compatibility are typically consolidated for batch treatment. For example:

- F006, 7, 8, 9, 11, 12, 19 waste streams are usually combined.
- D004-011 waste streams are usually combined.

Batches are analyzed after treatment to ensure that all treatment standards for all waste codes in the batch have been met. Containers of debris are also consolidated for treatment; however, there are no concentration-based standards for encapsulation. Instead, the requirements of 40 CFR Part 268.45 and USEI's permit must be met to ensure that debris was treated for each contaminant subject to treatment.

Containers of waste that do not require further treatment are placed directly into the landfill, based upon compatibility. The coordinates of the containerized wastes are recorded to permit retrieval in the future, if for any reason this is desired.

1.9.2 Processing Bulk Wastes

Bulk wastes requiring treatment may be off-loaded into three different areas; 50-cubic yard stabilization bins at the Stabilization Plant, 100-cubic yard stabilization tanks in the Stabilization Building, or onto the sort floors in the Debris Handling Facility. Alternatively, containerized bulk waste may be stored in one of USEI's RCRA storage areas. Waste off-loaded directly into bins or tanks can be treated immediately. Wastes that are off-loaded onto the sort floors typically need additional handling prior to treatment. Downsizing, sorting, crushing and other handing may be required prior to treatment.

Bulk wastes destined for direct landfill are directed to the landfill cell specified on the WPQ summary sheet after inspection and approval for receipt. Waste locations in the landfill are based upon compatibility, and disposal locations are recorded.

1.10 Scope of Assessment

This scope of this NCSA is limited to safe handling and disposal of the solid wastes at USEI based on the following low level waste streams being shipped from the Hematite site:

1. Exhumed burial waste from the Hematite burial pits and contaminated soils and backfill materials associated with the Hematite burial pits and other remediation areas at the Hematite site; and
2. Solids recovered from the site Water Treatment System (i.e., used filter media, IX beds, solids in the holding tanks, etc.).

The safe collection and staging of these wastes is addressed in References 18, and 19. However, this NCSE credits characterization controls established as one of the numerous factors that provide the basis to demonstrate that a criticality is not credible at USEI for the burial of the Hematite low level waste.

1.11 Methodology

1.11.1 Approach

This NCSA uses a risk-informed approach. Risk insights, gained from the findings of the risk assessment, are used to establish aspects of the design and process that are susceptible to faults important to nuclear criticality safety.

The risk informed approach is complemented with an As Low As Reasonably Achievable (ALARA) assessment that is focused on identifying practicable measures that can be reasonably implemented to further reduce the risk of criticality to a level as low as is reasonably achievable. The ALARA assessment also serves to provide an additional degree of confidence that a criticality incident resulting from the activities assessed is not credible.

In summary, the approach used in this NCSA is as follows:

1. Establish the margin of safety between normal (i.e., expected) conditions and foreseen credible abnormal conditions.

2. Determine whether the inherent margin of safety is sufficient to safely accommodate the credible deviations from normal conditions, and if not, identify feature(s) of the process* that are important to ensuring criticality safety under all credible conditions.
3. Establish what additional practicable measures, if any, can reasonably be implemented to ensure that the risks from criticality are as low as is reasonably achievable.

1.11.2 Method of Criticality Control

The criticality safety basis for low level waste burial at USEI is provided below and is based on the controls established at the Hematite site.

1.11.2.1 Waste Collection and Characterization

Unless exempted by an NCSA, all waste exhumed or otherwise collected will have an initial characterization to ensure that safety it is safely accumulated at the Hematite site and that it meets the concentration limit for safe disposal at USEI. This will involve the use of calibrated instruments performed by trained personnel.

1.11.2.2 Final Characterization for Shipment

Unless exempted by an NCSA, all of these waste sources will be verified by second, independent, assay or in-situ measurements to ensure that they do not contain an average ^{235}U concentration greater than 0.1 $g^{235}U/L$. The combination of the two independent measurements to ensure that the ^{235}U average concentration of the wastes does not exceed 0.1 $g^{235}U/L$ will ensure that they will meet the burial criteria at the USEI site. These verifications along with the low probability to uncover material with high concentrations will ensure that a criticality accident is not credible during receipt and burial at the USEI site.

* In the selection of safety controls, preference is placed on use of engineered controls over procedural controls.

2.0 CRITICALITY SAFETY ASSESSMENT

The criticality safety assessment is organized as follows:

- **Section 2.1** describes the hazard identification technique employed in the criticality safety assessment of waste disposal at the USEI site and provides a summary of the hazard identification results.
- **Section 2.2** outlines the generic assumptions used in the criticality safety assessment.
- **Section 2.3** contains the criticality safety assessment of waste disposal at the USEI site under normal (i.e., expected) conditions.
- **Section 2.4** contains the criticality safety assessment of waste disposal at the USEI site under abnormal (i.e., unexpected) conditions.

2.1 Criticality Hazard Identification

This section outlines the technique used to identify criticality hazards associated with the Hematite waste disposal at USEI site. A summary of the hazards identified is also provided, together with a brief description of their disposition in the NCSA.

2.1.1 Hazard Identification Method

The hazard identification technique employed in this criticality safety assessment uses a *What-if* analysis where the remediation approach and overall objectives are scrutinized and examined against postulated situations, focused on challenging criticality safety. As part of this process, the *What-if* analysis steps through the eleven (11) criticality safety controlled parameters to determine the extent of their importance to criticality safety.

The eleven (11) criticality safety controlled parameters examined include:

- Geometry
- Interaction
- Mass
- Isotopic/Enrichment
- Moderation
- Density
- Heterogeneity
- Neutron Absorbers
- Reflection
- Concentration
- Volume

The eleven (11) parameters listed above are traditionally considered in criticality safety assessments of processes at operating facilities possessing Special Nuclear Material (SNM). Typically, the non-processed based nature of decommissioning operations and associated residues limits the ability to control many parameters, resulting in the need to use bounding values for parameters in the NCSA in many instances.

2.1.2 Hazard Identification Results

A summary of the criticality hazards identified from the *What-if* analysis is presented in Table 2-1. Hazards that result in events with similar consequences and safeguards are grouped in single criticality accident event sequences, analyzed in Section 2.4.

Table 2-1 Criticality Hazards Identified from the What-if Analysis

What-if...	Causes	Consequences	Accident Sequence in NCSA
Geometry			
There are no identified hazards associated with geometry because the safety assessment is based on safe concentration for an infinite system.			
Interaction			
Wrong waste is loaded for shipment.	• Procedure non-compliance.	Potential interaction between packages that may normally require spacing.	**Section 2.4.3**
Mass			
Wrong waste is loaded for shipment.	• Procedure non-compliance.	Potential to exceed a maximum safe mass of ^{235}U in a localized area.	**Section 2.4.3**
There is a reconfiguration of ^{235}U solids in a waste cell.	• Uranium dissolution and migration due to ground water and/or water from precipitation.	Potential to exceed a maximum safe mass of ^{235}U in a localized area. Potential to exceed a maximum safe mass of ^{235}U in the leachate or evaporation pond(s).	**Section 2.4.4**
The package/shipment is improperly characterized.	• Procedure non-compliance.	Potential to exceed a maximum safe mass of ^{235}U in a localized area.	**Sections 2.4.1 and 2.4.2**
Isotopic/Enrichment			
There are no identified hazards associated with presence of variable enrichment uranium. This is because the safety assessment is conservatively based on subcritical limits derived for uranium metal at maximum theoretical density, with 100 wt.% $^{235}U/U$ enrichment.			
Moderation			
There are no identified hazards associated with moderation of uranium particulates. This is because the safety assessment is conservatively based on subcritical limits derived for uranium-H_2O mixtures at optimum concentration.			
Density			
There are no identified hazards associated with presence of variable density uranium. This is because the safety assessment is conservatively based on subcritical limits derived for uranium metal at maximum theoretical density.			

What-if...	Causes	Consequences	Accident Sequence in NCSA
Heterogeneity			
There are no identified hazards associated with heterogeneity of uranium. This is because the safety assessment is conservatively based on subcritical limits derived for homogeneous uranium-H_2O mixtures (with 100 wt.% $^{235}U/U$ enrichment), for which subcritical limits are smaller than equivalent heterogeneous uranium-H_2O mixtures.			
Neutron Absorbers			
There are no identified hazards associated with absence of fixed neutron absorbers. This is because the safety assessment does not credit fixed neutron absorbers.			
Reflection			
There are no identified hazards associated with reflection of uranium. This is because the safety assessment conservatively uses subcritical limits based on full (i.e., 30 cm) thickness close fitting water, concrete, and/or soil reflection conditions, which are considered to bound any credible reflection condition.			
Concentration			
Wrong package(s) are shipped.	• Procedure non-compliance.	Potential to exceed a maximum safe concentration of ^{235}U in a localized area.	**Section 2.4.3**
There is a reconfiguration of ^{235}U solids in a waste cell.	• Uranium dissolution and migration due to ground water and/or water from precipitation.	Potential to exceed a maximum safe concentration of ^{235}U in a localized area. Potential to exceed a maximum safe concentration of ^{235}U in the leachate or evaporation pond(s).	**Section 2.4.4**
The package/shipment is improperly characterized.	• Procedure non-compliance.	Potential to exceed a maximum safe concentration of ^{235}U in a localized area.	**Sections 2.4.1 and 2.4.2**
Volume			
Volume control is not viable due to the large volume of waste to be shipped.			

2.2 Generic Safety Case Assumptions

The activities considered in this criticality safety assessment relate to the processes as defined in Section 1. This section outlines the generic assumptions on which this criticality safety assessment is based.

2.2.1 Fissile Material Assumptions

The pertinent underlying assumptions of the assessment related to the *fissile material* that may be encountered in these activities are as follows:

- This assessment does not consider fissile nuclides other than ^{235}U. Based on the history of the Hematite site and site documentation (refer to Sections 1.2 and 1.3), there is no expectation that fissile nuclides other than ^{235}U could exist within the Hematite site boundary. In the event that any SNM associated with buried wastes, soils or backfill materials are discovered to contain fissile nuclides other than ^{235}U, a stop work order will be issued.
- *Fissile material* limits have been derived assuming homogeneous mixtures of ^{235}U with water (H_2O) and soil. This approach is conservative with respect to other *fissile materials* containing uranium, including soils, process wastes, and host rock.
- The *fissile material* associated with low level waste originating from the Hematite site is predominantly insoluble particulates of uranium as opposed to dissolved, or water-soluble compounds.
- The Hematite waste received at the USEI site will not be treated and will be consigned directly to a waste cell.

2.2.2 Operational Practice and Equipment Assumptions

The pertinent underlying assumptions of this NCSA related to operational practice and equipment use are described and documented in Section 1.

2.3 Normal Conditions

Under normal (i.e., expected) conditions Hematite decommissioning wastes will contain only trace quantities of radionuclides, or at worst, a very low presence of fissile nuclides. This will be verified by comprehensive in-situ radiological surveys prior to waste exhumation, as explained in the following paragraph. Solid wastes generated in the waste water recovery systems will also be characterized at the Hematite site to confirm low concentration of fissile nuclides.

Unless exempted by an NCSA, prior to removal of soil/waste from a remediation area of the Hematite site, comprehensive in-situ radiological survey and visual inspection of a clearly defined survey area (i.e., the area to be exhumed) is undertaken to identify *Non-NCS Exempt Material.*

The in-situ radiological survey will typically use NaI scintillator probes to provide gamma ray measurements of the surface area of interest. The survey technique that may be routinely performed is the Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM) protocol which involves walking straight parallel lines over an area while moving the detector in a serpentine motion, 2 inches to 4 inches above the surface. Employing the MARSSIM protocol provides a high degree of assurance that all areas will be properly characterized prior to exhumation.

The objective of the in-situ radiological surveys is to identify *Hot Spots*, which are defined as any item or region of soil/waste with an average *fissile nuclide* concentration exceeding 0.1 $g^{235}U/L$. The low 0.1 $g^{235}U/L$ threshold provides a high degree of assurance that any items with elevated (i.e., non-trivial) levels of ^{235}U contamination would be identified. The in-situ radiological surveys will be repeated by a second independent measurement to provide an additional safety barrier to ensure that material with an average fissile nuclide concentration exceeding 0.1 $g^{235}U/L$ would be detected.

The in-situ radiological surveys are complemented by visual inspection of the survey area by two independent qualified individuals with the aim of identifying objects that are potentially not consistent with the calibration basis. Objects meeting this criterion include:

1) Items that resemble *Intact Containers*;
2) *Non-Conforming Items* (i.e., any items with the potential to contain *fissile material* (e.g., a process filter); bulky objects with linear dimensions exceeding the permitted *cut depth*; and thick metallic items*.

Refer to Section 1.5.1 for a discussion of these Non-NCS Exempt Materials.

Any *Non-NCS Exempt Materials* identified from the results of the radiological survey and

* The concern with metallic items is that their properties may not be consistent with the calibration basis of the in-situ radiological survey equipment. For example, their high atomic number and/or density could provide more photon attenuation than accounted for in the calibration basis of the in-situ radiological survey equipment.

visual inspection are carefully removed, and will not be shipped to USEI unless distributed within low concentration material to reduce the average concentration of the bulk waste materials to no greater than 0.1 $g^{235}U/L$, or if more detailed characterization later confirms that the *Non-NCS Exempt Materials* actually qualify as *NCS Exempt Material* on the basis of low average ^{235}U concentration or low ^{235}U mass content (specifically, a total mass content not exceeding 15 $g^{235}U$ for items packaged in a container with a volume of atleast 5 liters). A second independent radiological survey/assay measurement will also be performed to provide an additional safety barrier to ensure that the *NCS Exempt Materials* consigned to the USEI site do not comprise an average concentration greater than 0.1 $g^{235}U/L$.

Once Non-NCS Exempt Materials have been removed from a surveyed area, the remaining portion(s) of the surveyed area, to a depth not exceeding the maximum permitted *cut depth* represents material not of interest from a NCS perspective. These *NCS Exempt Materials* are exhumed and transferred to a suitable material stockpile in a WHA* and will be eventually be shipped to the USEI site.

All Hematite WTS components and wastes (i.e., filters, filter media, sediments) will be radiologically surveyed and/or sampled and assayed to determine radiological content. In the event that the radiological survey and/or sample assay results indicate that the solids to be removed contain an average concentration exceeding 0.1 $g^{235}U/L$, then the subject solids are designated as *non-NCS Exempt Material* and must be recovered directly into CDs pre-loaded with absorbent material, as necessary, to soak up any residual water associated with the solids. Each loaded drum will be lidded, transferred to a WEA/MAA, and subject to a primary evaluation/assay measurement and a secondary independent evaluation/assay measurement, both of which will be independently verified to determine radiological content. In order to be shipped to the USEI site for burial, the evaluation/assay results must demonstrate that the contents of the drum(s) does not contain greater than 0.1 $g^{235}U/L$. In the event that the drum content is established to meet *NCS Exempt Material* criteria at the Hematite site, the materials will be aggregated with other bulk *NCS Exempt Material* waste streams.

* An overview of WHA operations is not provided in this NCSA because operations in WHAs are not subject to NCS controls or oversight. WHAs are used to stage and accumulate exhumed wastes and impacted soils in preparation for waste consolidation and shipment from the site in large gondola rail cars.

2.4 Abnormal Conditions

Postulated abnormal conditions associated with final waste characterization and burial at the USEI site concern the potential for an increase in uranium mass and/or concentration levels on receipt, or following emplacement within the disposal system.

The following postulated criticality scenarios are discussed and assessed in this section:

- Concentration limit is exceeded when exhumed burial waste/contaminated soil is prepared for shipment;
- Concentration limit is exceeded when solids recovered from the Water Treatment System (i.e., used filter media, IX beds, solids in the holding tanks, etc.,) are prepared for shipment;
- Wrong material is loaded for shipment to the USEI site; and
- Migration and localized concentration of ^{235}U in USEI Landfill Cells, Leachate System, and/or Evaporation pond.

2.4.1 Concentration Limit is Exceeded when Exhumed Burial Waste/ Contaminated Soil is Prepared for Shipment

2.4.1.1 Discussion

Any waste shipped from the Hematite site to the USEI site must not exceed an average concentration of 0.1 $g^{235}U/L$. This concentration limit is below the concentration limit for transportation and is substantially below (by a factor of 40) the maximum subcritical infinite sea concentration of 4.0 $g^{235}U/L$ for nominal soil (Appendix A).

This upset scenario involves the waste being improperly characterized for shipment, with the potential to ship waste with an excessively high ^{235}U concentration to be USEI site. However, the risk assessment that follows demonstrates that the resulting accident sequence is not credible to result in a criticality incident at the USEI site. This assessment is based on the risk presented by excavation operations in the documented burial pit area and is considered to bound other buried waste and contaminated soil areas. Therefore, areas that are subject to reduced NCS controls or are exempt from NCS controls (as justified in a HDP NCSA) are not explicitly discussed in this NCSA.

2.4.1.2 Risk Assessment

Based on historic data it is unlikely that the burial pits, individually, could contain an unsafe mass of ^{235}U. According to the documented burial logs (Ref. 5), the recorded total uranium mass associated with the historic waste consignments range from 178 $g^{235}U$ to 802 $g^{235}U$ per burial pit. Based on best available information, it is believed that the burial pits are nominally 20' × 40' and 12' deep. Using these approximate burial pit dimensions and the highest recorded burial pit inventory of 802 $g^{235}U$, it is seen that the average concentration of ^{235}U within exhumed burial wastes and contaminated soils would likely not exceed ~3.0 $mg^{235}U/L$, even if no radiological monitoring performed and no segregation of *fissile material* was undertaken. This very low fissile concentration is more than three orders of magnitude less than the maximum subcritical infinite sea concentration of 4.0 $g^{235}U/L$ for nominal soil (Appendix A).

It is acknowledged that it is possible a burial pit could be excavated that contains burial waste with an elevated concentration of ^{235}U, due to the compaction of process wastes (over time or from the remediation activities), or due to an unusually high incidence of high inventory process waste items in a localized burial area. The burial logs recorded at the time of operation of the burial pits indicate that the vast majority of the 15,000 waste consignments were assigned a nominal 1 $g^{235}U$ inventory, based on the limit of detection capability (Ref. 2). Only a very small number of waste consignments (ten) involved non-trivial ^{235}U loadings. The waste consignments with the highest recorded ^{235}U contents included:

- Wood filters (4 entries ranging from 22 to 44 $g^{235}U$);
- Metal shavings (one entry at 41 $g^{235}U$);
- Leco crucibles (4 entries ranging from 29 to 31.6 $g^{235}U$); and

- Reactor tray (one entry at 40.4 g^{235}U).

The nature of uranium residues associated with typical process wastes is such that it is improbable that the documented burial logs could be grossly in error with respect to fissile loading. Irrespective of the strict documented logging of process waste consignments, which were conducted under procedures in place at the time (Ref. 5), the quantity of ^{235}U associated with the buried wastes would be expected to be low, in criticality safety terms, because:

- Economic and operational incentives would have ensured that the ^{235}U associated with the buried wastes would have been present only as surface contamination. In particular, Highly Enriched Uranium (HEU) had high economic value and there would have been very strong incentives to fully utilize and account for all HEU.
- The dangers of uncontrolled handling of *fissile material* were fully appreciated during the 1950s, 1960s and 1970s, as by that time several fatalities had been reported. It is very unlikely that potentially unsafe items would have been deliberately consigned to the burial pits, as operators preparing the waste would have been fully aware of the dangers.

Even if the documented burial logs were grossly in error with regard to fissile loading, the random factors of *fissile material* distribution, the very high fissile to non-fissile ratio associated with contaminated soil/wastes, and the poor moderating property and reasonable parasitic neutron absorption characteristics of the soil/waste matrix would, in practice, ensure the safety of exhumed buried wastes and contaminated soils.

Unless exempted by an NCSA, prior to removal of soil/waste from a burial area of the Hematite site, comprehensive in-situ radiological survey and visual inspection of the area to be exhumed is undertaken to identify *Non-NCS Exempt Materials* including *Hot Spots, Intact Containers*, and *Non-Conforming Items*. Refer to the discussion in Section 1.5.1 for further details. Following removal of the identified *Non-NCS Exempt Materials* the remaining *NCS Exempt Materials* (up to the maximum permitted *cut depth*) are exhumed and consigned to the USEI site for disposal. This process ensures that the waste materials consigned to the USEI site for disposal do not comprise an average *fissile nuclide* concentration exceeding 0.1 g^{235}U/L.

Even if the burial waste/soil exhumed contained a significant uranium concentration, the in-situ radiological survey and visual inspection activities described above would have to fail concurrently before the 0.1 g^{235}U/L average concentration limit could be exceeded for shipment to the USEI site. In addition, the potential to bulk and ultimately ship high ^{235}U concentration wastes to the USEI site is further reduced because the in-situ radiological survey and visual inspection activities are independently performed by two qualified individuals. Based on these considerations, there is no potential for a criticality incident during bulking of wastes at the Hematite site in preparation for shipment, and subsequently, during receipt and burial of the Hematite wastes at the USEI site. This is because this scenario requires independent verifications of the uranium concentration to fail concurrently with the low probability of encountering materials with high uranium concentrations.

2.4.1.3 Summary of Risk Assessment

Based on the discussion provided above, it is concluded that the following conditions must occur before a criticality accident due to transferring remediation wastes from the Hematite site to the USEI site would be possible:

- Failure of multiple independent simple administrative Criticality Safety Controls (CSCs) related to conducting in-situ radiological surveys and visual inspection to identify *Non-NCS Exempt Material* would have to occur; and
- The exhumed soil/waste would have to comprise material with a ^{235}U concentration more than three orders of magnitude greater than the worst-case average uranium concentration recorded in the burial logs; and
- The uranium would have to be of a high ^{235}U enrichment; and
- Non fissile and non-hydrogenous elements (e.g., soil) would have to be non-abundant, otherwise these constituents would result in dilution and parasitic neutron absorption.

2.4.1.4 Safety Controls

The explicit CSCs relevant to ensuring concentration control for receipt and burial of Hematite wastes at the USEI site are provided below. In addition, a practicable measure for reducing criticality risk is identified and listed as Defense-in-Depth (DinD) control. Its implementation will ensure that the risks from criticality are as low as is reasonably achievable.

> **Administrative CSC 01:** *Unless approved by another NCSA, only the following waste with maximum average concentration of 0.1 g^{235}U/L SHALL be allowed for shipment to USEI:*
>
> 1. *Exhumed burial waste from the Hematite burial pits and contaminated soils and backfill materials associated with the Hematite burial pits and other remediation areas of the hematite site*
> 2. *Solids recovered from the Water Treatment System (i.e., used filter media, IX beds, solids in the holding tanks, etc.).*

> **Administrative CSC 02:** *All HDP remediation areas SHALL be radiologically surveyed to identify Hot Spots prior to exhumation of any material, unless exempted by an NCSA. Any identified Hot Spots SHALL be extracted, loaded into a Field Container, and containerized in a CD in accordance with the applicable fissile material exhumation and handling procedures. Following removal, the surveyed area SHALL be re-surveyed to verify the removal of all Hot Spots. Upon confirmation, the remaining portion(s) of the surveyed area may be exhumed to a depth not exceeding the maximum permitted cut-depth, and*

dispositioned as NCS Exempt Material.

Notes:

1. *Hot Spots are defined according to the criteria in NSA-TR-09-15 Adm CSC 04.*
2. *Sample(s) may be extracted and analyzed for ^{235}U content, and the results used in lieu of in-situ radiological survey results, provided that the samples analyzed are representative of, or bound, the entire Hot Spot under investigation.*
3. *Sample extraction, packaging, transport, and analysis SHALL be performed in accordance with the governing NCSA for these operations.*
4. *The collar associated with the CD being loaded may be fitted after the drum has been loaded.*

Administrative CSC 03: *In conjunction with in-situ radiological surveys, all HDP remediation areas SHALL be visually inspected prior to exhumation of any material, unless exempted by an NCSA. In the event that any items are identified to potentially comprise Non-NCS Exempt Material (e.g., a process filter is identified), the item(s) SHALL be extracted, placed inside a Field Container, and containerized in a CD, in accordance with the applicable fissile material exhumation and handling procedures.*

Notes:

1. *Non-NCS Exempt items that possess a volume greater than that of a Field Container may be placed directly into a CD.*
2. *The collar associated with the CD being loaded may be fitted after the drum has been loaded.*

Administrative CSC 04: *Radiological surveys performed in support of CSCs SHALL use only equipment that is approved and appropriately calibrated to satisfy the NCS Performance Requirement of accounting for potential under-reading due to the effect of credible variation in uranium distribution, particle size and attenuation of the photon intensity within the surrounding soil/waste medium.*

Notes:

1. *The NCS Performance Requirement for in-situ radiological surveys dictates that the in-situ radiological screening criteria used for remediation operations is not greater than the detector response imputed for both of the conditions defined below:*
   a. *A uniform distribution of ^{235}U throughout nominal soil up to the maximum permitted cut depth and with a ^{235}U concentration of 0.1 g ^{235}U/L.*
   b. *A compact spherical accumulation of ^{235}U/nominal soil that*

is situated at the base of the maximum permitted cut depth, comprises a total ^{235}U mass content of 350 $g^{235}U$, and is surrounded by nominal soil.

Administrative CSC 05: *In conjunction with in-situ radiological surveys, all HDP remediation areas SHALL be visually inspected prior to exhumation of any material, unless exempted by an NCSA. In the event that any of the following items are identified, the identified items SHALL be extracted and containerized individually in a CD (i.e., one item per CD) or multiple items per CD consistent with NSA-TR-09-15 Adm CSC 16:*

- *Items that resemble intact containers;*
- *Non-Conforming Items (i.e., bulky objects with linear dimensions exceeding the permitted cut depth, and thick metallic items).*

Notes:

1. *This CSC does not apply to individual Non-Conforming Items when inspected local to the excavation area and determined (using an approved method) to not comprise any significant ^{235}U content. This CSC also does not apply to exhumed Intact Containers that are designated as NCS Exempt Material based on the results of close-proximity radiological surveys of their surfaces (specifically, a fissile nuclide concentration not exceeding 0.1 $g^{235}U/L$, or a fissile nuclide mass content not exceeding 15 $g^{235}U$ and occupying a container with a volume of at least 5 liters).*
2. *The approved inspection methods for determining if an exhumed Non-Conforming Item constitutes Non-NCS Exempt Material are as follows. At least one of these three methods SHALL be applied to determine if an exhumed Non-Conforming Item represents Non-NCS Exempt Material. Note that these methods are not required to be applied if the exhumed item is conservatively treated as Non-NCS Exempt Material without any inspection at the excavation area:*
   a. *The item is confirmed to be free of interior spaces (i.e., voids) and is determined by radiological surveys of its exterior surfaces to not comprise (as surface contamination) an average fissile nuclide concentration exceeding 0.1 $g^{235}U/L$.*
   b. *The item satisfies the external surfaces criteria specified in (a) and comprises interior spaces/voids that have been sampled, visually inspected, and/or radiologically surveyed and determined to not comprise material with an average fissile nuclide concentration exceeding 0.1 $g^{235}U/L$.*

c. *NCS staff have evaluated the item and determined that it qualifies as NCS Exempt Material based on visual inspections, radiological surveys, or sampling and analysis.*

3. *The NCS Organization SHALL be contacted for direction in the event that any individual item is too large to fit within a CD.*
4. *The collar associated with the CD being loaded may be fitted after the drum has been loaded.*

Administrative CSC 06: *Following removal of any identified Non-NCS Exempt Materials from a HDP remediation area, the remaining portion(s) of the radiologically surveyed area may be exhumed and dispositioned as NCS Exempt Material. However, the material excavation depth SHALL NOT exceed the maximum permitted cut depth established in the radiological survey equipment calibration basis.*

<u>*Notes:*</u>

1. *Exceeding the maximum permitted cut depth is an anticipated process upset due to the potential difficulty in performing precise depth excavations. More than three concurrent instances of failing to adhere to the maximum permitted cut depth in an excavation area would not present any credible criticality safety concerns, and is credited as an unlikely condition. Consequently, more than three concurrent instances of failing to adhere to the maximum permitted cut depth constitutes a violation of this CSC.*

Administrative CSC 07: *In the event that a large Intact Container or Non-Conforming Item is identified during visual inspection of a remediation area, removal of material surrounding the item may be necessary in order to facilitate its removal. In this case, the surrounding material SHALL be removed and handled consistent with the fissile material exhumation and handling procedures.*

<u>*Notes:*</u>

1. *Intact Containers and Non-Conforming Items may be exhumed by other means (e.g., hoist or crane) provided that the removal method selected minimizes the potential for disturbance of other buried materials compared to other practicable removal methods.*

Administrative CSC 08: *Designated Non-NCS Exempt Material SHALL not be consigned to the USEI site for disposal unless evaluated for fissile concentration in a WEA and/or a MAA and established to actually not contain an average ^{235}U concentration greater than 0.1 $g^{235}U/L$, or distributed within low ^{235}U concentration waste and* *demonstrated to not contain an average ^{235}U concentration greater than 0.1 g^{235}U/L.*

Administrative CSC 09: *Administrative CSCs NSA-TR-09-14 CSC 02, 03, 05, 06, 07, and 08 SHALL be followed/observed by a second individual that is independent of the first individual. Equipment used by the second individual in support of these CSCs SHALL be independent of the equipment used by the first individual.*

Notes:

1. *Independent equipment is defined as equipment that is physically separate. Such equipment may be either diverse (i.e., different manufacturer and/or model) or non-diverse (i.e., same manufacturer and model).*
2. *NSA-TR-09-14 CSC 04 is not required to be independently followed/observed since the set point established in HDP work procedures to comply with CSC 04 is common to both surveys.*

DinD Administrative Control 01: *HDP remediation areas should be clearly sub-divided/marked with survey area(s) prior to performing radiological surveys by using marking paint, construction flags, and/or stakes, etc. In addition, physical markings or other suitable methods should be used to delineate any identified Hot Spots within each survey area.*

2.4.2 Concentration Limit is Exceeded When Solids Recovered from the Water Treatment System (i.e., used filter media, IX beds, solids in the holding tanks, etc.,) are Prepared for Shipment

2.4.2.1 Discussion

As stated previously, any waste shipped from the Hematite Site to the USEI site must not exceed an average concentration of 0.1 $g^{235}U/L$. This is significantly below the maximum subcritical infinite sea concentration of 4.0 $g^{235}U/L$ for nominal soil (Appendix A).

This upset scenario involves the Hematite waste being improperly characterized for shipment, with the potential to ship waste with an excessively high ^{235}U concentration to be USEI site. However, the risk assessment that follows demonstrates that the resulting accident sequence is not credible to result in a criticality incident at the USEI site.

2.4.2.2 Risk Assessment

Waste Water Holding Tanks

All sampling to date from wells both within the burial pit area of the Hematite site and around the site periphery consistently indicates minimal fissile contaminant presence in the ground water. The highest concentration observed for samples collected from site wells is only 0.16 $mg^{235}U/L$. This highest recorded concentration is nearly four orders of magnitude less than the maximum subcritical infinite sea concentration of 4.0 $g^{235}U/L$ for nominal soil (Appendix A). Based on this minimal concentration, ground water collection and treatment in the WTS is not expected to accumulate an unsafe concentration of uranium.

It is not expected that large volumes of ground water will be contaminated to a level of 0.16 $mg^{235}U/L$, however, even if this were to occur, the total mass of ^{235}U associated with a completely filled 20,000 gallon capacity holding tank would be only ~12 g. However, it is recognized that any settling of uranium particulates within a holding tank could result in a progressive accumulation of SNM over time.

A drum vacuum will be used to remove wet sediments from the bottom of the WTS Holding tanks. As operationally necessary, the water in a tank to be cleaned will first be emptied using a portable sump pump. The sediments will be radiologically surveyed and/or sampled and analyzed for fissile contamination before removal from the holding tank and at least once a month during tank operations. If the radiological survey and/or sample assay results indicate that the subject solids contain an average concentration exceeding 0.1 $g^{235}U/L$ then the subject solids are designated as *non-NCS Exempt Material* and must be recovered* directly into CDs pre-loaded with absorbent material (e.g., an immobilizing compound) to soak up any residual water associated with the sediments. Each loaded drum will be lidded, transferred to a WEA/MAA, and subject to a primary

* The sediment recovery process will be achieved by opening the access hatches to the tank and guiding the vacuum suction hose intake to recover the designated *non-NCS Exempt Material.*

evaluation/assay measurement and a secondary independent evaluation/assay measurement, both of which will be independently verified to determine radiological content. In order to be shipped to the USEI site for burial, the evaluation/assay results must demonstrate that the contents of the drum(s) does not contain greater than 0.1 $g^{235}U/L$. In the event that the drum content is established to meet *NCS Exempt Material* criteria at the Hematite, the materials will be aggregated with other bulk waste streams.

The combination of these two abovementioned independent measurements will ensure that these sources will meet the criteria for waste acceptance and burial at the USEI site. Based on these considerations, there is no potential for a criticality incident during bulking of solid wastes from the Hematite WTS holding tanks during preparation for shipment, and subsequently, during receipt and burial of these wastes at the USEI site. This is because this scenario requires independent verifications of the uranium concentration to fail concurrently with the low probability of encountering solids with high uranium concentrations in waste water.

Filtration and Ion Exchange Equipment

As stated above, all sampling to date from wells both within the burial pit area of the Hematite site and around the site periphery consistently indicates minimal fissile contaminant presence in the ground water. Based on this minimal concentration, ground water collection and treatment in the WTS, including the numerous treatment / filtration equipment, poses little risk of criticality.

In practice, any fissile contaminants entrained in collected water would be accompanied by a far greater quantity of non-fissile, inert particulates, such as soil sediments, etc. Consequently, any fissile particulates deposited in the WTS treatment / filtration equipment will likely be diluted by a significant quantity of *non-fissile material*, which generally represent significantly poorer moderators than water*. These material characteristics serve to increase the mass of *fissile material* required before a criticality accident would be possible.

Recovery and containerization of soiled filters from filtration equipment is achieved by manually accessing the filtration unit, removing the soiled filter and placing the soiled filter in a waste drum. Based on the insufficient *fissile material* mass within any individual equipment, and the servicing (i.e., recovery of solids) from only one equipment at any one time, it is seen that containerization of solid wastes does not present any criticality risk under normal conditions.

Following loading of a waste drum with solid wastes, the loaded drum is lidded, transferred

* Soil is a significantly poorer moderator than water. For example, the minimum critical mass in a plutonium system moderated by fully water saturated soil (40% soil-in-water) (Fig III.A.6(97)-4 of Ref. 13) is a factor of ~2.5 greater than the minimum critical mass for an otherwise equivalent aqueous system (Fig III.A.6-1 of Ref. 13). Scaling the minimum critical mass of ^{235}U in water (820 g, Table A-1) by the this ratio (2.5), it is estimated that a minimum of ~2 kg(^{235}U) would be required for a criticality to be possible by adsorption in soil. Note that the soil composition for the above data is defined in Table III.A.1-6 of Ref. 13.

to a WEA/MAA, and subject to a primary evaluation/assay measurement and a secondary evaluation/assay measurement, both of which will be independently verified to determine radiological content. In order to be shipped to the USEI site for burial, the evaluation/assay results must demonstrate that the drum content does not contain greater than 0.1 $g^{235}U/L$. In the event that the drum content is established to meet *NCS Exempt Material* criteria at the Hematite site, the materials will be aggregated with other bulk waste streams.

The treatment beds (GAC and IX) will require periodic changing (need for changing is determined by measurement of the head pressure required to pump water through the respective treatment vessel). Unlike the bag filters, the GAC units will be backwashed to break up the carbon bed and remove entrained solids that are plugging or blinding the carbon bed. Treated effluent water from a tank will be used as backwash water. Water will be pumped from the tank backwards (up) through the GAC vessel being backwashed. The system is designed so that one set of two (2) GAC absorbers can be taken off-line for servicing or backwashing while the system runs at capacity (50 gpm) with only the second set of two (2) GAC units on-line. Backwash water from the GAC vessel being backwashed flows under pressure back to the inlet of storage tank T-3 for removal of suspended solids from the backwash water.

Prior to any replacement of the GAC media, the GAC vessel is valved out of service and the treatment media blown down with a portable air compressor, as necessary, to effectively dry the media. Samples of the media are extracted via the access ports on the media vessel and analyzed for fissile contamination at least once a week during operation to further ensure no significant *fissile material* concentration accumulates. However, it is noted that radiological survey of the vessels may be performed in lieu of sampling and analysis provided that it is performed with at least the same frequency. In the event that the radiological survey and/or sample assay results indicate that the solids to be removed contain an average concentration exceeding 0.1 $g^{235}U/L$, then the subject solids are designated as *non-NCS Exempt Material* and must be recovered directly into CDs pre-loaded with absorbent material, as necessary, to soak up any residual water associated with the solids. The loaded CDs are then lidded, transferred to a WEA/MAA, and subject to a primary evaluation/assay measurement and a secondary independent evaluation/assay measurement, both of which will be independently verified to determine radiological content In order to be shipped to the USEI site for burial, the evaluation/assay results must demonstrate that the drum content does not contain greater than 0.1 $g^{235}U/L$. In the event that the drum content is established to meet *NCS Exempt Material* criteria at the Hematite site, the materials will be aggregated with other bulk waste streams.

The combination of the two abovementioned independent measurements will ensure that these sources will meet the criteria for waste acceptance and burial at the USEI site. Based on these considerations, there is no potential for a criticality incident during bulking of Hematite WTS ion exchange media and filter bags during preparation for shipment, and subsequently, during receipt and burial of these wastes at the USEI site. This is because this scenario requires independent verifications of the uranium concentration to fail concurrently with the low probability of colleting any significant uranium concentration from the waste water.

2.4.2.3 Summary of Risk Assessment

Based on the discussion provided above, it is concluded that the following conditions must occur before a criticality accident due to transferring WTS solid wastes from the Hematite site to the USEI site would be possible:

- Failure of multiple independent simple administrative CSCs related to conducting waste evaluation and/or assay measurements would have to occur; and
- The WTS solid wastes would have to comprise material with a ^{235}U concentration more than three orders of magnitude greater than the worst-case average uranium concentration recorded in the burial logs; and
- The uranium would have to be of a high ^{235}U enrichment; and
- Non fissile and non-hydrogenous elements (e.g., soil) would have to be non-abundant, otherwise these constituents would result in dilution and parasitic neutron absorption.

2.4.2.4 Safety Controls

The explicit CSCs relevant to ensuring concentration control for receipt and burial of Hematite WTS solid wastes at the USEI site are provided below. In addition, a practicable measure for reducing criticality risk is identified and listed as DinD control. Its implementation will ensure that the risks from criticality are as low as is reasonably achievable.

> **Administrative CSC 10:** *Prior to shipping any WTS solids to the USEI site for burial, the WTS solids (i.e., used filter media, IX beds, solids in the holding tanks, etc.,) identified as Non-NCS Exempt Material through radiological survey and/or sampling and assay SHALL be distributed as necessary and re-evaluated for fissile concentration in a WEA and/or a MAA and established to not contain an average ^{235}U concentration greater than 0.1 $g^{235}U/L$.*
>
> **Administrative CSC 11:** *Administrative CSC NSA-TR-09-14 CSC 10 SHALL be followed by a second individual that is independent of the first individual. Equipment used by the second individual in support of this CSC SHALL be independent of the equipment used by the first individual, unless approved by an NCSA.*
>
> *Notes:*
>
> 1. *Independent equipment is defined as equipment that is physically separate. Such equipment may be either diverse (i.e., different manufacturer and/or model) or non-diverse (i.e., same manufacturer and model).*

In support of the above Administrative CSCs, radiological survey equipment used for waste evaluation operations in a WEA and assay equipment used for material assay operations in a MAA are designated as Safety Related Equipment, the Safety Functional Requirement being to permit estimation of ^{235}U content when properly calibrated and used in accordance with applicable procedures.

> **Safety Related Equipment 02:** *Radiological survey and assay equipment used in support of waste evaluation operations in a WEA and material assay operations in a MAA (when used in support of a CSC) SHALL be capable of measuring ^{235}U content when used in conjunction with approved hardware/software (e.g., ISOCS) or an approved calibration basis.*

> **DinD Administrative Control 02:** *Settled sediments in each of the WTS Holding Tanks should be radiologically surveyed and/or sampled and assayed for ^{235}U content according to the following schedule:*
>
> - *At least once per month during excavation activities; and*
> - *Prior to clean-out of the sediments from a tank.*
>
> *In the event a sample assay result indicates a ^{235}U concentration >0.1 mg/cc (>0.1 g/L) then the NCS organization should be notified.*

> **DinD Administrative Control 03:** *The filtration (bag filters) and treatment media (GAC and ion exchange beds) should be radiologically surveyed and/or sampled and assayed for ^{235}U content at least once per week during excavation activities. In the event radiological survey result or sample assay result indicates a ^{235}U mass >350 g ^{235}U further use of the associated media should be discontinued and the NCS organization notified.*

> **DinD Administrative Control 04:** *GAC and ion exchange media should be radiologically surveyed and/or sampled and assayed for ^{235}U content prior to clean-out of the media. In the event a sample assay result indicates a ^{235}U concentration >0.1 mg/cc (>0.1 g/L) then the NCS organization should be notified.*

2.4.3 Wrong Material is Loaded for Shipment to USEI

2.4.3.1 Discussion

As stated previously, any waste shipped from the Hematite Site must not exceed an average concentration of 0.1 $g^{235}U/L$. This is significantly below the maximum subcritical infinite sea concentration of 4.0 $g^{235}U/L$ for nominal soil (Appendix A).

This upset scenario involves loading the wrong waste for shipment. This upset has the potential to allow the concentration limit to be exceeded by shipping higher concentration *non NCS Exempt Materials* segregated at the Hematite site to the USEI site. However, the risk assessment that follows demonstrates that the resulting accident sequence is not credible to result in a criticality incident at the USEI site.

2.4.3.2 Risk Assessment

As demonstrated in all the previous scenarios for the different sources of wastes, it is considered improbable that the waste streams will contain a ^{235}U average concentration above the 0.1 $g^{235}U/L$ limit for acceptance at the USEI site based on the types of wastes and the low probability of encountering significant concentrations of uranium. Furthermore, the sampling of wells and soils across the site indicate concentrations well below the USEI concentration limit. In addition to the low likelihood that any wastes with significant concentration will be exhumed, strict controls will be in place to segregate and properly label waste, if waste streams are generated with concentrations above the USEI limits. The controls will be used in up front processes to not only ensure the USEI limits are met, but also to maintain criticality safety at the Hematite site during remediation activities. These strict controls are discussed below.

Based on the results of in-situ monitoring, *Hot Spots* will be exhumed either into *Field Containers* as large as 20 liter volume containers (equivalent to a nominal 5-gallon container) and over-packed into collared 55-gallon or larger diameter drums. The containerized materials will be subsequently transferred to a waste evaluation area for detailed characterization. In the waste evaluation area the waste will be spread to create a thin layer on a 'sorting surface'. Visual inspection and gamma survey (using hand-held gamma detectors) will be used to identify any uranium that is discrete within the waste matrix. Portion(s) of the waste matrix determined to not contain uranium (or to contain acceptably low uranium content) will be extracted and returned to the main waste stream. The remaining portion(s) of the waste matrix will be packaged into a known geometry container (up to 20 liters in volume) and transferred to an adjacent area for counting using a High Resolution Gamma Spectrometer (HRGS). The HRGS equipment returns a total ^{235}U mass content for the package. The HRGS mass estimate is assigned to the assayed container, which is labeled with a description of the container content, an item number, date, and ^{235}U mass. The container is then transferred within a collared drum to a secure area for storage or to a repack area (in the event that the drum ^{235}U mass content is relatively small).

In the collared drum repacking area, the drum content (i.e., inner container) is removed from the drum and placed into an empty or partially filled standard 55 gallon waste drum (if allowed by packaging limits). The drum inventory log traveler is updated to reflect the new consignment.

The Entry and Repack Zone is the only entrance/exit into or from the secure area. All *Non-NCS Exempt Material* generated from site operations is brought in collared drums into this Entry and Repack Zone for proper logging of the material. The secure area personnel are given advance notice prior to all transfers to the secure area. The doors of the Entry and Repack Zone are maintained in a locked condition when the secure area is not in operation.

When a collared drum is introduced into the Entry and Repack Zone, personnel first ensure that other *Non-NCS Exempt Material* is not present in the Entry and Repack Zone. Since the purpose of this Entry and Repack Zone is to consolidate *Non-NCS Exempt Material* into 55-gallon drums for subsequent storage, the personnel determine an appropriate stored 55-gallon drum to retrieve from the Storage Zone and transfer it to the Entry and Repack Zone. The item from the collared drum is removed and placed into the retrieved 55-gallon drum. The ^{235}U mass tally on the drum is properly updated. The drum is then re-lidded and returned to the Storage Zone. The empty collared drum is verified empty and removed from the secure area. The drum repacking limit is ≤ 125 g ^{235}U per drum.

All *Non-NCS Exempt Material* introduced into the Entry and Repack Zone and subsequent consolidations/transfers are logged by the personnel. To ensure that too much *Non-NCS Exempt Material* does not exist at any given time within the Entry and Repack Zone, a minimum of two operators with adequate supervision/oversight (such as security cameras) are always present when the secure area doors are unlocked. This ensures that *Non-NCS Exempt Material* is not brought into the Entry and Repack Zone without the recognition and acceptance of the secure area personnel and supervision. In addition, only a single package of containerized *Non-NCS Exempt Material* along with an appropriate consolidation drum is approved at a time within the Entry and Repack Zone thereby also preventing too much *Non-NCS Exempt Material* in this zone at a time.

Operations in a secure storage area that is not also a repack area attract the same generic container logging, entry, segregation and oversight controls.

Even if exhumed burial waste contained a significant uranium concentration, the container labeling and the very prescriptive segregation of the waste that does not meet the USEI limits would have to fail concurrently before any waste could be loaded for shipment to USEI.

Based on these considerations, there is no potential for a criticality incident due to inadvertent transfer of high concentration Hematite segregated wastes to the USEI site.

2.4.3.3 Summary of Risk Assessment

Based on the discussion provided above, it is concluded that the following conditions must occur before a criticality accident due to inadvertently transferring high concentration Hematite segregated wastes to the USEI site would be possible:

- Failure of multiple independent simple administrative CSCs related to segregating and properly labeling *Non-NCS Exempt Material*, and not allowing shipment of such wastes with concentrations above the USEI limits; and
- The *Non-NCS Exempt Material* would have to comprise material with a ^{235}U concentration significantly higher than expected based or process history and sampling.

2.4.3.4 Safety Controls

The explicit CSCs relevant to ensuring concentration control for receipt and burial of Hematite WTS solid wastes at the USEI site are provided below. In addition, CSCs relevant to ensuring segregation of high ^{235}U concentration wastes at the Hematite site are also provided below. These controls ensure that the risks from criticality are as low as is reasonably achievable.

> **Administrative CSC 01:** *Unless approved by another NCSA, only the following waste with maximum average concentration of 0.1 g^{235}U/L SHALL be allowed for shipment to USEI:*
>
> 1. *Exhumed burial waste from the Hematite burial pits and contaminated soils and backfill materials associated with the Hematite burial pits and other remediation areas of the hematite site*
> 2. *Solids recovered from the Water Treatment System (i.e., used filter media, IX beds, solids in the holding tanks, etc.).*

> **Administrative CSC 12:** *The number of qualified personnel present within (or within cognitive surveillance of) a CD repack and storage area during all activities SHALL be a minimum of three.*

> **Administrative CSC 13:** *Secure area doors (and zone doors within) each CD repack and storage area SHALL be maintained closed when not in use. The doors SHALL be maintained with two locks in proper working condition. The combination or key of each lock SHALL be different. Supervision SHALL maintain confidentiality from operators of one lock combination or key while operators SHALL maintain confidentiality from supervision of the second lock. Particularly, at no time, will the combination of both locks be known by a single individual.*

Administrative CSC 14: *Movement/handling of Non-NCS Exempt Materials SHALL be accompanied by at least two different persons that are cognizant of fissile material handling responsibilities.*

2.4.4 Migration and Localized Concentration of ^{235}U in USEI Landfill Cells, Leachate System, and/or Evaporation pond

2.4.4.1 Discussion

The preceding event sequences in this NCSA demonstrate that there is no potential to ship Hematite wastes with an average concentration exceeding 0.1 $g^{235}U/L$ to the USEI site. This low concentration level is significantly below the maximum subcritical infinite sea concentration of 4.0 $g^{235}U/L$ for nominal soil (Appendix A). This low concentration level is also substantially below a fictitious minimum critical concentration of 1.4 $g^{235}U/L$ for bounding soil consisting of only SiO_2 per NUREG/CR-6505 (Ref. 17).

This upset scenario pertains to the ^{235}U migration and reconfiguration into an area of the cell that exceeds the minimum critical concentration. The risk assessment that follows demonstrates that the resulting accident sequence is not credible to result in a criticality incident.

2.4.4.2 Risk Assessment

NUREG/CR-6505 (Ref. 17, pg. 45) demonstrates that nominal soil in a slab configuration requires a lower areal density for a criticality to be possible versus a cylindrical or spherical geometry. For instance, at a concentration of 0.006 $g^{235}U/cm^3$ (i.e., 6 $kg^{235}U/L$), the calculated critical areal density is 5.2 kg $^{235}U/m^2$ for an infinite slab in a planar configuration whereas the corresponding critical linear density for an infinite cylinder is 7.8 kg $^{235}U/m^2$. Therefore, achieving a criticality in a cylindrical geometry requires significant lateral and vertical ^{235}U migration. In addition, NUREG/CR-6505 (Ref. 17, pg. 46) demonstrates the corresponding critical areal density for a spherical geometry is 9.34 kg $^{235}U/m^2$. Based on the above comparisons, a slab provides the most likely condition for a possible criticality.

Considering that a slab provides the most efficient condition for a criticality, NUREG/CR-6505 (Ref. 17, pg. 96) demonstrates that a slab thickness of 2131 cm and areal density of 30.2 kg/m^2 is required for a criticality to be possible for corresponding density of 1.4 $g^{235}U/L$ for bounding SiO_2 soil. Therefore, not only does the Hematite waste average concentration of 0.1 $g^{235}U/L$ have to increase by a factor of more than ten, but a significant quantity has to migrate to a layer at least 2131 cm (21.31 m) thick for a criticality to be possible. For higher ^{235}U concentrations a smaller slab thickness is required, but the concentration factor must also be higher before a criticality could be possible. For instance, NUREG/CR-6505 (Ref. 17, pg. 99) demonstrates that a slab thickness of 94.57 cm and areal density of 5.4039 kg/m^2 is critical, corresponding to a density of 5.7 $g^{235}U/L$ for the bounding SiO_2 soil. Also, for nominal soil NUREG/CR-6505 (Ref. 17, pg. 94) demonstrates that a slab thickness of 78.86 cm and areal density of 4.732 kg/m^2 is critical, corresponding density of 6.0 $g^{235}U/L$.

The maximum safe ^{235}U mass of 760 $g^{235}U$ corresponds to a full water-reflected spherical homogeneous mixture of ^{235}U and water ~14 L in volume at an optimum concentration of 55 $g^{235}U/L$ (Ref. 16). It is not reasonable to postulate that such idealized conditions could be achieved or even approximated in a waste/soil due to the poor moderating characteristics of these soil/waste materials, relative to full density water, as previously noted. In practice an accumulation representing kilogram quantities of *fissile material* would be required in a compact volume, and with an efficient geometry and distribution, before a criticality could credibly occur.

Section 10 of NUREG/CR-6505 (Ref. 17, pg. 45) concludes that a concentration factor of greater than ten is not considered credible for migration of ^{235}U based on the hydrogeochemical modeling and assumptions used for the Envirocare Site. Section 1.4 of NUREG/CR-6505 (Ref. 17, pg. 2) states that no other sites were considered, but the same analysis methods can be used to evaluate other sites. Therefore, the methodology was compared to the conditions at the USEI site and Reference 20 confirms that the methods and results in NUREG/CR-6505 also support that a concentration factor of greater than ten is also not considered credible for migration of ^{235}U at the USEI site. As stated above, the concentration limit is 0.1 g^{235}U/L for waste shipments from the Hematite site to the USEI site. Based on this low concentration level, a criticality incident is not credible at the USEI site due to migration and concentration of ^{235}U, because it would require a concentration increase by more than a factor of ten and Reference 20 concludes that a concentration increase by more than a factor of ten is not credible.

The conclusion that a criticality is not credible at the USEI site is further supported by the following supporting information.

Disposal Cell Placement Practices

Once in the cell, the concentration of ^{235}U will be reduced by the process of spreading and the inevitable commingling of the Hematite waste with other materials in the cell. This occurs because the Hematite waste will be emplaced concurrently with wastes from other generators. The projected receipts from Hematite are expected to be received over a period of nine months and would comprise approximately five 20-ton truck shipments daily. Since the USEI site receives an average of one hundred 20-ton truck shipments daily, the ^{235}U concentration in the Hematite waste is likely to be reduced by a factor of 20 as a result of the disposal process.

Since the average precipitation at the facility is only 5-7 inches per year, with an evapo-transpiration potential of greater than 42 inches per year, there is very little potential for infiltration once the cell is closed. Since the uranium is an oxide and the cell is an anoxic environment with an approximate pH of 10, it is not readily transportable.

Much of the waste that will be received concurrent to the Hematite waste receipts is treated prior to disposal. The treatment process involves the use of reagents, clay, or other materials that greatly reduce the potential for contaminants to be transported. These treated wastes, which will be commingled with the Hematite waste, will form barriers to moisture infiltration, and also reduce the potential for infiltration to transport any ^{235}U that may leach from the Hematite waste.

For these reasons, no concentration of Hematite waste is anticipated to occur due to existing waste placement practices. Rather, a 20-to-1 dilution factor is projected due to waste placement.

Leachate

Because USEI's disposal cell meets EPA's Minimum Technical Requirements (MTR), it is constructed of a triple liner system consisting of two synthetic liners and a natural clay liner. Leachate collection systems exist between the two synthetic liners, and above the top synthetic liner. Historic leachate generation data was analyzed to determine whether concentration could occur in the leachate or the leachate sump system.

USEI's disposal cells collect leachate that is generated as a result of precipitation in open cells, dust control water applied to waste in the cells, and condensation of moisture from wastes. Once a cell is closed, the amount of leachate produced decreases with time. The conditions at the USEI facility are such that after five years, leachate is generally no longer being produced in quantities to be pumped. Consequently, consistent with the MTR and design purpose of the cell, the infiltration transport mechanism is nullified for the long-term.

In 2008 USEI generated 300,000 gallons of leachate from its current active disposal cell (Cell 15). The leachate is produced primarily from precipitation and dust control water, and represents the most likely transport mechanism for contaminants in disposed wastes. The leachate is pumped regularly and sampled periodically by USEI, with results reported to the State of Idaho as a condition of the facility's operating permit. Due to the conditions in the disposal cell, the leachate produced meets EPA F039 Non-Wastewater treatment standards for inorganic metals. In other words, such low concentrations of heavy metals are found in USEI's leachate that it does not qualify as a "characteristic" hazardous waste. This is also supported by empirical data documented in annual reports to the State of Idaho and USEPA. These facts support the view that extremely small quantities of ^{235}U from Hematite waste, if any, would be expected to be transported to the leachate while Cell 15 remains open, and would present no criticality safety concern.

The Hematite waste is expected to be received over a period of nine months. As the waste is received, it will be commingled with other wastes. As the waste is covered, an infiltration and evaporative barrier is formed, limiting the moisture transport mechanism's ability to dissolve and transport available ^{235}U from the Hematite waste.

USEI collects leachate from the sumps in four 16,500 gallon tanks. Periodically, USEI pumps the collected leachate in the tanks through an activated carbon filtration system. The carbon used in the filtration system is a coarse grain grade specifically designed to remove volatile organics and is ineffective for removing metals. Consequently, ^{235}U or other inorganic contaminants do not concentrate in the carbon. Once a year, USEI checks the tanks for sediment and removes any that may have collected.

Surface Impoundments (Collection and Evaporation Ponds)

Leachate collected in USEI's active landfill sumps is pumped by remote means through an enclosed piping system to large storage tanks where it is commingled with leachate produced by closed, non-radioactive disposal cells. A small dilution factor occurs, but is not used in the calculation below. Conversely, no further concentration occurs in the storage tanks.

Since the leachate produced at USEI's facility meets EPA F039 Non-Wastewater F039 treatment standards for inorganic heavy metals and all other chemicals pertaining to the F039 waste code, it is discharged from the interim storage tanks directly to a RCRA Subtitle K permitted surface impoundment. All of the liquid being discharged to the surface impoundment is eventually evaporated. If ^{235}U from the Hematite waste were to be discharged to the impoundment, it would be commingled with the sludge already in the impoundment. As of April 2009, the impoundment contains approximately 725 yards of sludge with a density of 90 lbs/ft3 (8.00E x 10^8 g). Based on the extremely small quantities of ^{235}U from Hematite waste, if any, that could be expected to be transported to the leachate while Cell 15 remains open, there would be an extremely high *non-fissile/fissile material* ratio, representing no potential for a criticality incident.

In summary, the waste placement practices, empirical leachate concentration data, and operating practices for USEI's surface impoundment support that the basis that there should be no increase in the ^{235}U concentration to the extent that it would present a credible criticality concern. The conclusions made in References 17 and 20 also demonstrate that a concentration increase by a factor of ten or greater is not credible. Therefore, the conclusion above that a criticality is not considered credible is fully supported based on the 0.1g ^{235}U/L Hematite waste concentration limit, considering a subcritical limit of 1.4 grams ^{235}U/L for a bounding soil (SiO_2 only) and the maximum subcritical infinite sea concentration of 4.0 g^{235}U/L for nominal soil (Appendix A).

2.4.4.3 Summary of Risk Assessment

Based on the discussion provided above, it is concluded that it is not credible for this scenario to result in a criticality accident at the USEI site. Consequently no controls are identified to ensure the subcriticality of Hematite wastes at the USEI site. All the controls for this scenario are provided in previous accident sequences to ensure that the USEI site waste acceptance concentration limit of 0.1 g^{235}U/L is not exceeded.

3.0 SUMMARY OF CRITICALITY SAFETY CONTROLS

3.1 Criticality Safety Parameters

The extent of control of each of the various criticality safety parameters introduced in Section 2.1 is summarized in Table 3-1.

Table 3-1 Criticality Safety Parameters

Nuclear Parameter	Controlled (Y/N)	Basis	Reference
Geometry	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site does not credit geometry.	N/A
Interaction	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site credits administrative CSCs to ensure that high concentration wastes that may normally require spacing are not shipped to the USEI site.	Section 2.4.3
Mass	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site credits administrative CSCs to ensure that there is no potential to form a maximum safe mass at the USEI site.	Section 2.4.1 Section 2.4.2 Section 2.4.3 Section 2.4.4
Isotopic / Enrichment	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site is conservatively based on subcritical limits derived for uranium metal with 100 wt.% $^{235}U/U$ enrichment.	N/A
Moderation	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site is conservatively based on subcritical limits derived for uranium-H_2O and/or uranium-soil mixtures at optimum concentration.	N/A
Density	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site is conservatively based on subcritical limits derived for uranium metal at maximum theoretical density.	N/A

Nuclear Parameter	Controlled (Y/N)	Basis	Reference
Heterogeneity	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site is conservatively based on subcritical limits derived for homogeneous uranium-H_2O mixtures (with 100 wt.% $^{235}U/U$ enrichment), for which subcritical limits are smaller than equivalent heterogeneous uranium-H_2O mixtures.	N/A
Neutron Absorbers	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site does not credit fixed neutron absorbers.	N/A
Reflection	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site conservatively uses subcritical limits based on full (i.e., 30 cm) thickness close fitting water reflection and/or soil conditions, which are considered to bound any credible reflection condition.	N/A
Concentration	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site credits administrative CSCs to ensure that there is no potential to ship waste with an unanalyzed concentration to the USEI site.	Section 2.4.1 Section 2.4.2 Section 2.4.3 Section 2.4.4
Volume	N	The safety assessment of receipt and burial of Hematite wastes at the USEI site does not credit volume control.	N/A

3.2 Criticality Safety Controls and Defense-in-Depth Controls

This section provides a schedule of Systems, Structures, and Components (SSCs), CSCs and DinD controls that have been established as important to safety in the risk assessment of Hematite waste receipt and disposal at the USEI site.

3.2.1 Systems, Structures, and Components

The following SSCs have been recognized as important to ensuring the criticality safety of Hematite waste receipt and disposal at the USEI site. The SSCs are identified as Safety Related Equipment (active function).

Safety Related Equipment 01: *Instruments used in support of in-situ radiological surveys (when used in support of a CSC) SHALL be capable of measuring ^{235}U content when used in conjunction with an approved calibration basis.*

Safety Related Equipment 02: *Radiological survey and assay equipment used in support of waste evaluation operations in a WEA and material assay operations in a MAA (when used in support of a CSC) SHALL be capable of measuring ^{235}U content when used in conjunction with approved hardware/software (e.g., ISOCS) or an approved calibration basis.*

3.2.2 Criticality Safety Controls

The following CSCs have been recognized as important to ensuring the criticality safety of Hematite waste receipt and disposal at the USEI site.

Administrative CSC 01: *Unless approved by another NCSA, only the following waste with maximum average concentration of 0.1 g ^{235}U/L SHALL be allowed for shipment to USEI:*

1. *Exhumed burial waste from the Hematite burial pits and contaminated soils and backfill materials associated with the Hematite burial pits and other remediation areas of the hematite site.*
2. *Solids recovered from the Water Treatment System (i.e., used filter media, IX beds, solids in the holding tanks, etc.).*

Administrative CSC 02: *All HDP remediation areas SHALL be radiologically surveyed to identify Hot Spots prior to exhumation of any material, unless exempted by an NCSA. Any identified Hot Spots SHALL be extracted, loaded into a Field Container, and containerized in a CD in accordance with the applicable fissile material exhumation and handling procedures. Following removal, the surveyed area SHALL be re-surveyed to verify the removal of all Hot Spots. Upon confirmation, the remaining portion(s) of the surveyed area may be exhumed to a* *depth not exceeding the maximum permitted cut-depth, and dispositioned as NCS Exempt Material.*

Notes:

1. *Hot Spots are defined according to the criteria in NSA-TR-09-15 Adm CSC 04.*
2. *Sample(s) may be extracted and analyzed for ^{235}U content, and the results used in lieu of in-situ radiological survey results, provided that the samples analyzed are representative of, or bound, the entire Hot Spot under investigation.*
3. *Sample extraction, packaging, transport, and analysis SHALL be performed in accordance with the governing NCSA for these operations.*
4. *The collar associated with the CD being loaded may be fitted after the drum has been loaded.*

Administrative CSC 03: *In conjunction with in-situ radiological surveys, all HDP remediation areas SHALL be visually inspected prior to exhumation of any material, unless exempted by an NCSA. In the event that any items are identified to potentially comprise Non-NCS Exempt Material (e.g., a process filter is identified), the item(s) SHALL be extracted, placed inside a Field Container, and containerized in a CD, in accordance with the applicable fissile material exhumation and handling procedures.*

Notes:

1. *Non-NCS Exempt items that possess a volume greater than that of a Field Container may be placed directly into a CD.*
2. *The collar associated with the CD being loaded may be fitted after the drum has been loaded.*

Administrative CSC 04: *Radiological surveys performed in support of CSCs SHALL use only equipment that is approved and appropriately calibrated to satisfy the NCS Performance Requirement of accounting for potential under-reading due to the effect of credible variation in uranium distribution, particle size and attenuation of the photon intensity within the surrounding soil/waste medium.*

Notes:

1. *The NCS Performance Requirement for in-situ radiological surveys dictates that the in-situ radiological screening criteria used for remediation operations is not greater than the detector response imputed for both of the conditions defined below:*
   a. *A uniform distribution of ^{235}U throughout nominal soil up to the maximum permitted cut depth and with a ^{235}U concentration of 0.1 g ^{235}U/L.*

b. *A compact spherical accumulation of ^{235}U/nominal soil that is situated at the base of the maximum permitted cut depth, comprises a total ^{235}U mass content of 350 g^{235}U, and is surrounded by nominal soil.*

Administrative CSC 05: *In conjunction with in-situ radiological surveys, all HDP remediation areas SHALL be visually inspected prior to exhumation of any material, unless exempted by an NCSA. In the event that any of the following items are identified, the identified items SHALL be extracted and containerized individually in a CD (i.e., one item per CD) or multiple items per CD consistent with NSA-TR-09-15 Adm CSC 16:*

- *Items that resemble intact containers;*
- *Non-Conforming Items (i.e., bulky objects with linear dimensions exceeding the permitted cut depth, and thick metallic items).*

Notes:

1. *This CSC does not apply to individual Non-Conforming Items when inspected local to the excavation area and determined (using an approved method) to not comprise any significant ^{235}U content. This CSC also does not apply to exhumed Intact Containers that are designated as NCS Exempt Material based on the results of close-proximity radiological surveys of their surfaces (specifically, a fissile nuclide concentration not exceeding 0.1 g^{235}U/L, or a fissile nuclide mass content not exceeding 15 g^{235}U and occupying a container with a volume of at least 5 liters).*
2. *The approved inspection methods for determining if an exhumed Non-Conforming Item constitutes Non-NCS Exempt Material are as follows. At least one of these three methods SHALL be applied to determine if an exhumed Non-Conforming Item represents Non-NCS Exempt Material. Note that these methods are not required to be applied if the exhumed item is conservatively treated as Non-NCS Exempt Material without any inspection at the excavation area:*
   a. *The item is confirmed to be free of interior spaces (i.e., voids) and is determined by radiological surveys of its exterior surfaces to not comprise (as surface contamination) an average fissile nuclide concentration exceeding 0.1 g^{235}U/L.*
   b. *The item satisfies the external surfaces criteria specified in (a) and comprises interior spaces/voids that have been sampled, visually inspected, and/or radiologically surveyed and determined to not comprise material with an average fissile nuclide concentration exceeding 0.1*

g ^{235}U/L.

c. *NCS staff have evaluated the item and determined that it qualifies as NCS Exempt Material based on visual inspections, radiological surveys, or sampling and analysis.*

3. *The NCS Organization SHALL be contacted for direction in the event that any individual item is too large to fit within a CD.*
4. *The collar associated with the CD being loaded may be fitted after the drum has been loaded.*

Administrative CSC 06: *Following removal of any identified Non-NCS Exempt Materials from a HDP remediation area, the remaining portion(s) of the radiologically surveyed area may be exhumed and dispositioned as NCS Exempt Material. However, the material excavation depth SHALL NOT exceed the maximum permitted cut depth established in the radiological survey equipment calibration basis.*

Notes:

1. *Exceeding the maximum permitted cut depth is an anticipated process upset due to the potential difficulty in performing precise depth excavations. More than three concurrent instances of failing to adhere to the maximum permitted cut depth in an excavation area would not present any credible criticality safety concerns, and is credited as an unlikely condition. Consequently, more than three concurrent instances of failing to adhere to the maximum permitted cut depth constitutes a violation of this CSC.*

Administrative CSC 07: *In the event that a large Intact Container or Non-Conforming Item is identified during visual inspection of a remediation area, removal of material surrounding the item may be necessary in order to facilitate its removal. In this case, the surrounding material SHALL be removed and handled consistent with the fissile material exhumation and handling procedures.*

Notes:

1. *Intact Containers and Non-Conforming Items may be exhumed by other means (e.g., hoist or crane) provided that the removal method selected minimizes the potential for disturbance of other buried materials compared to other practicable removal methods.*

Administrative CSC 08: *Designated Non-NCS Exempt Material SHALL not be consigned to the USEI site for disposal unless evaluated for fissile concentration in a WEA and/or a MAA and established to actually not contain an average ^{235}U concentration greater than 0.1*

$g^{235}U/L$, or distributed within low ^{235}U concentration waste and demonstrated to not contain an average ^{235}U concentration greater than 0.1 $g^{235}U/L$.

Administrative CSC 09: *Administrative CSCs NSA-TR-09-14 CSC 02, 03, 05, 06, 07, and 08 SHALL be followed/observed by a second individual that is independent of the first individual. Equipment used by the second individual in support of these CSCs SHALL be independent of the equipment used by the first individual.*

Notes:

1. *Independent equipment is defined as equipment that is physically separate. Such equipment may be either diverse (i.e., different manufacturer and/or model) or non-diverse (i.e., same manufacturer and model).*
2. *NSA-TR-09-14 CSC 04 is not required to be independently followed/observed since the set point established in HDP work procedures to comply with CSC 04 is common to both surveys.*

Administrative CSC 10: *Prior to shipping any WTS solids to the USEI site for burial, the WTS solids (i.e., used filter media, IX beds, solids in the holding tanks, etc.,) identified as Non-NCS Exempt Material through radiological survey and/or sampling and assay SHALL be distributed as necessary and re-evaluated for fissile concentration in a WEA and/or a MAA and established to not contain an average ^{235}U concentration greater than 0.1 $g^{235}U/L$.*

Administrative CSC 11: *Administrative CSC NSA-TR-09-14 CSC 10 SHALL be followed by a second individual that is independent of the first individual. Equipment used by the second individual in support of this CSC SHALL be independent of the equipment used by the first individual, unless approved by an NCSA.*

Notes:

1. *Independent equipment is defined as equipment that is physically separate. Such equipment may be either diverse (i.e., different manufacturer and/or model) or non-diverse (i.e., same manufacturer and model).*

Administrative CSC 12: *The number of qualified personnel present within (or within cognitive surveillance of) a CD repack and storage area during all activities SHALL be a minimum of three.*

Administrative CSC 13: *Secure area doors (and zone doors within) each CD repack and storage area SHALL be maintained closed when not in use. The doors SHALL be maintained with two locks in proper working condition. The combination or key of each lock SHALL be different. Supervision SHALL maintain confidentiality from operators of one lock combination or key while operators SHALL maintain confidentiality from supervision of the second lock. Particularly, at no time, will the combination of both locks be known by a single individual.*

Administrative CSC 14: *Movement/handling of Non-NCS Exempt Materials SHALL be accompanied by at least two different persons that are cognizant of fissile material handling responsibilities.*

3.2.3 Defense-in-Depth Controls

This section lists those controls that either reinforce CSCs, or provide additional protection to ensure that the risk of criticality is as low as is reasonably achievable.

DinD Administrative Control 01: *HDP remediation areas should be clearly sub-divided/marked with survey area(s) prior to performing radiological surveys by using marking paint, construction flags, and/or stakes, etc. In addition, physical markings or other suitable methods should be used to delineate any identified Hot Spots within each survey area.*

DinD Administrative Control 02: *Settled sediments in each of the WTS Holding Tanks should be radiologically surveyed and/or sampled and assayed for ^{235}U content according to the following schedule:*

- *At least once per month during excavation activities; and*
- *Prior to clean-out of the sediments from a tank.*

In the event a sample assay result indicates a ^{235}U concentration >0.1 mg/cc (>0.1 g/L) then the NCS organization should be notified.

DinD Administrative Control 03: *The filtration (bag filters) and treatment media (GAC and ion exchange beds) should be radiologically surveyed and/or sampled and assayed for ^{235}U content at least once per week during excavation activities. In the event radiological survey result or sample assay result indicates a ^{235}U mass >350 g ^{235}U further use of the associated media should be discontinued and the NCS organization notified.*

DinD Administrative Control 04: *GAC and ion exchange media should be radiologically surveyed and/or sampled and assayed for ^{235}U content prior to clean-out of the media. In the event a sample assay result indicates a ^{235}U concentration >0.1 mg/cc (>0.1 g/L) then the NCS organization should be notified.*

4.0 CONCLUSION

This criticality safety assessment demonstrates that the disposal of Hematite waste at the USEI site can be safely performed. The assessment has determined that there are very large margins of safety under normal (i.e., expected) conditions and that there is considerable tolerance to abnormal conditions. Under all normal and foreseen abnormal conditions a criticality event is considered either not credible or is precluded by controls in place at the Hematite site.

This analysis applies to disposal of Hematite decommissioning wastes at the USEI site. The scope of this assessment is limited to wastes with the following attributes:

1. Maximum average *fissile nuclide* concentration of 0.1 $g^{235}U/L$;
2. Exhumed burial waste from the Hematite burial pits and contaminated soils and backfill materials associated with the Hematite burial pits and other remediation areas at the Hematite site; and
3. Solids recovered from the Hematite Water Treatment System (i.e., used filter media, IX beds, solids in the holding tanks, etc.).

5.0 REFERENCES

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20. SAHEM00194-09-0003, Application of NUREG-6505V2 to Waste from the Hematite Site, Geological Engineering and Environmental Services Company, February 6, 2009.

21. Section II US Ecology Idaho Facility Overview.

22. 49 CFR 173.453(c)(1) and (2).

APPENDIX A

Relevant Criticality Data

CHARACTERISTICS OF BURIED WASTES AND CONTAMINATED SOILS

It is considered that the SNM residues associated with the buried wastes and contaminated structures and soils at the Hematite site is generally a low-risk *fissile material* because the form and associated matrix conditions are far from optimum for a neutron chain reaction. The characteristics of the wastes are completely dissimilar to those of an efficient fissile system. Efficient critical systems comprise:

- Efficient moderating materials;
- Uniform fissile / moderator mixtures;
- Concentrations of several tens of grams fissile per liter;
- Compact arrangements;
- Lack of voidage and diluents;
- Lack of neutron poisons; and
- Efficient reflectors or interaction with other *fissile material.*

As each parameter, or combination of parameters, moves away from the optimum the fissile mass required for a criticality increases. As this mass increases the probability that such a high fissile mass could have arisen and remained undetected decreases.

While criticality would be possible under highly non-optimum conditions (e.g., in low density, poisoned systems) the fissile mass needed for criticality (i.e., many kilograms) would far exceed credible quantities.

Single Items

The presence of a sufficiently large fissile mass (i.e., ≥ a minimum critical mass) in a single accumulation could potentially result in a criticality. The maximum subcritical mass for ^{235}U in water is 760 g (Ref. 12), corresponding to optimum conditions of:

- Spherical homogeneous accumulation of ^{235}U/ water;
- Full water moderation (i.e., full density water, no poisons, diluents, voidage etc.);
- Optimum concentration of approximately 55 g^{235}U/L (corresponding to a volume of approximately 14 liters);
- Full water reflection; and
- Isotopic content of 100 w/o ^{235}U.

This value has traditionally been used in the assessment of isolated HEU units as a pessimistic but bounding case to generically consider all possible conditions within contaminated wastes.

As discussed above, the nature of SNM residues is such that it is not considered credible that a situation could arise in which all parameters are optimized and the presence of a minimum critical mass would result in a criticality. The reactivity of any system and hence the fissile mass that would be required for criticality is dependent on the combination of a number of parameters, e.g., concentration, moderating properties of the waste matrix, geometry and reflection conditions.

CRITICAL AND SUBCRITICAL LIMITS

Table A-1 outlines the subcritical and critical limits for ^{235}U-water systems used in the safety assessment. It is acknowledged that there is potential to exhume or encounter hydro-carbon based liquids that could be more efficient moderators than water. However, due to the nature of the uranium residues and their associated waste matrix, the aqueous limits are considered conservative.

Table A-1 Single Parameter Limits for homogeneous ^{235}U/water mixtures

Parameter	Critical Limit[1]	Maximum Subcritical Limit[2]	Description / Restrictions
Mass	820 g^{235}U	760 g^{235}U	Any geometrical configuration, even when optimally moderated and fully reflected by water. Applies to all chemical forms (e.g., oxides as powders, metals, etc.).
Concentration	11.8 g^{235}U/L	11.6 g^{235}U/L	Unlimited volume of homogeneous solution in any chemical form (e.g., nitrate, oxalate, etc.), and in any geometry.
Volume	6.1 L	5.5 L	Homogeneous solution in any chemical form (e.g., nitrate, oxalate, etc.), at any concentration, fully reflected by water.
Geometry (∞ Cylinder Diameter)	14.3 cm	13.7 cm	Homogeneous solution in any chemical form (e.g., nitrate, oxalate, etc.), at any concentration and volume, and fully reflected by water.
Geometry (∞ Slab Thickness)	4.9 cm	4.4 cm	Homogeneous solution in any chemical form (e.g., nitrate, oxalate, etc.), at any concentration and volume, and fully reflected by water.
Geometry (∞ Slab Areal Concentration)	390 g/ft^2 (0.42 g/cm^2)	372 g/ft^2 (0.40 g/cm^2)	Homogeneous solution in any chemical form (e.g., nitrate, oxalate, etc.), any volume (i.e., any slab depth) and fully reflected by water.

Source: Ref. 12 and Ref. 13

Notes:
1. Ref. 13, page III.B-2
2. Ref. 12, Table 1

Table A-2 outlines the single parameter critical limits for homogeneous U-water systems as a function of the U enrichment.

Table A-2 Critical Limits for homogeneous U/water mixtures as a function of U enrichment

U Enrichment wt.% ^{235}U/U	Spherical Critical Mass (g)	Spherical Critical Volume (L)	Critical ∞ Cylinder Diameter (cm)	Critical ∞ Slab Thickness (cm)
3#	3200	80.0	38.0	20.0
5#	1950	37.0	28.0	14.0
30.3#	990	11.0	19.0	7.4
100##	820	6.1	14.3	4.9

Source: Ref. 13 and Ref. 14

Notes:

Ref. 13, page III.B-2
Ref. 14, Figures 14-17

Reference 16 presents the results of a broad and comprehensive set of calculations performed to compare the reactivity of various finite and infinite systems containing uranium. This calculation established a minimum critical infinite sea concentration for a ^{235}U/soil mixture of 5.5 g^{235}U/L. Assuming a maximum safe fissile concentration of 4.0 g^{235}U/L provides a substantial subcritical margin of 0.15 g^{235}U/L. This margin is considered sufficiently large to also address any additional penalty that may be appropriate to account for validation of the materials modeled in the calculations used to establish the limit.

APPENDIX B

Hematite Site Sampling Data Excerpts

License Well Rad Results

Sample ID	Station ID	Screened Horizon	Sample Date	Analyte	Result	Units	MDL
WS-15	WS-15	Overburden	5/15/2003	U-235	**5.0**	pCi/L	47.2
WS-15	WS-15	Overburden	3/30/2004	U-235	**2.2**	pCi/L	20.6
WS-15	WS-15	Overburden	9/29/2004	U-235	**-29.2**	pCi/L	40.3
WS-15	WS-15	Overburden	12/21/2004	U-235	**-17.6**	pCi/L	48.8
WS-15	WS-15	Overburden	1/21/2005	U-235	**13.8**	pCi/L	68.1
WS-16	WS-16	Overburden	5/15/2003	U-235	**-58.7**	pCi/L	108.0
WS-16	WS-16	Overburden	3/30/2004	U-235	**-0.6**	pCi/L	13.6
WS-16	WS-16	Overburden	9/29/2004	U-235	**-10.8**	pCi/L	57.0
WS-16	WS-16	Overburden	12/21/2004	U-235	**-12.3**	pCi/L	90.0
WS-16	WS-16	Overburden	1/21/2005	U-235	**-35.9**	pCi/L	55.9
WS-15	WS-15	Overburden	5/15/2003	U-235 (AS)	**0.0**	pCi/L	0.1
WS-15	WS-15	Overburden	3/30/2004	U-235 (AS)	**0.0**	pCi/L	0.0
WS-15	WS-15	Overburden	9/29/2004	U-235 (AS)	**0.0**	pCi/L	0.1
WS-15	WS-15	Overburden	12/21/2004	U-235 (AS)	**0.2**	pCi/L	0.4
WS-15	WS-15	Overburden	1/21/2005	U-235 (AS)	**-0.1**	pCi/L	0.2
WS-16	WS-16	Overburden	5/15/2003	U-235 (AS)	**1.6**	pCi/L	0.4
WS-16	WS-16	Overburden	3/30/2004	U-235 (AS)	**0.3**	pCi/L	0.1
WS-16	WS-16	Overburden	9/29/2004	U-235 (AS)	**0.0**	pCi/L	0.2
WS-16	WS-16	Overburden	12/21/2004	U-235 (AS)	**0.1**	pCi/L	0.3
WS-16	WS-16	Overburden	1/21/2005	U-235 (AS)	**0.0**	pCi/L	0.1
WS-16	WS-16	Overburden	11/2/2007	U-235 (AS)	**0.0**	pCi/L	0.5
WS-16	WS-16	Overburden	11/2/2007	U-235 (AS)	**0.3**	pCi/L	1.0

2nd Quarter 2007 IGMP Rad Results

Sample ID	Station ID	Screened Horizon	Sample Date	Analyte	Result	Units	MDL
GW-WS31-062807	WS-31	Jefferson City	6/28/2007	U-235	**0.0**	pCi/L	0.1
GW-PZ04-062807	PZ-04	Jefferson City	6/28/2007	U-235	**0.0**	pCi/L	0.0
GW-WS16-062907	WS-16	Overburden	6/29/2007	U-235	**0.0**	pCi/L	0.1
GW-BP20A-062607	BP-20A	Overburden	6/26/2007	U-235	**0.0**	pCi/L	0.1
GW-BP22A-062507	BP-22A	Overburden	6/25/2007	U-235	**0.0**	pCi/L	0.1
GW-BP21-062607	BP-21	Overburden	6/26/2007	U-235	**0.0**	pCi/L	0.1
GW-NB80-062807	NB-80	Overburden	6/28/2007	U-235	**0.0**	pCi/L	0.0
GW-BP17-062807	BP-17	Overburden	6/28/2007	U-235	**0.0**	pCi/L	0.0
GW-BP22B-062807	BP-22B	Overburden	6/28/2007	U-235	**0.0**	pCi/L	0.0
GW-BP20B-062707	BP-20B	Overburden	6/27/2007	U-235	**0.2**	pCi/L	0.1
GW-WS24-062907	WS-24	Overburden	6/29/2007	U-235	**2.6**	pCi/L	0.1

3rd Quarter 2007 IGMP Rad Results

Sample ID	Station ID	Screened Horizon	Sample Date	Analyte	Result	Units	MDL
GW-PZ04-091907	PZ-04	Jefferson City	9/19/2007	U-235	**0.0**	pCi/L	0.0
GW-WS31-091907	WS-31	Jefferson City	9/19/2007	U-235	**0.0**	pCi/L	0.0
GW-BP17-092107	BP-17	Overburden	9/21/2007	U-235	**0.1**	pCi/L	0.0
GW-BP20A-091807	BP-20A	Overburden	9/18/2007	U-235	**0.0**	pCi/L	0.0
GW-BP21-092007	BP-21	Overburden	9/20/2007	U-235	**0.0**	pCi/L	0.0
GW-BP22A-091807	BP-22A	Overburden	9/18/2007	U-235	**0.0**	pCi/L	0.0
GW-NB80-092007	NB-80	Overburden	9/20/2007	U-235	**0.0**	pCi/L	0.0
GW-WS16-091807	WS-16	Overburden	9/18/2007	U-235	**0.0**	pCi/L	0.1
GW-WS24-092107	WS-24	Overburden	9/21/2007	U-235	**3.0**	pCi/L	0.1

4th Quarter 2007 IGMP Rad Results

Sample ID	Station ID	Screened Horizon	Sample Date	Analyte	Result	Units	MDL
GW-PZ04-120507	PZ-04	Jefferson City	12/5/2007	U-235	**0.0**	pCi/L	0.0
GW-WS31-120307	WS-31	Jefferson City	12/3/2007	U-235	**0.0**	pCi/L	0.0
GW-BP17-120307	BP-17	Overburden	12/3/2007	U-235	**0.1**	pCi/L	0.2
GW-BP20A-120307	BP-20A	Overburden	12/3/2007	U-235	**0.1**	pCi/L	0.2
GW-BP21-120307	BP-21	Overburden	12/3/2007	U-235	**0.0**	pCi/L	0.1
GW-BP22A-120307	BP-22A	Overburden	12/3/2007	U-235	**0.0**	pCi/L	0.0
GW-NB80-120507	NB-80	Overburden	12/5/2007	U-235	**0.0**	pCi/L	0.1
GW-WS16-120407	WS-16	Overburden	12/4/2007	U-235	**0.0**	pCi/L	0.0

1st Quarter 2008 IGMP Rad Results

Sample ID	Station ID	Screened Horizon	Sample Date	Analyte	Result	Units	MDL
GW-PZ04-030608	PZ-04	Jefferson City	3/6/2008	U-235	**0.0**	pCi/L	0.0
GW-WS31-030408	WS-31	Jefferson City	3/4/2008	U-235	**0.0**	pCi/L	0.0
GW-BP17-030308	BP-17	Overburden	3/3/2008	U-235	**0.0**	pCi/L	0.1
GW-BP20A-030408	BP-20A	Overburden	3/4/2008	U-235	**0.0**	pCi/L	0.2
GW-BP20B-030508	BP-20B	Overburden	3/5/2008	U-235	**0.0**	pCi/L	0.0
GW-BP21-030508	BP-21	Overburden	3/5/2008	U-235	**0.0**	pCi/L	0.0
GW-BP22A-030508	BP-22A	Overburden	3/5/2008	U-235	**0.0**	pCi/L	0.0
GW-BP22B-030608	BP-22B	Overburden	3/6/2008	U-235	**0.0**	pCi/L	0.1
GW-NB80-030608	NB-80	Overburden	3/6/2008	U-235	**0.0**	pCi/L	0.0
GW-WS16-030508	WS-16	Overburden	3/5/2008	U-235	**0.0**	pCi/L	0.1
GW-WS24-030408	WS-24	Overburden	3/4/2008	U-235	**2.2**	pCi/L	0.1