Sludge Treatment Project KOP Conceptual Design Control Decision Report

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

**P.O. Box 1600
Richland, Washington 99352**

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C. A. Carro

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TERMS

ARF	Airborne Release Fraction
CHPRC	CH2M HILL Plateau Remediation Company
CSB	Canister Storage Building
CSER	Criticality Safety Evaluation Report
CVDF	Cold Vacuum Drying Facility
IWTS	Integrated Water Treatment System
KOP	Knock-Out Pot
KPS	Knock-Out Pot Processing System
KW	105-K West (Basin)
MAR	Material-at-Risk
MCO	Multi-Canister Overpack
PCM	Primary Clean Machine
PISA	Potential Inadequacy in the Safety Analysis
RF	Respirable Fraction
SSCs	Structures, Systems, and Components
USQ	Unreviewed Safety Question

1.0 INTRODUCTION

This control decision addresses the Knock-Out Pot (KOP) Disposition KOP Processing System (KPS) conceptual design. The KPS functions to (1) retrieve KOP material from canisters, (2) remove particles less than 600 μm in size and low density materials from the KOP material, (3) load the KOP material into Multi-Canister Overpack (MCO) baskets, and (4) stage the MCO baskets for subsequent loading into MCOs.

Hazard and accident analyses of the KPS conceptual design have been performed to incorporate safety into the design process. The hazard analysis is documented in PRC-STP-00098, *Knock-Out Pot Disposition Project Conceptual Design Hazard Analysis*. The accident analysis is documented in PRC-STP-CN-N-00167, *Knock-Out Pot Disposition Sub-Project Canister Over Lift Accident Analysis*. Based on the results of these analyses, and analyses performed in support of MCO transportation and MCO processing and storage activities at the Cold Vacuum Drying Facility (CVDF) and Canister Storage Building (CSB), control decision meetings were held to determine the controls required to protect onsite and offsite receptors and facility workers. At the conceptual design stage, these controls are primarily defined by their safety functions. Safety significant structures, systems, and components (SSCs) that could provide the identified safety functions have been selected for the conceptual design. It is anticipated that some safety SSCs identified herein will be reclassified based on hazard and accident analyses performed in support of preliminary and detailed design.

2.0 FACILITY AND PROCESS DESCRIPTION

The KPS facility and process descriptions provided below are supported by engineering drawings in Appendix A. Figure A-1 is the process flow diagram. Figures A-2 through A-4 present the piping and instrumentation drawings. Figure 2-1 provides an overview of the KPS equipment and process. The engineering drawings in Appendix A are revisions of the drawings upon which the hazard analysis documented in PRC-STP-00098 was based. The principal change was the elimination of the oxide purge station. The drawing revisions were reviewed and it was determined that the changes do not introduce new hazardous conditions nor change the consequences of the previously identified hazards.

The separation function of the KPS is critical to the successful disposition of KOP material. The separation function has two functional requirements: (1) the removal of particles less than 600 μm , and (2) the removal of low-density, non-uranium materials. As discussed in KBC-38156, *Conceptual Feasibility Report for KOP Accelerated Disposition*, the removal of particles smaller than 600 μm and non-uranium materials reduces the amount of hydrates that must be assumed in the material (which determines the quantity of chemically bound water), reduces the reactive surface area that must be assumed (which impacts the hydrogen generation rate, thermal stability, and the material at risk for MCO accidents), facilitates drying at the CVDF, and reduces the overall volume of material that must be loaded into MCOs.

2.1 FACILITY DESCRIPTION

The KPS will be comprised of existing and new equipment located in the West Bay of the 105-K West (KW) KW Basin. A description of the KW Basin can be found in HNF-SD-WM-SAR-062, *KW Basin Final Safety Analysis Report*, Chapter 2, Section 2.4.1.2, "105-KW Fuel Storage Basin." The principal existing equipment that will be used is the Primary Clean Machine (PCM), the Integrated Water Treatment System (IWTS), and MCO Mark 1A scrap baskets. New equipment includes screened canisters, a Screened Separations Table, a vacuum wand and associated low density collection strainers, Verification Containers, and MCO basket Copper Inserts.

2.1.1 Primary Clean Machine

The PCM is described in HNF-SD-WM-SAR-062, Chapter 2, Section 2.5.3.1, "Primary Clean Machine Equipment Description." The PCM was originally used to clean fuel and debris canisters. Recently, the PCM has been used to clean canisters of KOP material as part of in-basin KOP characterization activities, as described in HNF-SD-WM-SAR-062, Chapter 2, Section 2.5.8.3, "KOP, PCM Strainer, and IWTS Strainer In-Basin Characterization."

Figure 2-1. KOP Material Retrieval, Separations, and Sampling Equipment and Process Overview.

The PCM includes the following equipment:

- Stationary outer enclosure box that houses the rotating fuel wash basket
- Wash basket drive assembly
- High-pressure flush nozzles
- Strainer basket located in the bottom of the PCM outer enclosure box
- Enclosure box water discharge pump housing
- Skid-mounted, high-pressure pump assembly and control valves
- PCM control station
- Hydraulic wash basket locking mechanism
- Fuel canister locating guides
- Fuel canister locking mechanism.

The stationary outer enclosure is a steel box. Hinges on one side allow the top of the box to be tipped up to gain access to the inside of the PCM. A two-piece cylindrical wash basket is mounted inside the enclosure. The wash basket, designed to hold a canister, is split in half with a joint allowing it to be opened by removing one half. The wash basket is rotated inside the enclosure by a drive mechanism. Water nozzles mounted inside the enclosure spray pressurized water through slots in the wash basket to flush out the sludge. A suction connection provides a continuous flow of water from the PCM enclosure to the IWTS. The IWTS is described in HNF-SD-WM-SAR-062, Chapter 2, Section 2.5.7.3, "Integrated Water Treatment System." Suction flow from the PCM is greater than pressurized water inflow to maintain basin water clarity.

For KPS use, KOP material will be washed in the PCM using a newly-designed, double-barreled screened canister. The screened canister openings will be a nominal 600 μm in size. An agitator will be placed in the canister with the KOP material to breakup friable non-uranium components (e.g., grafoil, aluminum hydroxide) into smaller particles during the cleaning process.

2.1.2 Screened Separations Table

The Screened Separations Table will be comprised of a wedge wire screened region and a Verification Container loading area. The openings of the screened region will be a nominal 600 μm in size. KOP material on the screened region will be moved and agitated using water spray nozzles and manual tools. Material smaller than 600 μm that passes through the screened region of the table will be pumped to the IWTS.

Low density material will be vacuumed from KOP material on the screened region using a vacuum wand and pumped to a low density collection strainer. The flow velocity through the vacuum end effector will be controlled such that 600 μm or larger uranium metal particles will not be collected. Particles collected by the vacuum wand that are less than 600 μm will pass through the low density collection strainer and be pumped to the IWTS. Material collected on the strainer will be disposed of as radioactive waste.

The Verification Container loading area of the Screened Separations Table includes openings under which Verification Containers will be positioned. The openings will be normally plugged to prevent foreign material from collecting in a Verification Container.

2.1.3 Verification Containers

The Verifications Containers are sized to hold approximately 1.3 L of KOP material. The containers are provided with markings so Operators can determine the actual volume of KOP material in the container. The containers will be filled by moving KOP material to the openings in the Verification Container loading area of the Screened Separations Table. The Verification Containers are provided with a bail for manually moving and weighing the containers.

2.1.4 MCO Baskets and Copper Inserts

The KOP material will be loaded into Copper Inserts which fit into a Mark 1A scrap basket. Mark 1A scrap baskets, made of stainless steel and copper, are approximately 22.6 in. in diameter and 23.3 in. high with a center post of 6.63 in. in diameter. The bottom of the baskets is supported by a flat plate with holes to permit effective water and gas flow. The center post provides handling capability.

The Copper Inserts are fabricated with a slot to hold the KOP material. The slot is approximately 1 in. wide by 4.5 in. long and 20.5 in. high (i.e., the entire height of the insert). The KOP material is held in the slot by a nominal 500 μm screen at the bottom of the insert. After KOP material is transferred from a Verification Container to a Copper Insert, a 500 μm top screen is put in place. The slots are sized to hold approximately 1.3 L of KOP material when the top and bottom screens are in place. A Mark 1A scrap basket will hold six Copper Inserts (see Figure-2-2).

Figure 2-2. Mark 1A Scrap Basket and Copper Inserts.

2.2 PROCESS DESCRIPTION

2.2.1 KOP Washing in the Primary Clean Machine

As of February 2010, there is a total of approximately 815 kg of KOP material stored in canisters in the West Bay of the KW Basin. The KPS process starts with the transfer of KOP material to a screened canister. Each barrel of the double-barreled screened canister will be filled with approximately 10 L of KOP material. An agitator will be placed in each canister barrel along with the KOP material and a canister lid put in place. The canister will then be washed in the PCM. During the washing cycle, the agitator will function to breakup friable, non-uranium components (e.g., grafoil, aluminum hydroxide) into smaller particles. Particles, both uranium and non-uranium, less than 600 μm in size will be washed out of the canister and into the IWTS.

After washing, the canister will be removed from the PCM and weighed using an existing safeguards scale. The canister will then be washed a second time and re-weighed. The wash/weigh cycle will be repeated until there is no appreciable weight loss. The KOP material is then ready for transfer to the Screened Separations Table.

2.2.2 Screened Separations Table Material Screening

After washing in the PCM, KOP material will be transferred to the screened region of the Screened Separations Table. Using water spray nozzles and manual tools, operators will move the KOP material over the 600 μm screen in multiple passes. Any remaining particles less than 600 μm in size will fall through the screen and be transferred to the IWTS.

Two additional activities will be performed in the screened region of the table, i.e., the removal of aluminum wires and the removal of other low density materials greater than 600 μm in size. Aluminum wire was used on the bottom of several hundred canisters of fuel. When these fuel canisters were washed in the PCM, some of the wire was damaged and subsequently collected in KOPs. The other low density materials of principal concern are grafoil and aluminum hydrates. Grafoil was used as a seal on the fuel canister lids. Aluminum hydrates were formed on the surfaces of aluminum fuel canisters during years of storage. The purpose of removing these materials is to increase the bulk density of the KOP material, which is used to determine the quantity of chemically bound water ultimately loaded into an MCO.

To remove the aluminum wire fragments and low density materials, operators will move the KOP material over a small section of coarse screen (e.g., 1/8 – 3/16 in. perforations). After this pre-screening, the wire fragments and low density materials will be removed from the KOP material with the vacuum wand.

As previously stated, the flow velocity through the vacuum end effector will be controlled such that uranium metal particles 600 μm and larger in size will not be collected. Low density particles and aluminum wire fragments collected by the vacuum wand that are greater than 600 μm will be collected on the low density collection strainer. A radiation detector will be used to verify that material collected on the strainer can be disposed of as radioactive waste. Material that passes through the low density collection strainer will be transferred to the IWTS.

After the KOP material has been screened, and aluminum wire and low density materials have been removed, it is ready for transfer to the Verification Container loading area of the Screened Separations Table.

2.2.3 Verification Container Filling and Density Verification

Empty Verification Containers, once placed in the basin water, will be weighed to obtain a tare weight. They will then be pre-positioned under the openings of the Verification Container loading area of the Screened Separations Table. Plugs in the openings prevent foreign material from dropping into the containers. When KOP material has been screened and low density materials removed, the plugs will be removed from the openings and the KOP material will be sluiced or pushed over the openings using the spray nozzles or manual tools.

Filled Verification Containers will be removed from their fixtures under the Screened Separations Table and weighed. From the known volume and measured mass, the bulk density of the KOP material will be calculated. If the calculated bulk density is lower than a target density, the material in the container may be returned to the PCM for additional size reduction or transferred back to the Screened Separations Table for additional processing. If the material equals or exceeds the target density requirement, it is ready for transfer to a Copper Insert.

2.2.4 Copper Insert Filling and MCO Basket Loading,

KOP material that meets the bulk density requirement will be transferred to a Copper Insert by use of a fill funnel. The fill funnel will be positioned over the slot of a Copper Insert and the Verification Container manually tipped such that the KOP material falls into the slot. The material is held in the slot at the bottom by a 500 μ m screen.

When the KOP material has been loaded into the Copper Insert slot, a 500 μ m top screen will be put in place. It has not yet been determined whether the Copper Inserts will first be filled with KOP material and then loaded into an MCO basket, or if empty Copper Inserts will be placed in an MCO basket and then filled.

3.0 ACCIDENT ANALYSIS RESULTS AND COMPARISON TO GUIDELINES

3.1 ACCIDENT ANALYSIS RESULTS

The hazardous conditions identified in PRC-STP-00098 with the potential for an uncontrolled release are:

- Load Drop
- Spent Nuclear Fuel Overlift
- MCO Overpressurization
- MCO Internal Hydrogen Deflagration
- MCO Thermal Runaway.

As stated in PRC-STP-00098, the spent nuclear fuel overlift and load drop hazardous conditions are not new or unique to the KPS. Spent nuclear fuel overlifts and load drops of fuel canisters and MCO baskets were identified and evaluated in the HNF-3960, *K Basins Hazard Analysis*, and are analyzed as design basis accidents in HNF-SD-WM-SAR-062. A spent nuclear fuel overlift accident specific to KOP material in a fuel canister is analyzed in PRC-STP-CN-N-00167.

It is important to note that the MCO overpressurization, deflagration, and thermal runaway accidents do not occur during KPS activities. The overpressurization and deflagration accidents potentially exist once the MCOs are loaded and ready for transport to the CVDF and CSB, and a thermal runaway accident is only credible at CVDF. However, the frequency and consequences of these accidents are dictated, in large part, by the quantity and physical and chemical characteristics of the KOP material that is loaded into the MCO baskets. Therefore, KPS activities must be controlled to prevent unacceptable accident consequences or unanalyzed accident conditions during subsequent MCO processing at CVDF, storage at CSB, and during inter-facility transfers. The overpressurization, deflagration, and thermal runaway design basis accidents with the bounding consequence are documented in HNF-3553, Volume 3, Annex B, *Cold Vacuum Drying Facility Final Safety Analysis Report*.

Table 3-1 presents the consequences of the load drop, spent nuclear fuel overlift, and MCO overpressurization, deflagration, and thermal runaway design basis accidents. A summary of each accident scenario is provided below:

- Load Drop: Load drop accidents are analyzed in HNF-SD-WM-SAR-062, Section 3.4.2.1, "105-KW Heavy Load Drops." As described in HNF-SD-WM-SAR-062, the scenario is an accidental drop of a heavy load into the basin or onto the basin floor due equipment failure, human error, or a seismic event. The drop of an MCO basket or knockout pot during normal operations is specifically addressed as is the drop of an MCO basket while loading the MCO. No consequences are calculated because the drops do not perforate the basin floor when credit for controls is taken.
- Spent Nuclear Fuel Overlift: As described in PRC-STP-CN-N-00167, the scenario is the overlift of a KOP canister out of the basin water due to human error or equipment failure. It is assumed that each barrel of the double-barreled canister contains 12 L of KOP material. The uranium metal in the KOP reacts with water to form UO_2 and reaches

a temperature of 100 °C. The material-at-risk is 12.6 kg UO₂ which is the quantity of uranium oxide generated during 2-hour release duration at 100 °C. The airborne release fraction (ARF) and respirable fraction (RF) are 2.0×10^{-3} and 1.0, respectively.

- **MCO Overpressurization:** An MCO overpressurization is analyzed in HNF-3553, Volume 3, Annex B, Section B.3.4.2.6, "Multi-Canister Overpressurization." The accident is assumed to begin during or following the water draining process, with some undrained water still present in the MCO to react with the fuel. The water reacts with uranium and uranium hydride producing hydrogen gas that pressurizes the MCO. Given sufficient time and water, the reactions will eventually lead to an increase in pressure sufficient to breach the MCO. The blowdown of particulate is assumed through a breach assumed to be an opening 1-in. in diameter at a pressure of 345 psig. The MAR for the blowdown is 57.2 kg of uranium and the ARF/RF is 2×10^{-3} . After the blowdown, there is a 2-hr continuous release as the fuel-water reactions continue. The MAR for the continuous release is 3.5 kg of uranium and the ARF/RF is 8×10^{-6} .
- **MCO Internal Hydrogen Deflagration:** An MCO internal hydrogen deflagration is analyzed in HNF-3553, Volume 3, Annex B, Section B.3.4.2.4, "Multi-Canister Overpack Internal Hydrogen Deflagration." Hydrogen is generated in the MCO during processing at CVDF. Given multiple failures of equipment and process monitoring, significant quantities of oxygen and hydrogen could accumulate inside an MCO during the drain and purge/flush, drying, proof, and pressure test portions of the CVDF process. An ignition source is assumed to be present in the MCO. The deflagration pressurizes the MCO and particulate material is blown-out through a line break or a rupture disk. The MAR is 27.2 kg of uranium. The ARF/RF is 2×10^{-3} .
- **MCO Thermal Runaway:** An MCO thermal runaway is analyzed in HNF-3553, Volume 3, Annex B, Section B.3.4.2.5, "Multi-Canister Overpack Thermal Runaway Reaction." Thermal runaway reaction accidents can occur if heat removal from the MCO is not sufficient to prevent the fuel from heating up as a result of decay heat and chemical reaction heat. As the temperature increases, the chemical reaction rate also increases. If the reaction were allowed to continue, the temperature would continue to increase until the water was consumed by the fuel-water reaction. The MCO thermal runaway is assumed to begin when the water draining process is finished but some residual water is still present to react with the fuel. Thermal calculations predict that the fuel could reach temperatures in excess of 700 °C. The maximum MCO wall temperature is less than 540 °C, which will not result in structural damage to the MCO. The MAR is 19.3 kg of uranium. The ARF/RF is 5×10^{-3} .

Table 3-1. Conceptual Design Accident Analysis Consequences

Accident	Facility	Consequences (rem, TEDE)		
		Facility Worker	Onsite	Offsite
Load Drop	KW Basin	Not calculated*	Not calculated*	Not calculated*
Nuclear Fuel Overlift	KW Basin	H	90	0.22
MCO Overpressurization	CVDF	H	1,200	0.75
MCO Internal Hydrogen Deflagration	CVDF	H	580	0.36
MCO Thermal Runaway	CVDF	H	175	0.44

*Load drop accident consequences are not calculated in HNF-SDWM-SAR-062 because the accident is prevented.

CVDF = Cold Vacuum Drying Facility
H = High (i.e., > 100 rem)
KW = 105-K West
MCO = Multi-canister overpack

The MCO overpressurization, deflagration, and thermal runaway accident consequences presented in Table 3-1 are based on material-at-risk (MAR) values derived for an MCO containing spent nuclear fuel. In each case, the MAR is the mass of uranium dioxide (UO₂) available for dispersion. A comparison of the spent nuclear fuel MCO MAR with an estimated KOP MCO MAR is presented in PRC-STP-00127, *Basket Washing and KOP Material at Risk Discussion*. Assuming the total volume of the Copper Insert slots in three MCO baskets is completely filled with UO₂, and using the same safety basis processing times and temperatures, the MAR increases from approximately 40 kg for a spent nuclear fuel MCO to approximately 60 kg for a KOP MCO. If all of the uranium metal in a KOP MCO was non-mechanistically converted to UO₂, the MAR would be 180 kg. In this hypothetical case, a portion of the UO₂ generated would overflow the Copper Inserts due to the volume expansion associated with conversion from uranium metal to UO₂.

In addition to the design basis accidents analyzed in the KW Basin, CVDF, and CSB safety bases, HNF-SD-TP-SARP-017, *Safety Analysis Report for Packaging (Onsite) Multi-Canister Overpack Cask*, addresses potential accidents during transportation.

3.2 COMPARISON TO GUIDELINES

Guidelines for the safety classification of SSCs are established in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented*

Safety Analyses, and DOE-STD-1189-2008. The public and collocated worker protection criteria are presented in Tables 3-2 and 3-3.

Table 3-2. Public Protection Criteria

Safety Class Controls	Unmitigated Consequence (TEDE)
Required	>25 rem
To be considered	≥5 rem

TEDE = total effective dose equivalent.

Table 3-3. Collocated Worker Protection Criteria, Radiological.

Safety Significant Controls	Unmitigated Consequence (TEDE)
Required	>100 rem

TEDE = total effective dose equivalent.

The facility worker protection criteria are as follows:

- significant exposure of the facility worker to radiological or other hazardous materials
- energetic releases of high concentrations of radiological or toxic materials where the facility worker would normally be immediately present and may be unable to take self-protective actions
- deflagrations or explosions within process equipment or confinement and containment structures or vessels where serious injury or death to a facility worker may result from the fragmentation of the process equipment or confinement/containment failing with the facility worker close by
- chemical or thermal burns to the a facility worker that could reasonably cover a significant portion of the facility worker body where self-protective actions are not reasonably available due to the speed of the event or where there may be no reasonable warning to the facility worker of the hazardous condition
- leaks from process systems where asphyxiation of a facility worker normally present may result.

Relative to a significant exposure to radiological materials, DOE-STD-1189-2008 provides the guidance presented in Table 3-4.

Table 3-4. Facility Worker Protection Criteria,
Radiological

Safety Significant Controls	Unmitigated Consequence (TEDE)
Required	Clearly >100 rem
To be considered	Approximately 100 rem
Not required	Clearly <100 rem

TEDE = total effective dose equivalent.

Calculating the precise radiological exposure to a facility worker is notoriously difficult since such calculations are very sensitive to the specific location of the facility worker relative to the release, the magnitude and respirable characteristics of the release, and the exposure duration. It is assumed, therefore, that the facility worker radiological consequences are a factor of 3 to 4 greater than the collocated worker for easily recognized events where the facility worker can be reasonably assumed to evacuate.

Comparing the radiological consequences presented in Table 3-1 with the above guidelines defines the accident-specific safety classification requirements for the conceptual design, which are presented in Table 3-5.

Table 3-5. Accident-Specific Safety Classification
Requirements

Accident	Safety Classification
Load Drop	Safety Significant ¹
Nuclear Fuel Overlift	Safety Significant ²
MCO Overpressurization	Safety Significant
MCO Internal Hydrogen Deflagration	Safety Significant
MCO Thermal Runaway	Safety Significant

¹As documented in HNF-SD-WM-SAR-062, load drop controls that prevent basin damage are safety significant

²Safety significant for facility worker safety

As discussed in Section 3.1, the potential exists for a KOP MCO to have a larger MAR than a spent nuclear fuel MCO, and thus higher accident consequence. However, accounting for such increases (e.g., from 40 kg to 60 kg) the offsite dose consequences are still below the evaluation guidelines for the consideration of safety class structures, systems, and components.

4.0 CONTROL DECISIONS

4.1 CONTROL DECISION METHODOLOGY

A control decision meeting was held to select controls for the conceptual design. The control selection team was comprised of Safety-in-Design Integration team members from the following organizational disciplines:

- Operations
- Engineering
- Industrial Safety and Health
- Radiological Control
- Nuclear Safety.

Additional attendees included representatives from the CH2M HILL Plateau Remediation Company Engineering and Nuclear Safety organizations. A listing of attendees is provided in Appendix B.

Controls were selected by the team using the following DOE-STD-1189-2008 control selection order of preference:

- Minimization of hazardous materials is the first priority
- Safety SSCs are preferred over administrative controls
- Passive SSCs are preferred over active SSCs
- Preventive controls are preferred over mitigative controls
- Facility safety SSCs are preferred over personnel protective equipment
- Controls closest to the hazard may provide protection to the largest population of potential receptors, including workers and the public
- Controls that are effective for multiple hazards can be resource-effective.

Controls were selected for a given hazard analysis entry by first identifying general safety functions based on the causes and consequences of the hazardous condition. The conceptual design was then reviewed to identify SSCs which could meet the safety function. It is important to note that the hazard analysis, the associated accident analysis, and this control decision are based on a conceptual design. It is expected that the safety functions and safety SSCs identified herein will change as the design matures and new hazard and accident analyses of the revised design are performed.

4.2 CONTROL DECISION RESULTS

The following sections identify the engineered and administrative controls selected for the prevention and mitigation of load drop, spent nuclear fuel overlift, and MCO overpressurization, internal hydrogen deflagration, and thermal runaway accidents. Appendix B provides the

detailed control allocation tables for the MCO overpressurization, internal hydrogen deflagration, and thermal runaway accidents. All safety SSCs will be procured, inspected and accepted, and verified in accordance with the requirements of PRC-MP-QA-599, *Quality Assurance Program*. All safety SSCs will undergo acceptance testing and start-up testing in accordance with PRC-PRO-EN-286, *Testing of Equipment and Systems*.

4.2.1 Load Drops

As discussed in Section 3.1, load drop accidents are not new or unique to the KPS. Load drop accidents are analyzed in the current KW Basin safety basis, and engineered and administrative controls have been implemented to prevent load drop accidents. Tables 4-1 and 4-2 present these existing engineered and administrative controls relative to KPS activities.

Table 4-1. Load Drop Engineered Controls

Item No.	Safety Function	Safety Significant SSCs	Functional Requirements
1	Prevent basin perforation by limiting the drop height of the MCO basket	MCO basket stiffback*	<ol style="list-style-type: none"> 1. The MCO basket stiffback shall be sufficiently long to prevent raising a loaded MCO out of the basin water (regardless of the hoist design or any hoist or operator failures). 2. The MCO basket stiffback shall be sufficiently long to ensure the MCO basket drop height is limited to the analyzed value in HNF-2229, <i>Fuel Retrieval Sub-Project Design Analysis Report for Safety Class In-Pool Equipment – Volumes I, II, and III</i>. <p>Note: The above functional requirements are documented in HNF-SD-WM-SAR-062, Section 4.3.4.3, "Functional Requirements."</p>

*The MCO basket stiffback is classified as Safety Class in HNF-SD-WM-SAR-062 for prevention of nuclear criticality. The Safety Class designation is historical in nature and is not driven by current evaluation guidelines.

Table 4-2. Load Drop Administrative Controls

Item No.	Safety Function	Administrative Control	Remarks
1	Prevent separation or perforation of the 105-K West Basin floor	For lifts over the 105-KW Basin, the maximum allowable load to be lifted shall not exceed the load criteria listed in Chapter 3.0, Table 3-10, of HNF-SD-WM-SAR-062, or on a case-by-case basis as described in Section 3.4.2.1.3 of HNF-SD-WM-SAR-062, or as approved by the Vice President, KBC Project, the maximum load allowed by the (independently reviewed) analysis that shows that a drop of the load will not result in perforation of the Basin Floor.	The stated administrative control is documented in HNF-SD-SNF-TSR-001, <i>K Basin Technical Safety Requirements</i> , Section 5.9.2.9, "105-KW Heavy Load Controls."

4.2.2 Spent Nuclear Fuel Overlift

As discussed in Section 3.1, spent nuclear fuel overlift accidents are not new or unique to the KPS. Overlifts of an MCO scrap basket, MCO fuel basket, PCM wash basket, and a KOP are addressed in HNF-SD-WM-SAR-0062. However, the overlift of a canister containing KOP material is not explicitly analyzed in HNF-SD-WM-SAR-0062 and was recently the subject of a Potential Inadequacy in the Safety Analysis (PISA) determination. As documented in PISA Determination 0322-2009, "Overlift of Canister Containing KOP Material," the overlift was determined to represent a PISA because it was judged to represent a hazardous condition not considered in the safety basis with the potential for significant impact to workers, the public, or environment. The associated Unreviewed Safety Question (USQ) determination (i.e., USQ Determination 0341-2009, "Overlift of Canister Containing KOP Material") concluded that the overlift constitutes a positive USQ because of the possibility of an accident of a different type and an associated reduction in the margin of safety.

In response to the positive USQ determination, the KW Basin Nuclear Safety organization will develop a safety basis change in accordance with the requirements of PRC-PRO-NS-062, *Unreviewed Safety Question Process*. Development of the safety basis change will include the identification of engineered and/or administrative controls to prevent and/or mitigate the overlift accident. The controls identified in the safety basis change will be adopted by the KOP Disposition Project.

4.2.3 Multi-Canister Overpack Thermal Runaway

The bounding MCO thermal runaway design basis accident is analyzed HNF-3553, Volume 3, Annex B Section B.3.4.2.5, "Multi-Canister Overpack Thermal Runaway Reaction."

Preliminary thermal analyses performed for an MCO containing KOP material are documented

in PRC-STP-00187, *Sludge Treatment Project KOP Disposition Thermal and Gas Analysis for the Cold Vacuum Drying Facility (OCRWM)*. The analyses demonstrate the thermal stability of the KOP material during vacuum drying at the CVDF.

Thermal runaway reactions at the CSB are addressed in HNF-3553, Volume 2, Annex A, *Canister Storage Building Final Safety Analysis Report*. As discussed in Section A3.4.2.5, "Thermal Runaway Reactions Inside the Multi-Canister Overpack," thermal runaway reactions caused by fuel reacting with water were found to be not credible due to the limited quantity of free and chemically-bound water.

Initial conditions assumed in thermal analyses that must be protected include the quantity of KOP material in an MCO basket, the total quantity of KOP material in an MCO, the KOP material particle size, the total quantity of chemically-bound water in an MCO, and the use of Copper Inserts. These assumptions are protected by a combination of engineered controls and administrative controls as indicated in Tables 4-3 and 4-4.

Table 4-3. MCO Thermal Runaway Engineered Controls

Item No.	Safety Function	Safety Significant SSCs	Functional Requirements
1	Prevent an MCO thermal runaway by protecting assumed initial conditions regarding the KOP material particle size	Size Separations Table screen	The Size Separations Table screen shall be sized such that KOP material remaining on the screen after washing has a Sauter mean diameter $\geq 600 \mu\text{m}$.
2	Prevent an MCO thermal runaway by protecting assumed initial conditions regarding the quantity of material in an MCO basket	<ul style="list-style-type: none"> Verification Container Verification Container weight measurement instrumentation 	<ol style="list-style-type: none"> 1. The Verification Container shall indicate the volume of KOP material in the container with a to-be-determined accuracy and precision. 2. The Verification Container weight measurement instrumentation shall indicated the mass of the KOP material with a to-be-determined accuracy and precision. <p>Note: The accuracy and precision functional requirements for the Verification Container volume and mass measurements will be quantified during preliminary and final design.</p> <p>Note: The total volume and mass of the KOP material in an MCO is used to verify compliance with limits for chemically-bound water.</p>

Table 4-3. MCO Thermal Runaway Engineered Controls

Item No.	Safety Function	Safety Significant SSCs	Functional Requirements
3	Prevent an MCO thermal runaway by protecting assumed initial conditions regarding the Copper Inserts	Copper Inserts	<ol style="list-style-type: none"> 1. The geometry of the Copper Inserts shall be as shown on drawing KOP-CDR-SK-710 (see Appendix A, Figures A-5 and A-6). 2. The physical and thermal properties of the Copper Inserts shall be to-be-determined. 3. The bottom of the Copper Inserts shall be screened to retain KOP material greater than 500 μ in size. <p>Note: The physical and thermal properties of the Copper Inserts will be based upon assumptions in thermal and gas analyses to be performed during preliminary and final design.</p>

Table 4-4. MCO Thermal Runaway Administrative Controls

Item No.	Safety Function	Administrative Control	Remarks
1	Prevent an MCO thermal runaway by protecting thermal analysis assumptions	<ol style="list-style-type: none"> 1. Size Separation Table operational controls 2. The chemically-bound water in an MCO shall not exceed 4.64 kg. 3. The maximum quantity of KOP material in a Copper Insert shall be to-be-determined. 4. The maximum total quantity of KOP material in an MCO shall be to-be-determined. 5. An MCO basket containing KOP material shall not be loaded in the bottom-most position of an MCO. 	<p>The Size Separations Table operational controls work in conjunction with the safety-significant Size Separations Table screen to ensure that the KOP material remaining on the screen after washing has a Sauter mean diameter $\geq 600 \mu\text{m}$.</p> <p>The mass of chemically-bound water is a function of the total quantity and average density of the KOP material in the MCO.</p> <p>The maximum quantity of KOP material in a Copper Insert, and the maximum total quantity of KOP material in an MCO will be determined during preliminary and final design.</p>

4.2.4 Multi-Canister Overpack Internal Hydrogen Deflagration

The bounding MCO internal hydrogen deflagration design basis accident is analyzed HNF-3553, Volume 3, Annex B Section B.3.4.2.4, "Multi-Canister Overpack Internal Hydrogen

Deflagration.” Hydrogen deflagrations are also analyzed in HNF-3335, Annex A, Volume 2, *Canister Storage Building Final Safety Analysis Report*, and in HNF-SD-TP-SARP-017, *Safety Analysis Report for Packaging (Onsite) Multi-Canister Overpack Cask*. The rate at which hydrogen is produced is a function of the rate at which uranium metal in the KOP material is oxidized, which in turn is a function of uranium metal surface area as defined by the mass and particle size of the uranium metal. The consequences of an internal hydrogen deflagration are a function of the quantity of uranium oxide in an MCO. There is also a product specification for limiting the volume of organic material in an MCO. Therefore, the initial conditions assumed in the analyses that must be protected include the total quantity of KOP material in an MCO, the KOP material particle size and density, the use of Copper Inserts, and the quantity of organic material. These assumptions are protected by a combination of engineered controls and administrative controls as indicated in Tables 4-3 and 4-4.

Table 4-5. MCO Internal Hydrogen Deflagration Engineered Controls

Item No.	Safety Function	Safety Significant SSCs	Functional Requirements
1	Prevent an MCO internal hydrogen deflagration by protecting assumed initial conditions regarding the KOP material particle size	Size Separations Table screen	<p>The Size Separations Table screen shall be sized such that KOP material remaining on the screen after washing has a Sauter mean diameter $\geq 600 \mu\text{m}$.</p> <p>Note: The particle size of the material affects the surface area which in turn affects the reaction rate.</p>
2	Prevent an MCO internal hydrogen deflagration by protecting assumed initial conditions regarding the quantity and density of the KOP material in an MCO basket	<ul style="list-style-type: none"> • Verification Container • Verification Container weight measurement instrumentation 	<ol style="list-style-type: none"> 1. The Verification Container shall indicate the volume of KOP material in the container with a to-be-determined accuracy and precision. 2. The Verification Container weight measurement instrumentation shall indicated the mass of the KOP material with a to-be-determined accuracy and precision. <p>Note: The accuracy and precision functional requirements for the Verification Container volume and mass measurements will be quantified during preliminary and final design.</p>

Table 4-5. MCO Internal Hydrogen Deflagration Engineered Controls

Item No.	Safety Function	Safety Significant SSCs	Functional Requirements
3	Prevent an MCO internal hydrogen deflagration by protecting assumed initial conditions regarding the Copper Inserts	Copper Inserts	<ol style="list-style-type: none"> 1. The geometry of the Copper Inserts shall be as shown on drawing KOP-CDR-SK-710 (see Appendix A, Figures A-5 and A-6). 2. The physical and thermal properties of the Copper Inserts shall be to-be-determined. 3. The bottom of the Copper Inserts shall be screened to retain KOP material greater than 500 μ in size. <p>Note: The physical and thermal properties of the Copper Inserts will be based upon assumptions in thermal and gas analyses to be performed during preliminary and final design.</p>

Table 4-6. MCO Internal Hydrogen Deflagration Administrative Controls

Item No.	Safety Function	Administrative Control	Remarks
1	Prevent an MCO internal hydrogen deflagration by protecting accident analysis assumptions	<ol style="list-style-type: none"> 1. Size Separation Table operational controls 2. An MCO basket containing KOP material shall not be loaded in the bottom-most position of an MCO. 3. Organic material in the KOP material that is identified by visual inspection shall not be loaded into a Verification Container with the exception of carbon materials, such as grafoil, that do not result in radiolytic gas production. 4. Prior to the addition of KOP material, Verification Containers and Copper Inserts will be inspected to identify and remove foreign materials. 	<p>The Size Separations Table operational controls work in conjunction with the safety-significant Size Separations Table screen to ensure that the KOP material remaining on the screen after washing has a Sauter mean diameter $\geq 600 \mu\text{m}$.</p> <p>Administrative Control #3 is based HNF-SD-SNF-TSR-001, <i>K Basin Technical Safety Requirements</i>, Section 5.9.2.3, "Multi-Canister Overpack Basket Loading Controls." During preliminary design, alternate means of removing organic material (e.g., use of the low-density retrieval wand) will be evaluated.</p> <p>The current product specification for MCOs allow a total of one pound of organic material.</p>

4.2.5 Multi-Canister Overpack Overpressurization

The bounding MCO overpressurization design basis accident is analyzed HNF-3553, Volume 3, Annex B Section B.3.4.2.6, "Multi-Canister Overpack Overpressurization." An

overpressurization is also analyzed in HNF-SD-TP-SARP-017. Overpressurization accidents are primarily caused by the generation of hydrogen gas from the oxidation of uranium metal. Therefore, the same initial conditions assumed in the hydrogen deflagration analyses must be protected for the overpressurization analyses. Tables 4-7 and 4-8 repeat the controls identified in Tables 4-5 and 4-6. The safety function of the controls is revised to reflect prevention of the overpressurization DBA.

Table 4-7. MCO Overpressurization Engineered Controls

Item No.	Safety Function	Safety Significant SSCs	Functional Requirements
1	Prevent an MCO overpressurization by protecting assumed initial conditions regarding the KOP material particle size	Size Separations Table screen	<p>The Size Separations Table screen shall be sized such that KOP material remaining on the screen after washing has a Sauter mean diameter $\geq 600 \mu\text{m}$.</p> <p>Note: The particle size of the material affects the surface area which in turn affects the reaction rate.</p>
2	Prevent an MCO overpressurization by protecting assumed initial conditions regarding the quantity and density of the KOP material in an MCO basket	<ul style="list-style-type: none"> • Verification Container • Verification Container weight measurement instrumentation 	<ol style="list-style-type: none"> 1. The Verification Container shall indicate the volume of KOP material in the container with a to-be-determined accuracy and precision. 2. The Verification Container weight measurement instrumentation shall indicated the mass of the KOP material with a to-be-determined accuracy and precision. <p>Note: The accuracy and precision functional requirements for the Verification Container volume and mass measurements will be quantified during preliminary and final design.</p> <p>Note: The total volume and mass of the KOP material in an MCO is used to verify compliance with limits for chemically-bound water.</p>

Table 4-7. MCO Overpressurization Engineered Controls

Item No.	Safety Function	Safety Significant SSCs	Functional Requirements
3	Prevent an MCO overpressurization by protecting assumed initial conditions regarding the Copper Inserts	Copper Inserts	<ol style="list-style-type: none"> 1. The geometry of the Copper Inserts shall be as shown on drawing KOP-CDR-SK-710 (see Appendix A, Figures A-5 and A-6). 2. The physical and thermal properties of the Copper Inserts shall be to-be-determined. 3. The bottom of the Copper Inserts shall be screened to retain KOP material greater than 500 μ in size. <p>Note: The physical and thermal properties of the Copper Inserts will be based upon assumptions in thermal and gas analyses to be performed during preliminary and final design.</p>

Table 4-8. MCO Overpressurization Administrative Controls

Item No.	Safety Function	Administrative Control	Remarks
1	Prevent an MCO overpressurization by protecting accident analysis assumptions	<ol style="list-style-type: none"> 1. Size Separation Table operational controls 2. The chemically-bound water in an MCO shall not exceed 4.64 kg. 3. An MCO basket containing KOP material shall not be loaded in the bottom-most position of an MCO. 4. Organic material in the KOP material that is identified by visual inspection shall not be loaded into a Verification Container with the exception of carbon materials, such as grafoil, that do not result in radiolytic gas production. 5. Prior to the addition of KOP material, Verification Containers and Copper Inserts will be inspected to identify and remove foreign materials. 	<p>The Size Separations Table operational controls work in conjunction with the safety-significant Size Separations Table screen to ensure that the KOP material remaining on the screen after washing has a Sauter mean diameter $\geq 600 \mu\text{m}$.</p> <p>The mass of chemically-bound water is a function of the total quantity and average density of the KOP material in the MCO.</p> <p>Administrative Control #4 is based HNF-SD-SNF-TSR-001, <i>K Basin Technical Safety Requirements</i>, Section 5.9.2.3, "Multi-Canister Overpack Basket Loading Controls." During preliminary design, alternate means of removing organic material (e.g., use of the low-density retrieval wand) will be evaluated.</p>

4.2.6 Nuclear Criticality Safety

The KOP material contains more than a minimum critical mass of fissile material such that an inadvertent nuclear criticality must be addressed. A criticality safety evaluation was performed to specifically address criticality safety requirements that will or may be necessary to support planned KOP Disposition Project activities associated. As documented in PRC-STP-00219, *Sludge Treatment Project KOP Disposition Conceptual Design Criticality Safety Evaluation*, fissile mass loading limits for the MCOs will probably be required to support MCO shipment and may be required for MCO loading. Consequently, scales used to determine the mass of fissile material loaded into an MCO basket may be safety significant for criticality safety. The scale used to weigh the Verification Container and determine the mass of KOP material has been classified as safety significant to protect initial conditions assumed in the thermal and gas analyses. If required by additional criticality studies performed during preliminary and detailed design, the safety function of the scale will be revised to include prevention of criticality accidents.

5.0 REFERENCES

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- HNF-2229, *Fuel Retrieval Sub-Project Design Analysis Report for Safety Class In-Pool Equipment – Volumes I, II, and III*, Rev. 0B, Fluor Hanford, Inc., Richland, Washington.
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- PRC-STP-00127, 2009, *Basket Washing and KOP Material at Risk Discussion*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.
- PRC-STP-00187, 2010, *Sludge Treatment Project KOP Disposition Thermal and Gas Analysis for the Cold Vacuum Drying Facility*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

PRC-STP-00219, 2010, *Sludge Treatment Project KOP Disposition Conceptual Design Criticality Safety Evaluation* Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

PRC-STP-CN-N-00167, 2009, *Knock-Out Pot Disposition Sub-Project Canister Over Lift Accident Analysis*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

PRC-STP-00206 REV 0

APPENDIX A
KOP DISPOSITION PROJECT CONCEPTUAL DESIGN
ENGINEERING DRAWINGS

Figure A-1. KOP Processing/KPS Process Flow Diagram (KOP-CDR-SK-150, Rev. A)

Figure A-2. Piping & Instrumentation Diagram Legends, Notes, and Key (KOP-CDR-SK-160, Rev. A, Sheet 1 of 1)

Figure A-3. Piping & Instrumentation Diagram (KOP-CDR-SK-170, Rev. A, Sheet 1 of 2)

Figure A-5. KOP MCO Basket Insert (KOP-CDR-SK-710, Rev. A, Sheet 1 of 2)

Figure A-6. KOP MCO Basket Insert (KOP-CDR-SK-710, Rev. A, Sheet 2 of 2)

APPENDIX B
CONTROL DECISION MEETING PARTICIPANTS

APPENDIX B
CONTROL DECISION MEETING PARTICIPANTS

Table B-1. Control Decision Meeting Participants
February 1, 2010

Name	Organization
Control Decision Team	
Craig Carro	STP Nuclear Safety – Facilitator
Ralph Crowe	STP Nuclear Safety
Jim Mathews	Operations
Greg Bergquist	100 K Area Engineering
Jim Sloughter	STP Process Engineering
Lindsay Nelsen	STP Radiological Control
Daren Schwartz	100 K Area Operational Safety and Health
Additional Attendees	
Gary Franz	STP Nuclear Safety
Bill Meeuwsen	STP Engineering

APPENDIX C
CONTROL ALLOCATION TABLES

Table C-1. Thermal Runaway Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
1.10	What if the screened canister openings are smaller than 600 µm?	Manufacturing error	If the openings were smaller than 600 µm, then material <600 µm would be retained and subsequently transferred to the Screened Separations Table. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	<ul style="list-style-type: none"> Screened canister safety classification Screened Separations Table safety classification 	<ul style="list-style-type: none"> Quality Assurance Program Administrative Control TSR for Screened Separations Table activities 	<p><u>Preventive Engineered:</u></p> <ul style="list-style-type: none"> Screened Separations Table safety classification <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none"> Quality Assurance Program Administrative Control TSR for Screened Separations Table activities <p><u>Mitigative Engineered:</u></p> <p>None</p> <p><u>Mitigative Administrative:</u></p> <p>None</p>	Both the screened canister and the Screened Separations Table function to remove particles <600 µm. The control decision team chose to credit the Screened Separations Table because it is a closer to a passive engineered system than is the PCM.
1.12	What if the scale erroneously indicates that the screened canister is no longer losing mass?	<ul style="list-style-type: none"> Operator error Equipment failure Calibration error 	If the scale erroneously indicates that the mass of a screened canister is no longer decreasing, then additional washing would not be performed. Consequently, the KOP material that is transferred to the Screened Separations Table would contain more particles <600 µm in size than it otherwise would. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	<ul style="list-style-type: none"> Scale safety classification Screened Separations Table safety classification 	<ul style="list-style-type: none"> Quality Assurance Program Administrative Control TSR for Screened Separations Table activities 	<p><u>Preventive Engineered:</u></p> <ul style="list-style-type: none"> Screened Separations Table safety classification <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none"> Quality Assurance Program Administrative Control TSR for Screened Separations Table activities <p><u>Mitigative Engineered:</u></p> <p>None</p> <p><u>Mitigative Administrative:</u></p> <p>None</p>	

Table C-1. Thermal Runaway Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
1.17	What if the screened canister becomes plugged?	None specified	If the screened canister becomes plugged, then <600 µm particles will not be washed from the KOP material in the PCM. Consequently, the KOP material that is transferred to the Screened Separations Table would contain more particles <600 µm in size than it otherwise would. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	Screened Separations Table safety classification	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> • Screened Separations Table safety classification <u>Preventive Administrative:</u> • Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	The Administrative Control TSR for Screened Separations Table activities will require operators to spread the material over the surface of the screen using the water sparger and/or manual tools and to perform a visual inspection.
2.11	What if the Screened Separations Table pump fails to operate?	• Loss of power to pump • Mechanical failure	If the Screened Separations Table pump fails to operate, then there will be no motive force besides gravity to draw <600 µm particles through the screen. Particles < 600 µm could be loaded into the Verification Containers.	None	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> • Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	During the control decision meeting, it was discussed that the pump suction is not required for <600 particles to pass through the screen. The function of the pump is to provide the motive force to transfer material that passes through the screen to the IWTS system.
2.20	What if the KOP material is not properly processed on the screened portion of the Screened Separations Table (i.e., what if not enough "laps" are performed).	Operator error	If the KOP is not properly processed on the screened portion of the table, then <600 µm particles could be loaded into a Verification Container and eventually into an MCO.	None	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> • Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	

Table C-1. Thermal Runaway Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
2.21	What if the screened portion of the Screened Separations Table becomes plugged?	None specified	If the screened portion of the table plugs, then particles < 600 µm could be loaded into the Verification Containers and eventually into an MCO.	None	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none">Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
2.22	What if the openings of the screened portion of the Screened Separations Table are smaller than 600 µm?	Manufacturing error	If the openings of the screened portion of the table are smaller than 600 µm, then particles < 600 µm could be loaded into the Verification Containers and eventually into an MCO.	Screened separation table safety classification	Quality Assurance Program	<u>Preventive Engineered:</u> <ul style="list-style-type: none">Screened Separations Table safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none">Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
4.1	What if the Copper Insert outer dimensions are smaller than specified?	Manufacturing error	Thermal Runaway: If the Copper Insert outer dimensions are smaller than specified, then the mass of copper will be less than analyzed in the thermal runaway analyses for CVDF.	Copper Insert safety classification	Quality Assurance Program	<u>Preventive Engineered:</u> <ul style="list-style-type: none">Copper Insert safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none">Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	The Copper Insert includes the top and bottom screens that retain the KOP material within the insert.

Table C-1. Thermal Runaway Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
4.4	What if the Copper Insert inner dimensions are larger than specified?	Manufacturing error	Thermal Runaway: If the Copper Insert inner dimensions are larger than specified, then the mass of copper will be less than analyzed in the thermal runaway analyses for CVDF.	Copper Insert safety classification	Quality Assurance Program	<u>Preventive Engineered:</u> <ul style="list-style-type: none">• Copper Insert safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none">• Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
4.7	What if a Copper Insert is overfilled?	Operator error	If a Copper Insert is overfilled, then the MCO basket into which it was loaded could contain a larger quantity of KOP material than analyzed in the Thermal Runaway at CVDF.	<ul style="list-style-type: none">• Safety classification of Verification Container• Copper Insert safety classification	<ul style="list-style-type: none">• Training Program• Quality Assurance Program• Administrative Control TSR for filling Copper Insert	<u>Preventive Engineered:</u> <ul style="list-style-type: none">• Copper Insert safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none">• Quality Assurance Program• Administrative Control TSR for filling Copper Insert <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	The Administrative Control TSR for filling the Copper Insert will include a verification of the quantity of material placed in the insert.
4.8	What if there is a void space in the Copper Insert?	Manufacturing error	Thermal Runaway: If there is a void space in the Copper Insert, then the mass of copper will be less than analyzed in the thermal runaway analyses for CVDF.	Copper Insert safety classification	Quality Assurance Program	<u>Preventive Engineered:</u> <ul style="list-style-type: none">• Copper Insert safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none">• Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	

Table C-2. Hydrogen Deflagration Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
1.10	What if the screened canister openings are smaller than 600 µm?	Manufacturing error	If the openings were smaller than 600 µm, then material <600 µm would be retained and subsequently transferred to the Screened Separations Table. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	<ul style="list-style-type: none">Screened canister safety classificationScreened Separations Table safety classification	<ul style="list-style-type: none">Quality Assurance ProgramAdministrative Control TSR for Screened Separations Table activities	<p><u>Preventive Engineered:</u></p> <ul style="list-style-type: none">Screened Separations Table safety classification <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none">Quality Assurance Program (as applied to the Screened Separations Table)Administrative Control TSR for Screened Separations Table activities <p><u>Mitigative Engineered:</u></p> <p>None</p> <p><u>Mitigative Administrative:</u></p> <p>None</p>	
1.12	What if the scale erroneously indicates that the screened canister is no longer losing mass?	<ul style="list-style-type: none">Operator errorEquipment failureCalibration error	If the scale erroneously indicates that the mass of a screened canister is no longer decreasing, then additional washing would not be performed. Consequently, the KOP material that is transferred to the Screened Separations Table would contain more particles <600 µm in size than it otherwise would. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	<ul style="list-style-type: none">Scale safety classificationScreened Separations Table safety classification	<ul style="list-style-type: none">Quality Assurance ProgramAdministrative Control TSR for Screened Separations Table activities	<p><u>Preventive Engineered:</u></p> <ul style="list-style-type: none">Screened Separations Table safety classification <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none">Quality Assurance Program (as applied to the Screened Separations Table)Administrative Control TSR for Screened Separations Table activities <p><u>Mitigative Engineered:</u></p> <p>None</p> <p><u>Mitigative Administrative:</u></p> <p>None</p>	

Table C-2. Hydrogen Deflagration Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
1.17	What if the screened canister becomes plugged?	None specified	If the screened canister becomes plugged, then <600 µm particles will not be washed from the KOP material in the PCM. Consequently, the KOP material that is transferred to the Screened Separations Table would contain more particles <600 µm in size than it otherwise would. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	Screened Separations Table safety classification	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> <ul style="list-style-type: none"> Screened Separations Table safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
2.8	What if foreign material falls onto the Screened Separations Table?	None specified	MCO Hydrogen Deflagration: If the foreign material was organic, and a significant quantity was loaded into an MCO, then oxygen generation due to decomposition of the organic molecules during long-term storage could result in a flammable concentration within an MCO at the CSB.	<ul style="list-style-type: none"> Cover over Screened Separations Table Low-density retrieval wand 	<ul style="list-style-type: none"> Administrative control TSR visual inspection for organic materials Administrative control TSR for determining bulk density Administrative control for a Foreign Material Exclusion Area above the Screened Separations Table 	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative control TSR visual inspection for organic materials Administrative control TSR for determining bulk density <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	For fuel MCO baskets, a foreign material exclusion process was established that required the Shift Manager to be notified if anything was dropped into the basin water. The Shift Manager would determine if the dropped item had to be recovered.

Table C-2. Hydrogen Deflagration Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
2.11	What if the Screened Separations Table pump fails to operate?	<ul style="list-style-type: none">• Loss of power to pump• Mechanical failure	If the Screened Separations Table pump fails to operate, then there will be no motive force besides gravity to draw <600 µm particles through the screen. Particles < 600 µm could be loaded into the Verification Containers.	None	Administrative Control TSR for Screened Separations Table activities	<p><u>Preventive Engineered:</u> None</p> <p><u>Preventive Administrative:</u> • Administrative Control TSR for Screened Separations Table activities</p> <p><u>Mitigative Engineered:</u> None</p> <p><u>Mitigative Administrative:</u> None</p>	During the control decision meeting, it was discussed that the pump suction is not required for <600 particles to pass through the screen. The function of the pump is to provide the motive force
2.20	What if the KOP material is not properly processed on the screened portion of the Screened Separations Table (i.e., what if no enough “laps” are performed).	Operator error	If the screened portion of the table plugs, then particles < 600 µm could be loaded into the Verification Containers and eventually into an MCO.	None	Administrative Control TSR for Screened Separations Table activities	<p><u>Preventive Engineered:</u> None</p> <p><u>Preventive Administrative:</u> • Administrative Control TSR for Screened Separations Table activities</p> <p><u>Mitigative Engineered:</u> None</p> <p><u>Mitigative Administrative:</u> None</p>	
2.21	What if the screened portion of the Screened Separations Table becomes plugged?	None specified	If the screened portion of the table plugs, then particles < 600 µm could be loaded into the Verification Containers and eventually into an MCO.	None	Administrative Control TSR for Screened Separations Table activities	<p><u>Preventive Engineered:</u> None</p> <p><u>Preventive Administrative:</u> • Administrative Control TSR for Screened Separations Table activities</p> <p><u>Mitigative Engineered:</u> None</p> <p><u>Mitigative Administrative:</u> None</p>	

Table C-2. Hydrogen Deflagration Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
2.22	What if the openings of the screened portion of the Screened Separations Table are smaller than 600 µm?	Manufacturing error	If the openings of the screened portion of the table are smaller than 600 µm, then particles < 600 µm could be loaded into the Verification Containers and eventually into an MCO.	Screened separation table safety classification	Quality Assurance Program	<u>Preventive Engineered:</u> <ul style="list-style-type: none">Screened Separations Table safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none">Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
3.7	What if foreign material gets into the Verification Container?	Feed chute plug not installed and foreign material present in vicinity of Screened Separations Table	MCO Hydrogen Deflagration: If the foreign material was organic, and a significant quantity was loaded into an MCO, then oxygen generation due to decomposition of the organic molecules during long-term storage could result in a flammable concentration within an MCO at CSB.	<ul style="list-style-type: none">Verification Container coverLow-density retrieval wand	<ul style="list-style-type: none">Administrative control TSR visual inspection of the Verification ContainerAdministrative control for a Foreign Material Exclusion Area above the Screened Separations Table	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none">Administrative control TSR for visual inspection of Verification Container <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	For fuel MCO baskets, a foreign material exclusion process was established that required the Shift Manager to be notified if anything was dropped into the basin water. The Shift Manager would determine if the dropped item had to be recovered.

Table C-3. Overpressurization Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
1.10	What if the screened canister openings are smaller than 600 µm?	Manufacturing error	If the openings were smaller than 600 µm, then material <600 µm would be retained and subsequently transferred to the Screened Separations Table. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	<ul style="list-style-type: none"> Screened canister safety classification Screened Separations Table safety classification 	<ul style="list-style-type: none"> Quality Assurance Program Administrative Control TSR for Screened Separations Table activities 	<p><u>Preventive Engineered:</u></p> <ul style="list-style-type: none"> Screened Separations Table safety classification <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none"> Quality Assurance Program (as applied to the Screened Separations Table) Administrative Control TSR for Screened Separations Table activities <p><u>Mitigative Engineered:</u></p> <p>None</p> <p><u>Mitigative Administrative:</u></p> <p>None</p>	
1.12	What if the scale erroneously indicates that the screened canister is no longer losing mass?	<ul style="list-style-type: none"> Operator error Equipment failure Calibration error 	If the scale erroneously indicates that the mass of a screened canister is no longer decreasing, then additional washing would not be performed. Consequently, the KOP material that is transferred to the Screened Separations Table would contain more particles <600 µm in size than it otherwise would. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	<ul style="list-style-type: none"> Scale safety classification Screened Separations Table safety classification 	<ul style="list-style-type: none"> Quality Assurance Program Administrative Control TSR for Screened Separations Table activities 	<p><u>Preventive Engineered:</u></p> <ul style="list-style-type: none"> Screened Separations Table safety classification <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none"> Quality Assurance Program (as applied to the Screened Separations Table) Administrative Control TSR for Screened Separations Table activities <p><u>Mitigative Engineered:</u></p> <p>None</p> <p><u>Mitigative Administrative:</u></p> <p>None</p>	

Table C-3. Overpressurization Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
1.17	What if the screened canister becomes plugged?	None specified	If the screened canister becomes plugged, then <600 µm particles will not be washed from the KOP material in the PCM. Consequently, the KOP material that is transferred to the Screened Separations Table would contain more particles <600 µm in size than it otherwise would. If not removed at the Screened Separations Table, the <600 µm material would be loaded into a Verification Container and eventually into an MCO.	Screened Separations Table safety classification	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> <ul style="list-style-type: none">Screened Separations Table safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none">Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
2.8	What if foreign material falls onto the Screened Separations Table?	None specified	MCO Overpressurization: If the foreign material was organic, and a significant quantity was loaded into an MCO, then gas generation due to decomposition of organic molecules during long-term storage could result in overpressurization of the MCO at the CSB	Cover over Screened Separations Table	<ul style="list-style-type: none">Administrative control TSR visual inspection for organic materialsAdministrative control TSR for determining bulk densityAdministrative control for a Foreign Material Exclusion Area above the Screened Separations Table	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none">Administrative control TSR visual inspection for organic materialsAdministrative control TSR for determining bulk density <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	For fuel MCO baskets, a foreign material exclusion process was established that required the Shift Manager to be notified if anything was dropped into the basin water. The Shift Manager would determine if the dropped item had to be recovered.

Table C-3. Overpressurization Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
2.11	What if the Screened Separations Table pump fails to operate?	<ul style="list-style-type: none"> Loss of power to pump Mechanical failure 	If the Screened Separations Table pump fails to operate, then there will be no motive force besides gravity to draw <600 µm particles through the screen. Particles < 600 µm could be loaded into the Verification Containers.	None	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
2.20	What if the KOP material is not properly processed on the screened portion of the Screened Separations Table (i.e., what if no enough "laps" are performed).	Operator error	If the screened portion of the table plugs, then particles < 600 µm could be loaded into the Verification Containers and eventually into an MCO.	None	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
2.21	What if the screened portion of the Screened Separations Table becomes plugged?	None specified	If the screened portion of the table plugs, then particles < 600 µm could be loaded into the Verification Containers and eventually into an MCO.	None	Administrative Control TSR for Screened Separations Table activities	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative Control TSR for Screened Separations Table activities <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	

Table C-3. Overpressurization Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
2.22	What if the openings of the screened portion of the Screened Separations Table are smaller than 600 µm?	Manufacturing error	If the openings of the screened portion of the table are smaller than 600 µm, then particles < 600 µm could be loaded into the Verification Containers and eventually into an MCO.	Screened separation table safety classification	Quality Assurance Program	<u>Preventive Engineered:</u> • Screened Separations Table safety classification <u>Preventive Administrative:</u> • Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
3.5	What if the Verification Container dimensions are incorrect?	Manufacturing error	MCO Overpressurization: If the Verification Container is larger than specified, then a lower-than-actual volume will be recorded. As a result, the calculated bulk density will be higher than actual. This could increase the quantity of water in the MCO which could result in MCO overpressurization during long-term storage at CSB.	Verification Container safety classification	Quality Assurance Program	<u>Preventive Engineered:</u> • Verification Container safety classification <u>Preventive Administrative:</u> • Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
3.6	What if the Verification Container tare weight is incorrectly measured or recorded?	• Operator error • Calibration error	MCO Overpressurization: If the recorded Verification Container tare weight is less than actual, then the calculated bulk density will be higher than actual. This could increase the quantity of water in the MCO which could result in MCO overpressurization during long-term storage at CSB.	Safety classification of instrumentation for measuring tare weight	• Administrative Control TSR for making measurement • Quality Assurance Program • Training Program	<u>Preventive Engineered:</u> Weight instrumentation safety classification <u>Preventive Administrative:</u> • Quality Assurance Program • Administrative control TSR for making weight measurement <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	

Table C-3. Overpressurization Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
3.7	What if foreign material gets into the Verification Container?	Feed chute plug not installed and foreign material present in vicinity of Screened Separations Table	MCO Overpressurization: If the foreign material was organic, and a significant quantity was loaded into an MCO, then gas generation due to decomposition of organic molecules during long-term storage could result in overpressurization of the MCO at CSB.	Verification Container cover	<ul style="list-style-type: none"> Administrative control TSR visual inspection of the Verification Container Administrative control for a Foreign Material Exclusion Area above the Screened Separations Table 	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative control TSR for visual inspection of Verification Container <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	For fuel MCO baskets, a foreign material exclusion process was established that required the Shift Manager to be notified if anything was dropped into the basin water. The Shift Manager would determine if the dropped item had to be recovered.
3.14	What if the instrument used for measuring the mass of the Verification Container reads higher than actual?	<ul style="list-style-type: none"> Equipment malfunction Calibration error 	MCO Overpressurization: If the instrument reads a higher than actual mass, then the calculated bulk density will be higher than actual. This could increase the quantity of water in the MCO which could result in MCO overpressurization during long-term storage at CSB.	Safety classification of instrumentation for measuring tare weight	<ul style="list-style-type: none"> Administrative Control TSR for making measurement Quality Assurance Program Training Program 	<u>Preventive Engineered:</u> Weight instrumentation safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Quality Assurance Program Administrative control TSR for making weight measurement <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
3.16	What if the operator records a higher than actual mass?	Operator error	MCO Overpressurization: If the operator records a higher than actual mass, then the calculated bulk density will be higher than actual. This could increase the quantity of water in the MCO which could result in MCO overpressurization during long-term storage at CSB.	None	<ul style="list-style-type: none"> Administrative Control TSR for determining bulk density Training Program 	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative Control TSR for determining bulk density <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	

Table C-3. Overpressurization Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
3.19	What if the operator records a lower than actual volume?	Operator error	MCO Overpressurization: If the operator records a lower than actual volume, then the calculated bulk density will be higher than actual. This could increase the quantity of water in the MCO which could result in MCO overpressurization during long-term storage at CSB.	None	<ul style="list-style-type: none"> Administrative Control TSR for determining bulk density Training Program 	<u>Preventive Engineered:</u> None <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative Control TSR for determining bulk density <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
3.20	What if the ruler scale/Verification Container are misaligned?	None specified	MCO Overpressurization: If the ruler scale is misaligned such that a lower than actual volume is recorded, then the calculated bulk density will be higher than actual. This could increase the quantity of water in the MCO which could result in MCO overpressurization during long-term storage at CSB.	Verification Container safety classification	<ul style="list-style-type: none"> Administrative Control TSR for making volume measurement Quality Assurance Program Training Program 	<u>Preventive Engineered:</u> <ul style="list-style-type: none"> Verification Container safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative control TSR for making volume measurement Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u> None	
3.21	What if the ruler scale is inaccurate?	Manufacturing error	MCO Overpressurization: If the ruler scale is inaccurate such that a lower than actual volume is recorded, then the calculated bulk density will be higher than actual. This could increase the quantity of water in the MCO which could result in MCO overpressurization during long-term storage.	Verification Container safety classification	<ul style="list-style-type: none"> Administrative Control TSR for making volume measurement Quality Assurance Program Training Program 	<u>Preventive Engineered:</u> <ul style="list-style-type: none"> Verification Container safety classification <u>Preventive Administrative:</u> <ul style="list-style-type: none"> Administrative control TSR for making volume measurement Quality Assurance Program <u>Mitigative Engineered:</u> None <u>Mitigative Administrative:</u>	

Table C-3. Overpressurization Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
						None	
3.22	What if the calculated bulk density is higher than actual?	Nodes 3.5, 3.6, 3.14, 3.16, 3.19, 3.20, 3.21	MCO Overpressurization: If the calculated bulk density is higher than actual, than low density material could be loaded into an MCO basket. This could increase the quantity of water in the MCO which could result in MCO overpressurization during long-term storage at CSB.	<ul style="list-style-type: none"> • Safety classification of instrumentation for measuring mass • Verification Container safety classification 	<ul style="list-style-type: none"> • Administrative Control TSR for determining bulk density • Quality Assurance Program • Training Program 	<p><u>Preventive Engineered:</u></p> <ul style="list-style-type: none"> • Safety classification of instrumentation for measuring mass • Verification Container safety classification <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none"> • Administrative control TSR for making weight measurement • Administrative control TSR for making volume measurement • Administrative Control TSR for determining bulk density • Quality Assurance Program <p><u>Mitigative Engineered:</u></p> <p>None</p> <p><u>Mitigative Administrative:</u></p> <p>None</p>	
4.7	What if a Copper Insert is overfilled?	Operator error	If a Copper Insert is overfilled, then the MCO basket into which it was loaded could contain a larger quantity of KOP material than analyzed in the Thermal Runaway at CVDF and the Overpressurization and Hydrogen Deflagration analyses at CVDF and CSB.	<ul style="list-style-type: none"> • Safety classification of Verification Container • Copper Insert safety classification 	<ul style="list-style-type: none"> • Training Program • Quality Assurance Program • Administrative Control TSR for filling Copper Insert 	<p><u>Preventive Engineered:</u></p> <ul style="list-style-type: none"> • Copper Insert safety classification <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none"> • Quality Assurance Program <p><u>Mitigative Engineered:</u></p> <p>None</p> <p><u>Mitigative Administrative:</u></p> <p>None</p>	

Table C-3. Overpressurization Control Decision

Node	What-If?	Cause	Consequence	Candidate Controls		Selected Controls	Remarks
				Safety SSC Options	Administrative Control Options		
4.12	What if there is foreign material in the insert prior to placing the screen on the insert?	None specified	MCO Overpressurization: If the foreign material was organic, and a significant quantity was loaded into an MCO, then gas generation due to decomposition of organic molecules during long-term storage could result in overpressurization of the MCO at CSB.	Copper Insert cover	<ul style="list-style-type: none">Administrative control TSR visual inspection of the Copper InsertAdministrative control for a Foreign Material Exclusion Area above the Screened Separations Table	<p><u>Preventive Engineered:</u> None</p> <p><u>Preventive Administrative:</u></p> <ul style="list-style-type: none">Administrative control TSR for visual inspection of Copper Insert <p><u>Mitigative Engineered:</u> None</p> <p><u>Mitigative Administrative:</u> None</p>	For fuel MCO baskets, a foreign material exclusion process was established that required the Shift Manager to be notified if anything was dropped into the basin water. The Shift Manager would determine if the dropped item had to be recovered.