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Subject: Nuclear Criticality Safety Contingency Plan
(License No. SNM-00033, Docket No. 070-00036)

Westinghouse Electric Company LLC (Westinghouse) submits herein as Attachment 1 the Hematite Nuclear Criticality Safety Contingency Plan related to the Westinghouse - U. S. Government Settlement Agreement-In-Principle.

Please contact Mark Michelsen, Acting Licensing Manager, of my staff at (314) 810-3376 should you have questions or need any additional information.

Sincerely,

E. Kurt Hackmann
Director, Hematite Decommissioning Project

Attachment: 1) Nuclear Criticality Safety Contingency Plan for Remediating Contingency Hot Spots, DO-10-002, Revision 0, dated 11/12/10

cc: J. J. Hayes, NRC/FSME/DWMEP/DURLD
J. W. Smetanka, Westinghouse, w/o attachment
J. E. Tapp, NRC Region III/DNMS/MCID, w/o attachment

ATTACHMENT 1

Nuclear Criticality Safety Contingency Plan for Remediating Contingency Hot Spots

Revision 0

November 12, 2010

NUCLEAR CRITICALITY SAFETY CONTINGENCY PLAN FOR REMEDIATING CONTINGENCY HOT SPOTS

DO-10-002

Revision 0

November 12, 2010

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1.0 INTRODUCTION

This document outlines the Nuclear Criticality Safety Contingency Plan (NCSCP) for remediating radiological *Hot Spots* that are identified to exceed the bounds of the operational envelope established for routine buried waste and contaminated soil remediation operations at the Hematite site. A Hot Spot is defined as a distinct, in-situ location where field instruments indicate 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. The bounds established for routine remediation operations are for a ^{235}U mass of 700 g or less. To exceed the bounds established for routine remediation operations, a *Hot Spot* would need to exceed 700 g of ^{235}U.

For the purpose of this document, this type of *Hot Spot* is designated as a *Contingency Hot Spot* and is defined as a discrete item with a ^{235}U mass estimate exceeding 700 g^{235}U (i.e., a distinct in-situ location where field instruments indicate the presence of more than 700 g of ^{235}U). This NCSCP will be employed whenever in-situ radiological survey and visual inspection activities performed in any Hematite Decommissioning Project (HDP) remediation area results in the identification of a *Contingency Hot Spot*.

1.1 Overview 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 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 burial area, two evaporation ponds, a site pond, storm drains, sewage lines with a corresponding drain field, and several locations comprising contaminated limestone fill.

Throughout its history, operations at the Hematite facility included the manufacture 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 U.S. 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.% or less ^{235}U), intermediate-enriched (i.e., more than 5 wt.% and up to 20 wt.% ^{235}U) and high-enriched (i.e., 20 wt.% or more ^{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.

On-site burial was used as a disposal method for contaminated materials and wastes at Hematite from 1965 until 1970 in accordance with reference requirements and specific license

authorizations. The detailed logbooks of waste burial described below document that the Burial Pit Area contains 40 unlined pits northeast of the plant buildings and southwest of the Northeast Site Creek. These Burial Pits were used to dispose of waste materials generated by the fuel fabrication processes. These onsite burials were created under the governance of the 1964 AEC regulations contained in 10 CFR 20.304. These regulations described the spacing of the pits, the thickness of the cover and the quantity of radioactive material that could be buried in each pit. The nominal dimensions of each Burial Pit are 20 ft wide by 40 ft long by 12 ft deep and the regulations provided that these were supposed to include an approximate cover depth of 4 ft.

Consignment of waste to the burial pits was reported to be in compliance with AEC regulations in effect at the time. Facility operating procedures described the size and spacing requirement for the burial pits, in addition to the required thickness of the overlying soil cover (4 ft), and the quantity of radioactive material that could be buried in each pit. 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 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.

The information recorded in the Burial Pit log books indicates that the waste consignments comprised a wide variety of waste types, and indicate that the on-site burial of radioactive material ceased in November of 1970. This information is further supported by interviews with former employees.

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 $g^{235}U$. 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 to 31.6 $g^{235}U$); and
- A Reactor tray (one entry at 40.4 $g^{235}U$).

Interviews with former employees indicate that on-site burials (in addition to the burial practices under 10 CFR 20.304 [1964]) may have occurred as early as 1958 or 1959. Available employee interview records indicate that three or four burials may have been performed each year, prior to

1965, for disposal of general trash and items that may have been slightly contaminated relative to the current radiological free release standards of that period. Accordingly it is estimated that 20-25 burials may exist for which there are no records. Burials prior to 1965 were not documented (logged), as they were not considered to contain significant quantities of SNM, and were not known to contain radioactive wastes. No information has been located to indicate the specific nature of the waste material buried in these undocumented pits. Additionally, no evidence has been found to indicate that burial of known Uranium-bearing materials (i.e., above free release criteria) occurred during this time period. These burials are believed to be in the area between the documented Burial Pits and the site buildings, under roadways in the eastern portion of the Central Tract Area.

Other burial areas at the Hematite site include the red room roof burial area (buried circa 1985) and the cistern burn pit area (used between mid-1960's and 1974). However, due to the former use of these areas and the non-process waste nature of the buried materials contained within the red room roof burial area, these areas are expected to contain materials with lower ^{235}U loading than the documented burial pits.

In addition to the burial areas described above, various contaminated soil areas are known to exist across the site. However, the ^{235}U contamination associated with these areas is expected to be less than the contamination associated with the documented burial pits.

1.2 Overview of the Hematite Decommissioning Project Operations

The Hematite Decommissioning Plan describes in detail the routine remediation operations that will be performed at the Hematite site, including activities involving the exhumation of buried process wastes and contaminated soils.

2.0 NUCLEAR CRITICALITY SAFETY APPROACH FOR ROUTINE REMEDIATION OPERATIONS

The criticality safety approach for removal of soil/waste from remediation areas of the Hematite site under routine operations relies on the identification of *non-NCS Exempt Materials* by comprehensive in-situ radiological survey and visual inspection, followed by careful extraction, containerization, and placement in Collared Drums (CDs) for segregation from other *non-NCS Exempt Materials*. *Non-NCS Exempt Materials* comprise *Hot Spots,* un-characterized intact containers, and un-characterized non-conforming items such as bulky objects or items with significant shielding.

The containerization of *non-NCS Exempt Materials* in CDs is important to ensuring safety prior to their evaluation in a Waste Evaluation Area (WEA) and assay in a Material Assay Area (MAA); the WEA, MAA, and a staging area that includes mechanical size reduction are planned to be located at Building 115. The general philosophy is to ensure that the conditions experienced by the *non-NCS Exempt Materials* during and following exhumation become no worse than those previously experienced. This is achieved by:

- Containerizing all exhumed *Hot Spots* using safe volume containers;
- Reducing the possibility of increased reactivity due to increased neutron interaction, by promptly placing each loaded safe volume container into a CD.
- Overpacking exhumed intact containers and non-conforming items using CDs or other approved conveyance, and treating the loaded CDs and other approved conveyances equivalently to CDs containing exhumed *Hot Spots*; and
- Ceasing exhumation of additional fissile materials within a distance of 12 feet or less until each loaded and lidded CD, or other approved conveyance, is transferred to a WEA/MAA or to an approved staging or storage area. Activities involving additional fissile materials that are at a distance of 12 feet or more may continue provided that the minimum spacing of 12 feet is maintained. Note that some areas allow CD de-collaring, which is justified in the governing Nuclear Criticality Safety Assessments (NCSAs).

For prudence and caution, all exhumed and containerized *non-NCS Exempt Materials* are treated as high fissile content materials until proven otherwise by radiological screening at a WEA, or radiological counting at an MAA.

The issued HDP NCSA for buried waste and contaminated soil remediation operations (Reference 1) establishes the requirements for operations involving the exhumation, handling, and packaging of *Hot Spots* comprising up to 350 $g^{235}U$. This NCSA demonstrates that all anticipated and foreseen abnormal conditions associated with routine operations concerning the exhumation, handling, and packaging of *Hot Spots* comprising up to 350 $g^{235}U$ will remain safely subcritical. The established NCS controls require that NCS staff shall be notified in the event of the identification of a *Hot Spot* with a ^{235}U mass content exceeding 350 $g^{235}U$, and require that the subject item shall not be disturbed without evaluation and direction by NCS staff. Since the issued NCSA (Reference 1) discussed above will be revised to allow for the safe exhumation, handling, and packaging of *Hot Spots* comprising up to 700 $g^{235}U$, the NCSCP described in Section 3.0 below will be invoked only for *Hot Spots* identified to contain in excess of 700 $g^{235}U$ (i.e., the *Contingency Hot Spots* defined in Section 1.0).

3.0 NUCLEAR CRITICALITY SAFETY PLAN FOR NON-ROUTINE REMEDIATION OPERATIONS INVOLVING CONTINGENCY HOT SPOTS

This section establishes the NCSCP for remediating *Contingency Hot Spots*. Specifically, it is intended that the NCSCP will be employed in the event of the discovery of any *Hot Spots* containing greater than 700 g ^{235}U during buried waste and contaminated soil remediation operations. The necessary limits and controls that cannot be specified in this NCSCP due to the need for case-specific information will be established in a case-specific NCSA. The limits and controls in the case-specific NCSA will ensure that the *Contingency Hot Spot* exhumation and subsequent operations will remain safely subcritical. All of the case specific NCSA requirements will be implemented and incorporated into the operations work package before proceeding.

3.1 Contingency Hot Spot Confirmation

Due to the conservatisms associated with the calibration basis for the radiological survey instruments used in support of the radiological survey of HDP remediation areas, it is likely that the identification of a *Contingency Hot Spot* would actually be the result of a much smaller mass positioned close to the detector as opposed to an object containing greater than 700 g ^{235}U. This is because the calibration basis for the radiological survey instruments conservatively assumes that all observed counts in the detector are the result of photon emission from a compact spherical object lying at the base of the soil/waste cut-depth. This scenario represents a low probability configuration relative to the likely distribution of any ^{235}U residues, which is expected to be typified by a relatively uniform low concentration distribution. Consequently, the coefficient that is used to correlate the observed counts in the detector to a ^{235}U mass estimate is very conservative. For this reason, the first step in the NCSCP for remediating a *Contingency Hot Spot* is to first verify that the *Hot Spot* is indeed a *Contingency Hot Spot* and not a *Hot Spot* of lower magnitude, or even the result of a small mass of ^{235}U close to the detector.

The *Contingency Hot Spot* confirmation process involves the successive removal of thin layers of material from the surface of the region immediately above the *Hot Spot*. Each layer will be removed as a maximum 2 inch thick layer of material. The removed material will be surveyed and collected in a safe volume container or other approved container if the removed material is determined to contain *non-NCS Exempt Material* (NCS-Exempt Material will be handled and removed for separate disposition). After each 2 inch thick layer of material is removed the depression created at the location of the *Hot Spot* will be re-surveyed. In the event that the radiological survey instrument records a similar or greater number of counts, but visual inspection does not reveal the presence of a discrete item (whether one object, a group of objects, or a cluster of material) with a significant ^{235}U mass loading, then another 2 inch thick layer of material is removed from the surface of the depression and is surveyed and loaded into a safe volume container or other approved container if the removed material is determined to contain *non-NCS Exempt Material*.

This process proceeds until either the *Hot Spot* has been completely remediated or until the investigation reveals that the *Hot Spot* is indeed a *Contingency Hot Spot* (without removing a revealed *Contingency Hot Spot*). Note that any *non-NCS Exempt Materials* placed in a safe volume container(s) or other approved container(s) during these operations will be over-packed using CDs (limit of only one container per CD), and evaluated similarly to the process described

in Section 3.6. Also note that only one safe volume container or other approved conveyance may be in use at one time, and following use, shall be over-packed in a CD. Until the lidded CD or other approved conveyance is transferred to a WEA/MAA or approved staging/storage area, additional fissile materials may not be exhumed at the respective remediation area (within 12 feet of the container). The drum may be de-collared for storage provided other means of neutronic isolation are established.

3.2 Determination of the Contingency Hot Spots Physical Attributes

Following confirmation that the *Hot Spot* is a *Contingency Hot Spot*, all activities involving other *non-NCS Exempt Materials* shall cease, except to the extent necessary to support operations associated with the *Contingency Hot Spot*.

The next step of the NCSCP is to establish the physical attributes of the *Contingency Hot Spot*. This involves identifying the volume, geometry, moderation state, and material properties (e.g., chemical form and density) of the *Contingency Hot Spot*. The methods used to ascertain the volume, geometry, moderation state and material properties could include visual inspection, sampling of surrounding soil, use of remote optical devices such as cameras, physical measurements, and/or radiological measurements. The determined attributes will be used to assess the margin of subcriticality of the *Contingency Hot Spot* in its in-situ condition, and to identify what precautions need to be exercised to support removal and packaging of the *Contingency Hot Spot*.

The Contingency Hot Spot could comprise: loose materials (e.g., loose pellets, powder, metal fragments, group of objects where each individual object contains less than 700 g of ^{235}U but the group exceeds 700 g, a cluster of material where the entire cluster contains more than 700 g of ^{235}U, etc.); or non-loose materials (e.g., a portion of a fuel rod, one or more objects where each individual object contains more than 700 g of ^{235}U, etc.). The differences in physical arrangements between loose and non-loose materials result in different safety approaches to exhumation and handling of the material, as described in subsequent sections of this document.

In addition, to the physical attributes evaluation described above, the enrichment of the uranium associated with the *Contingency Hot Spot* may also be determined to support its exhumation and packaging. If evaluated, the enrichment of the uranium will be determined by an appropriate analytical method. Examples of methods that may be used include in-situ measurement using a calibrated and collimated High Resolution Gamma Spectrometer, or sampling and analysis.

Note that limited volume samples may also be extracted, as necessary, to obtain as accurate information as possible to assist in the physical attributes evaluation (specifically, the material properties and enrichment attributes) described above. If this option is exercised then the combined volume of the samples collected at one time will be minimized to a safe volume. The collected samples will undergo field analysis and, if found to contain *non-NCS Exempt Materials,* will be placed into safe volume container(s) and over-packed using CDs (limit of only one container per CD). Unless prepared for shipment for off-site analysis, samples that are designated as *non-NCS Exempt Material* will be stored equivalent to CDs containing exhumed *Hot Spots*.

It is noted that the method(s) used to establish the volume, geometry, and moderation state of the *Contingency Hot Spot* will be appropriate and reflective of the need to avoid its disturbance.

3.3 Environmental Precautions

As noted in the preceding subsection, the physical attributes evaluation will permit an evaluation of the margin of subcriticality for the *Contingency Hot Spot* in its in-situ condition. Environmental precautions will be exercised, as necessary, to preserve the assessed margin of subcriticality. This may involve the erection of a weather shelter surrounding the *Contingency Hot Spot* and immediate surrounding area. In addition, a berm may be created surrounding the perimeter of the erected shelter to prevent the infiltration of surface water. Depending on the ground water conditions, portable suction hose(s) may also be employed to minimize the ingress of groundwater. Each of these measures will act to preserve or reduce the moderation state of the *Contingency Hot Spot* in its in-situ condition.

In addition to the moderation precautions outlined above, the terrain in the vicinity of the *Contingency Hot Spot* will be stabilized, if necessary, to prevent unintended movement of the *Contingency Hot Spot* or buried materials in the vicinity of the *Contingency Hot Spot*. If utilized, stabilization may involve the use of portable structures to support the surface of the soil/waste. For example, any voids may be filled with empty containers to prevent movement or slumping of the surrounding materials from disturbing the *Contingency Hot Spot*.

3.4 Exhumation and Containerization of the Contingency Hot Spot

The physical attributes evaluation described in Section 3.2 is focused on providing information about the *Contingency Hot Spot* including its volume, geometry, moderation state, material properties (e.g., chemical form and density), and uranium enrichment. The material properties and enrichment data provided by this evaluation will facilitate quantification of the bounding maximum subcritical mass for the *Contingency Hot Spot*. This will be achieved through the use of standards, handbook values, or validated calculational methods. For example, the subcritical values provided in ANSI 8.1 may be used and safety factors may be applied to critical values provided in handbooks such as LA-10860, LA-12808, and ARH-600. The derived bounding maximum subcritical mass will be used, as direct input, to the case specific NCSA which will be developed to establish the necessary limits and controls to ensure that the *Contingency Hot Spot* exhumation and subsequent operations will remain safely subcritical. All of the NCSA requirements will be implemented and incorporated into the operations work package before proceeding.

For *Contingency Hot Spot* consisting of loose material, a portion of the *Contingency Hot Spot* operations are amenable to using the routine operations evaluated by issued NCSAs for up to 350 g of ^{235}U. As stated in Section 2.0 above, the issued NCSAs will be revised to address as part of routine operations the safe exhumation, handling, and packaging of *Hot Spots* comprising up to 700 g^{235}U. Thus, the following discussions that utilize the routine operations NCSAs as part of the contingency process will also utilize these future revised NCSAs for *Hot Spots* comprising up to 700 g^{235}U.

In the event that the estimated ^{235}U mass associated with the *Contingency Hot Spot* is established to not exceed the bounding maximum subcritical mass, then any disturbance of the *Contingency Hot Spot* during its exhumation would necessarily not result in an unsafe condition. This is because the bounding maximum subcritical mass described above is based on an idealized spherical uranium-water mixture at optimum concentration and with full water reflection. Consequently, any potential reconfiguration of the *Contingency Hot Spot* during its exhumation

could not result in a critical state. Nevertheless, when feasible HDP will preserve the maximum ^{235}U mass loading limit of 350 g^{235}U for CDs, as established in the HDP NCSAs. The results of the radiological surveys and/or sample analysis will be used to guide the exhumation of the *Contingency Hot Spot*. Specifically, the results will be used to ensure that the maximum mass of ^{235}U exhumed at one time does not exceed 350 g^{235}U, and to ensure that each loaded CD will not contain greater than 350 g^{235}U. However, if the *Contingency Hot Spot* cannot be exhumed and containerized in pieces due to the nature of the item, or if the *Contingency Hot Spot* is too large to be accommodated within a CD, then its retrieval and containerization will proceed as defined below for 'Non-Loose Materials'.

Until the *Contingency Hot Spot* has been exhumed and containerized within CD(s), activities involving other *non-NCS Exempt Materials* shall not occur within 12 feet of the *Contingency Hot Spot*.

In the event that the estimated total ^{235}U mass content of the *Contingency Hot Spot* is established to exceed the bounding maximum subcritical mass for an idealized spherical geometry and optimum water moderated system, then exhumation of the *Hot Spot* will proceed as follows:

<u>*Contingency Hot Spots* Comprising Loose Materials</u>

If the *Contingency Hot Spot* is observed to comprise loose materials (e.g., loose pellets, powder, metal fragments, etc.), then small quantities (safe volume) of material may be removed from the *Contingency Hot Spot* at one time. The exhumed materials will be loaded into a safe volume container. Each loaded safe volume container will be lidded and over-packed using an empty CD, which will be limited to containing a maximum of only one loaded safe volume container at one time. Until the lidded CD is transferred to a WEA/MAA or approved staging/storage area, activities involving other *non-NCS Exempt Materials* shall not occur within 12 feet of the container. (The drum may be de-collared at the staging/storage area provided other means of neutronic isolation are established.) This process will continue until the entire *Contingency Hot Spot* has been remediated. The approach outlined represents an effective criticality safety strategy because the use of safe volume containers in addition to the moderation mitigation measures outlined in Section 3.3 will ensure that the exhumed materials will remain safely subcritical during exhumation and containerization. Moreover, the use of safe volume containers provides reasonable assurance that each loaded CD will not comprise in excess of 350 g^{235}U, which is important to the safety basis of the operations described in Sections 3.5 and 3.6.

Contingency Hot Spots Comprising Non-Loose Materials

If the *Contingency Hot Spot* is observed to comprise non-loose materials (e.g., a portion of a fuel rod, etc.) then the non-loose portions of the *Contingency Hot Spot* may be removed at one time provided that an analysis determines that the physical attributes of each non-loose portion (refer to Section 3.2) render it intrinsically safe. However, any physical attributes credited for this evaluation will be sufficiently robust to ensure that the credited attributes will remain valid during the item exhumation, handling, and packaging operations. These precautions, in addition to the moderation mitigation measures outlined in Section 3.3, will ensure that the *Contingency Hot Spot* will remain safely subcritical during its exhumation, handling, and containerization. Moreover, because the reflection conditions experienced by the *Contingency Hot Spot* would tend to be reduced during and following retrieval than compared to its in-situ condition, the margin of subcriticality would be expected to increase. Additionally, neutron interaction with other materials would be expected to be negligible following exhumation relative to the potential condition experienced by the *Contingency Hot Spot* while in-situ.

The exhumed intact *Contingency Hot Spot* (or intact *Contingency Hot Spot* portions) will be over-packed using an empty CD or other larger volume container in the event that the item is too large to be accommodated within a CD. However, if the *Contingency Hot Spot* (or intact *Contingency Hot Spot* portion) cannot be accommodated in a container that is suitable for transit and storage then the item may be transferred directly from the site of its exhumation to the WEA/MAA, or to a staging/storage area if necessary. Under such circumstances, the conveyance method used will be appropriate to the characteristics of the *Contingency Hot Spot* (e.g., its size and shape) and will be controlled to ensure that the credited physical attributes will remain valid during its handling, evaluation/assay, and storage.

Until the *Contingency* Hot *Spot* has been exhumed and containerized activities involving other *non-NCS Exempt Materials* shall not occur within 12 feet of the *Contingency Hot Spot*.

3.5 Handling and Transit of the Contingency Hot Spot

Contingency Hot Spots Over-packed using CDs

Following loading of the CD(s) with the exhumed materials associated with portions of the *Contingency Hot Spot*, the CD(s) will be transferred to the WEA/MAA for characterization or to a staging/storage area until characterization at the WEA/MAA can be accomplished. (The drum may be de-collared at the staging/storage area provided other means of neutronic isolation are established.) The HDP NCSA for CD transit, staging, and storage operations (Reference 2) establishes the requirements for the handling and transit of loaded CDs, and demonstrates that CDs containing up to 350 g ^{235}U each will remain safely subcritical under all anticipated and foreseen abnormal conditions. Since the operations described in the preceding section for *Contingency Hot Spots* comprising loose materials will ensure that all CDs loaded with such materials will not comprise in excess of 350 g ^{235}U, the CD handling and transit operations will remain safely subcritical.

The preceding section also discusses *Contingency Hot Spots* comprising non-loose materials and recognizes that they may comprise in excess of 350 g ^{235}U, and/or may have dimension(s) that are too large to be accommodated within a CD. If the *Contingency Hot Spot* does fit within a CD but is estimated to contain greater than 350 g ^{235}U, then a CD may be used to over-pack the item provided that all other *non-NCS Exempt Materials* are segregated from the *Contingency Hot*

Spot, with a minimum administrative separation distance of 12 ft maintained at all times. Furthermore, any CDs loaded with greater than 350 g ^{235}U will be clearly marked as "high ^{235}U mass" CDs. These precautions will ensure that the *Contingency Hot Spot* remains in a safely subcritical state during handling and transit.

In the event that *Contingency Hot Spots* comprising non-loose materials cannot be overpacked by a CD due to their dimension(s), then the packaging/conveyance method used will be as described below.

Contingency Hot Spots Over-packed using Other Containers

The exhumed intact *Contingency Hot Spot* (or intact *Contingency Hot Spot* portions) will be over-packed using a container that has a minimum dimension larger than the inner diameter of a CD if the item is too large to be accommodated within a CD. Any container that is estimated to contain greater than 350 g ^{235}U will be clearly marked as "high ^{235}U mass" container. In the event that the *Contingency Hot Spot* is too large to be accommodated within a CD or larger dimension container that is suitable for transit and storage, then the *Contingency Hot Spot* may be transferred directly from the site of its exhumation to the WEA/MAA, or to a staging/storage area if necessary. The conveyance method used will be appropriate to the characteristics of the *Contingency Hot Spot* (e.g., its size and shape) and will be controlled to ensure that the credited physical attributes will remain valid during handling and transit.

To ensure that any exhumed *Contingency Hot Spot* not packaged within a CD will remain neutronically isolated during transit, all other *non-NCS Exempt Materials* will be segregated from the *Contingency Hot Spot*, with a minimum administrative separation distance of 12 ft maintained at all times. These precautions will ensure that the *Contingency Hot Spot* remains in a safely subcritical state during handling and transit.

3.6 Characterization of the Contingency Hot Spot

Contingency Hot Spots Over-packed using CDs

The HDP NCSA for waste evaluation and assay activities (Reference 3) establishes the requirements for waste characterization operations and demonstrates that such operations will remain safely subcritical under all anticipated and foreseen abnormal conditions. Where the CD(s) loaded with the materials exhumed from the *Contingency Hot Spot* do not comprise in excess of 350 g ^{235}U (with one exception noted below), they are bounded by the operational assumptions used in the NCSA for routine waste characterization (Reference 3). Consequently, characterization of the CD(s) containing the exhumed *Contingency Hot Spot* according to the requirements of the governing NCSA (Reference 2) will ensure that the *Contingency Hot Spot* characterization operations will remain safely subcritical.

The one exception noted above concerns *Contingency Hot Spots* comprising non-loose materials that possess dimensions that can be accommodated by a CD but are estimated to comprise in excess of 350 g ^{235}U. Any CDs meeting these criteria will be accepted and evaluated within the WEA/MAA only following the removal of all other *non-NCS Exempt Materials* from the subject WEA/MAA. The WEA/MAA characterization operations will be conducted in a manner that does not erode the safety margin afforded by the *Contingency Hot Spots* physical characteristics. These precautions will ensure that all operations associated with characterization of the *Contingency Hot Spot* will remain safely subcritical.

Contingency Hot Spots Over-packed using Other Containers

All *Contingency Hot Spots* that are not contained within a CD will be accepted and evaluated within the WEA/MAA only following the removal of all other *non-NCS Exempt Materials* from the subject WEA/MAA. The WEA/MAA characterization operations will be conducted in a manner that does not erode the safety margin afforded by the *Contingency Hot Spots* physical characteristics. These precautions will ensure that all operations associated with characterization of the *Contingency Hot Spot* will remain safely subcritical.

3.7 Storage of the Contingency Hot Spot

All *non-NCS Exempt Materials* generated as a result of the operations conducted under this NCSCP will be stored in accordance with the Physical Security Plan (PSP). The following additional precautions will be exercised to ensure the subcriticality of the storage configuration.

Contingency Hot Spots Over-packed using CDs

The HDP NCSA for storage operations (Reference 4) establishes the requirements for the storage of CDs containing *non-NCS Exempt Material*. The NCSA demonstrates that CDs containing up to 350 $g^{235}U$ each will remain safely subcritical under all anticipated and foreseen abnormal conditions. Consequently, storage of the characterized CD(s) containing the materials associated with the exhumed *Contingency Hot Spot*, in accordance with the requirements of the governing NCSA (Reference 4), will ensure that the containerized materials will remain safely subcritical.

It is noted that in the unlikely event the *Contingency Hot Spot* characterization operations described in Section 3.6 identifies that any container containing greater than 350 $g^{235}U$, the subject container will be stored in an isolated storage configuration, with a minimum separation distance of 6 ft between the content of any container(s) in an isolated storage configuration. HDP Nuclear Criticality Safety Calculations (NCSCs) (Reference 7) demonstrates no adverse neutron interaction effects are realized in an infinite planar array of nominal 55-gallon drums when the separation distance between the drums is at least 6 ft. This is demonstrated by showing that the effective neutron multiplication factor, k_{eff}, of a single fully reflected drum is greater than the k_{eff} of an infinite planar array of drums with a drum surface-to-surface separation distance of 6 ft, and with each drum containing the same drum content as the single fully reflected drum. It is noted that stacking of CDs is not currently authorized under routine operations and will be prohibited for any operations performed under this NCSCP.

The storage area for *non-NCS Exempt Materials* exhumed during NCSCP operations is covered and inadvertent flooding (i.e., moderation / reflection from water) is precluded by design. Furthermore, the containers are securely closed and sealed when placed into storage.

Contingency Hot Spots Over-packed using Other Containers

Any *Contingency Hot Spot* that is not contained within a CD will be stored in an isolated storage configuration, with a minimum 12 ft separation distance from all other *non-NCS Exempt Materials*. This substantial minimum separation distance ensures that the *Contingency Hot Spot* will be effectively neutronically isolated.

3.8 Disposition of the Contingency Hot Spot

Disposition of the *Contingency Hot Spots* generated from the operations conducted under this NCSCP will be performed in accordance with the case-specific NCSA that will be developed to establish the necessary limits and controls to ensure that the *Contingency Hot Spot* exhumation and subsequent operations (e.g., evaluation, size reduction, packaging for off-site transportation, etc.) will remain safely subcritical. In addition, the disposition operations will recognize the requirements of the PSP, and will be performed in accordance with the Department of Transport (DOT) and Nuclear Regulatory Commission (NRC) transportation regulations.

3.9 Transfer of Contingency Hot Spot Material to DOE Container(s) for Transportation

The transfer of the *Contingency Hot Spots* generated from the operations conducted under this NCSCP to a Department of Energy (DOE) conveyance will be conducted in a manner that ensures effective neutronic isolation from other *non-NCS Exempt Materials*. Specifically, a minimum 12 ft separation distance from all other *non-NCS Exempt Materials* will be maintained during loading operations, and will apply until the materials designated for transportation have been placed within the approved DOE container in accordance with the containers ^{235}U mass loading limit. This substantial minimum separation distance preserves the effective neutron isolation between the *Contingency Hot Spots* while outside of the approved DOE conveyance.

Other precautions that will be exercised during transfer of *Contingency Hot Spots* to a Department of Energy (DOE) conveyance include ensuring that the area in which the transfer operations are performed is sufficiently sheltered from precipitation, other moderation (water) sources, and is not subject to inadvertent flooding.

4.0 EMERGENCY RESPONSE

This NCSCP will be employed under any circumstances in which in-situ radiological and visual inspection activities performed in any HDP remediation area results in the identification of a *Contingency Hot Spot*. While it is expected that the probability of encountering a *Contingency Hot Spot* is extremely small, the possibility of encountering such an object necessitates the need for provision of a portable Criticality Accident Alarm System (CAAS). For this reason, a portable CAAS will be employed for all NCSCP operations, with the exception of any operations that are exempted by an NRC approved exemption request.

Because the provision of a CAAS introduces conventional hazards associated with the response to false alarms, a CAAS will be employed only following confirmation that the *Hot Spot* is indeed a *Contingency Hot Spot*. This posture is consistent with the national consensus standard for criticality monitoring systems, ANSI/ANS-8.3 (Reference 5), which is endorsed by the NRC in Regulatory Guide 3.71 (Reference 6), with certain exceptions. This is because it is stated (in Section 4.1.1 of Reference 5) that installation of a CAAS implies a nontrivial risk of criticality. This statement suggests that a CAAS should only be installed when it will result in a reduction in total risk. Stated conversely, a CAAS should not be installed when it will result in an increase in personnel risk. The standard also makes it clear that the hazards associated with false alarms are an important consideration.

When employed for NCSCP operations, the portable CAAS will be calibrated and functionally checked prior to use and will be configured in accordance with the requirements of 10 CFR 70.24 (a)(2). In addition to the provision of a portable CAAS for NCSCP operations, the following emergency response measures will be implemented:

- Restrict access to the site in accordance with the site PSP;
- Deploy only authorized personnel that are trained specifically to the NCSCP and PSP for work involving *Contingency Hot Spot*s;
- Prohibit movement of all *non-NCS Exempt Materials* in the event of loss of portable CAAS coverage, including any deactivation to facilitate relocation to cover other areas.
- Establish site emergency response procedures and facilities in accordance with the requirements of 10 CFR 70.24 (a)(3), (b)(1), and (b)(2).

5.0 CONCLUSIONS

This NCSCP prescribes the approach that will be followed in the event of the discovery of a *Contingency Hot Spot*, and demonstrates that the prescribed operational response will ensure that all associated operations will remain safely subcritical with a large margin of safety.

6.0 REFERENCES

1. NSA-TR-09-15, Rev. 0, Nuclear Criticality Safety Assessment of Buried Waste Exhumation and Contaminated Soil Remediation at the Hematite Site, B. Matthews, May 2009.
2. NSA-TR-09-10, Rev. 0, Nuclear Criticality Safety Assessment of Collared Drum Staging, Buffer Storage, and Transit at the Hematite Site, B. Matthews, May 2009.
3. NSA-TR-09-09, Rev. 0, Nuclear Criticality Safety Assessment of Waste Evaluation and Assay Activities at the Hematite Site, B. Matthews, May 2009.
4. NSA-TR-09-12, Rev. 0, Nuclear Criticality Safety Assessment of Fissile Material Storage at the Hematite Site, D. Vaughn, May 2009.
5. ANSI/ANS-8.3-1997, Criticality Accident Alarm System – an American National Standard, American Nuclear Society.
6. Regulatory Guide 3.71, Rev. 1, Nuclear Criticality Safety Standards for Fuels and Material Facilities, US Nuclear Regulatory Commission, October 2005.
7. NSA-TR-09-04, Rev. 0, Nuclear Criticality Safety Calculations for Isolated Drum Storage, D. Vaughn, April 2009.