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DROP ACCIDENTS IN THE CANISTER STORAGE BUILDING ADDRESSED BY DESIGN FEATURES AND/OR DESIGN CALCULATIONS

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Abstract A variety of drop shear or impact scenarios have been identified for the Canister Storage Building Some of these are being addressed by new calculations or require no specific action This document describes five of them which are addressed by design features and/or existing design calculations For each of the five a position is stated indicating the reason for assurance that the safety functions of the MCO will not be jeopardized by the accident Following the position is a description of the basis for that position

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Drop Accidents in the Canister Storage Building Addressed by Design Features and/or Design Calculations

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1 0 INTRODUCTION

A total of 36 possible drop, shear, or impact scenarios have been identified for the Canister Storage Building They are summarized in a table in Appendix A Some of these are being addressed by new calculations or require no specific action This document describes five of them, which are addressed by design features and/or existing design calculations For each of the five, a position is stated, indicating the reason for assurance that the safety functions of the MCO will not be jeopardized by the accident Following the position is a description of the basis for that position

In the heading of each section, a number in parenthesis following the title corresponds to the number of the scenario in Appendix A

2 0 CASK – MCO DROP INTO CASK RECEIVING PIT (7)

Position – The impact absorber in the cask receiving pit will limit deceleration forces in the MCO to 35 g The MCO and its internals were designed to withstand this deceleration

Basis – 1) *CSB Impact Absorber Analysis Report*, ED-037, Rev 0, by PacTec of Tacoma, Washington, (Noss, 1999) demonstrates the design requirements have been met The document states, "The primary design requirement for the CSB impact absorber designs is to not exert a force in excess of 34g (35g for the MCO Service Station application) For the IMP-4, the gross weight of the MCO Transportation Cask is 59,000 pounds which results in a force limit of 2,065,000 pounds corresponding to the 35g limit ' The impact absorber for the cask receiving pit is designed for a drop height of 23 42 ft (281 in) The maximum height of the cask receiving pit impact absorber is 45 in The impact absorber design was developed by a combination of calculations and both static and dynamic tests

2) Full scale prototypic tests of the designed impact absorber were performed and are documented in *Test Report for the CSB Prototypic Impact Absorbers*, TR-003, Rev 0, by PacTec of Tacoma, Washington (Clark, 1999) The test uses video records to demonstrate an acceptable deceleration While a direct crush measurement of the impact absorber indicates a deceleration load that is higher than expected and higher than the design criteria, this is attributed to energy transferred to the ground upon impact The video record is regarded as the more reliable method of demonstrating that the design criteria have been met

3) The *Multi-Canister Overpack Design Report*, HNF SD-SNF-DR 003, Rev 2 DE&S Hanford Richland, Washington, (Smith, 1999) demonstrates that the MCO will meet design criteria Appendix 7 contains the design calculation that shows that the Mark 1A internals can withstand design basis conditions of a 35g vertical drop or a 101g horizontal drop These criteria are to preclude criticality in the Mark 1A fuel with a flooded MCO and do not apply to the Mark IV internals Table 7 of the appendix summarizes analysis of 12 components of the Mark 1A baskets, all with predicted maximum loads below allowable values

3 0 DROP CASK LID ONTO MCO (12)

Position – A drop of the cask lid onto the MCO would cause only local cosmetic damage at the point of impact, but the MCO would maintain its containment and confinement functions

Basis - *Multi-Canister Overpack Analysis File Documentation*, Appendix B *Cask Lid Accidental Drops Onto Multi-Canister Overpack* HNF-SD-SNF-DP-007, Rev 0, DE&S Hanford, Richland, Washington, (Chenault, 1997) evaluated cask lid drops In this analysis the critical lid orientation, when the lid center of gravity is vertically above the first point of contact, was used for three different impact positions The three impact positions were to the lifting ring, the shield plug at the location of one of the cover plates, and the MCO outer cylinder along side the lifting ring

The analysis concludes that the MCO maintains containment and confinement of all Spent Nuclear Fuels during and after a 5 ft drop of a cask lid The local plastic damage would only be found by close inspection of the hardware after the event

4 0 MHM FALL ONTO OPERATING DECK, RESULTING IN MAJOR STRUCTURAL DAMAGE TO DECK (19)

Position – The MHM is designed for seismic loads and will not fall onto the operating deck

Basis – The MHM design includes seismic features that preclude it from falling in a seismic event These are described in *Multicanister Overpack Handling Machine (MHM) 100% Design Report*, (Foster Wheeler, 1998)

The trolley is provided with lateral seismic restraints in the "X direction Two trolley seismic locks are provided to hold the trolley during seismic motions in the East-West direction The restraints consist of pins that engage with pockets in steel pads welded to the top surface of each bridge beam

The trolley is restrained in the Y" and "Z" directions with passive systems that do not require deployment
The trolley is restrained in the Y" direction by the wheel flanges The trolley is restrained in the "Z ' direction by four lugs which hook beneath the top flange of the girders

The bridge is restrained in the 'Y' direction by rail clamps that are spring applied and hydraulically removed Passive restraints are in place in the X and Z" directions It is restrained in the X" direction by wheel flanges and in the Z" direction by shaped hooks which reach under the rail head to prevent vertical uplift

A seismic shutdown contactor is mounted in the CSB such that in a seismic event the main incoming power to the MHM is disconnected, thereby, putting the MHM into its 'safe shutdown' state

Seismic analysis of the MHM was performed and is documented in *Hanford MHM Seismic Analysis of the Hanford MCO Handling Machine* ESL/R(96)083, Rev 3, Alstom Automation Ltd Leicester England (Cluskey, 1998) The document concludes that no gross structural failure, overturning, or derailment will occur and no breach of containment results from the Safe Shutdown Earthquake This document does not address the unrestrained case, which will be addressed by a separate calculation

5 0 DROP MCO ONTO IMPACT ABSORBER IN STORAGE TUBE OR WELD/SAMPLE STATION (29)

Position – The impact absorber in the storage tube or weld/sample station will limit deceleration forces in the MCO to 35 g The MCO and its internals were designed to withstand this deceleration

Basis - 1) *CSB Impact Absorber Analysis Report*, ED-037, Rev 0, by PacTec of Tacoma, Washington (Noss, 1999) demonstrates the design requirements have been met The document states, "The primary design requirement for the CSB impact absorber designs is to not exert a force in excess of 34g (35g for the MCO Service Station application) The lower impact absorber for the storage tube is designed for a drop height of 44 33 ft (532 in) The maximum combined height of the two storage tube impact absorbers is 60 in The weld/sample station impact absorber is designed for a drop height of 20 25 ft (243 in) The height of the weld/sample station impact absorber is 18 in The impact absorber designs were developed by a combination of calculations and both static and dynamic tests

2) Full scale prototypic tests of the designed impact absorbers were performed and are documented in *Test Report for the CSB Prototypic Impact Absorbers*, TR-003, Rev 0, by PacTec of Tacoma Washington (Clark, 1999) The test uses video records and direct crush measurements to demonstrate acceptable decelerations

3) The *Multi-Canister Overpack Design Report*, HNF-SD SNF-DR-003, Rev 2, DE&S Hanford, Richland Washington (Smith 1999) demonstrates that the MCO will meet design criteria Appendix 7 contains the design calculation that shows that the Mark 1A internals can withstand design basis conditions of a 35g vertical drop or a 101g horizontal drop These criteria are to preclude criticality in the Mark 1A fuel with a flooded MCO and do not apply to the Mark IV internals Table 7 of the appendix summarizes analysis of 12 components of the Mark 1A baskets, all with predicted maximum loads below allowable values

4) *Design Calculation for the MCO Sampling Station – Shield Components*, Calculation Number CSB-RM-0016, Fluor Daniel, Inc , (Keller 1998) demonstrates that the breakaway ring is designed to break free in a MCO drop accident, but not during normal operation The MCO is supported, during normal operation so that it does not rest on the impact absorber However the breakaway ring allows the impact absorber to absorb the load during a drop accident

6 0 DROP MCO ONTO ANOTHER MCO IN STORAGE TUBE (NO INTERMEDIATE IMPACT ABSORBER) (31)

Position – A drop of an MCO onto another MCO already loaded into the storage tube would cause plastic deformation to the bottom of the dropped MCO and the top of the impacted MCO shield plug but the containment and confinement functions of the MCO are not jeapordized The deceleration associated with such a drop would not damage the MCO internals

Basis – *Multi-Canister Overpack Analysis File Documentation* Appendix D *Multi-Canister Overpack to Multi-Canister Overpack Drop Analysis* HNF-SD-SNF-DP-007, Rev 0, DE&S Hanford, Richland, Washington, (Chenault, 1997) documents the simulation of a 31 ft drop of a loaded MCO onto another MCO There is an impact absorber under the lower MCO, but no intermediate impact absorber between them

The analysis indicates that plastic deformation of the impacted MCO shield plug seal and shoulder would be a maximum of 0 030 inches

The impact absorber under the bottom MCO would be compressed 6 to 9 inches

7 0 REFERENCES

Chenault, D M , 1997, *Multı-Canıster Overpack Analysıs Fıle Documentatıon*, HNF-SD-SNF-DP-007, Rev 0, DE&S Hanford, Rıchland, Washıngton
Appendıx B *Cask Lıd Accıdental Drops Onto Multı-Canıster Overpack*
Appendıx D *Multı-Canıster Overpack to Multı-Canıster Overpack Drop Analysıs*

Clark, G L , 1999, *Test Report for the CSB Prototypıc Impact Absorbers*, TR-003, Rev 0, PacTec, Tacoma, Washıngton

Cluskey, D R , 1998 *Hanford MHM Seısmıc Analysıs of the Hanford MCO Handlıng Machıne*, ESL/R(96)083, Rev 3, Alstom Automatıon Ltd Leıcester, England

Foster Wheeler, 1998 *Multıcanıster Overpack Handlıng Machıne (MHM) 100% Desıgn Report*, Foster Wheeler Envıronmental Corporatıon

Keller, C 1998 *Desıgn Calculatıon for the MCO Samplıng Statıon – Shıeld Components*, Calculatıon Number CSB-RM-0016 Fluor Danıel, Inc

Noss, P W , 1999, *CSB Impact Absorber Analysıs Report*, ED-037 Rev 1, PacTec, Tacoma, Washıngton

Smıth, K E 1999 *Multı-Canıster Overpack Desıgn Report*, HNF-SD-SNF-DR-003, Rev 2, DE&S Hanford Rıchland, Washıngton

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 1 of 16)

Process step or event	Drop, shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis: Chapter 3 0	Controls for safety basis: Chapter 6 0	Concurrence documentation
Cask–MCO arrival at CSB	1	None	NA	Need to show arrival of MCO filled with water is unlikely Need an approved SARP	Revise SNF-4042 Revise SARP	Nuclear Safety Nuclear Safety	- Evaluate potential need for additional controls to preclude receipt and processing of MCO full of water		
Cask–MCO moved by the receiving crane to the cask receiving pit	2	Drop cask–MCO onto trailer edge with horizontal slap-down onto floor Drop height. 60 in.	Yes	Approved calculation showing that the cask can be credited as a confinement boundary Revisit dose consequence calculations potential to reduce onsite dose	Issue engineering calculation Revise SNF-4042 and SNF 3328	WMNW Technical Operations Nuclear Safety	SSCs - Cask (SS) for confinement (leak tight) - 60-in. lift yoke (SS) to protect drop height assumption Receiving crane (SS) for ITS TSRs - Control for using proper yoke	SSCs Cask (SC) barrier to exclude moderator 60-in. lift yoke (SC) to protect drop height assumption - MCO (SC) for pre-accident geometry control TSRs Control for using proper yoke Moderator control achieved through compliance with pre-fire plan	
	3	Drop cask–MCO vertically directly onto concrete floor Drop height 60 in.	Yes	Approved calculation showing that the cask can be credited as a confinement boundary Revisit dose consequence calculations potential to reduce onsite dose	Issue engineering calculation Revise SNF-4042 and SNF-3328	WMNW Technical Operations Nuclear Safety	SSCs - Cask (SS) for confinement - 60-in. lift yoke (SS) to protect drop height assumption Receiving crane (SS) for ITS TSRs - Control for using proper yoke	SSCs Cask (SC) barrier to exclude moderator 60-in. lift yoke (SC) to protect drop height assumption - MCO (SC) for pre-accident geometry control TSRs Control for using proper yoke - Moderator control achieved through compliance with pre-fire plan	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 2 of 16)

Process step or event	Drop shear*	Drop, shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis: Chapter 3 0	Controls for safety basis: Chapter 6 0	Concurrence documentation
Cask–MCO moved by the receiving crane to the cask receiving pit (continued)	4	Drop cask–MCO onto edge of cask receiving pit with slap-down	Yes	For items 4–6 approved calculation showing that the cask can be credited as a confinement boundary during cask receiving pit drops	Issue engineering calculation	WMNW Technical Operations	SSCs - Cask (SS) for confinement 60-in. lift yoke (SS) to protect drop height assumption Receiving crane (SS) for ITS TSRs Control for using proper yoke	SSCs - Cask (SC) barrier to exclude moderator - 60 in. lift yoke (SC) to protect drop height assumption - MCO (SC) for pre-accident geometry control TSRs Control for using proper yoke Moderator control achieved through compliance with pre-fire plan	
	5	Drop cask–MCO onto edge of cask receiving pit spanning the pit		Confirm cask receiving pit configuration for isolation from service area	Issue confirmation	Design Authority Operations			
	6	Drop cask–MCO onto edge of cask receiving pit with cask impact on opposite edge of service pit		Revisit dose consequence calculations potential to reduce onsite dose	Revise SNF-4042 and SNF 3328	Nuclear Safety			
	7	Drop cask–MCO into cask receiving pit	Yes	Approved calculation showing no loss of confinement after cask drop with impact absorber and include drop into pit without impact absorber as backup Revisit dose consequence calculations potential to reduce onsite dose	Provide existing calculations and test results Revise SNF-4042 and SNF 3328	Design Authority Nuclear Safety	SSCs Cask (SS) for confinement 60-in. lift yoke (SS) to protect drop height assumption Receiving crane (SS) for ITS Impact absorber (SS) to protect cask confinement function TSRs Control for using proper yoke Control for placement of cask receiving pit impact absorber	SSCs - Cask (SC) barrier to exclude moderator - 60 in. lift yoke (SS) to protect drop height assumption Impact absorber (SC) to protect cask confinement TSRs - Control for using proper yoke - Moderator control achieved through compliance with pre-fire plan - Control for placement of cask receiving pit impact absorber	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 3 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
Cask–MCO moved by the receiving crane to the cask receiving pit (continued)	8	Shear of cask–MCO by moving receiving crane while cask–MCO is partially lowered into pit	No	Verify shear forces not sufficient to breach transportation cask (verify bounded by MHM collision calculation)	Issue letter report	WMNW Design Authority	SSCs - Cask (SS) for confinement	SSCs Cask (SC) barrier to exclude moderator	
	9a	Drop cask–MCO onto edge of or into maintenance pit	Yes	Revisit dose consequence calculations potential to reduce onsite dose Demonstrate cask confinement not lost for drop	Revise SNF-4042 and SNF-3328 Issue engineering calculation	Nuclear Safety Technical Operations	SSCs Receiving crane (SS) for ITS TSRs Receiving crane load path control (E-switch) DID Interlock and fortress key (SS) for controlling receiving crane location	TSRs Receiving crane load path control (E-switch) Moderator control achieved through compliance with pre-fire plan	
	9b	Drop cask–MCO onto edge of or into FFTF pit	Yes	Revisit dose consequence calculations, potential to reduce onsite dose Demonstrate cask confinement not lost for drop	Revise SNF-4042 and SNF-3328 Issue engineering calculation on parallel path	Nuclear Safety Technical Operations	SSCs Receiving crane (SS) for ITS TSRs Receiving crane load path control (E-switch) DID Interlock and fortress key (SS) for controlling receiving crane location	TSRs Receiving crane load path control (E-switch) Moderator control achieved through compliance with pre-fire plan	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 4 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	*Chapter 6 0*	
Cask–MCO moved by the receiving crane to the cask receiving pit (continued)	10	Shear of MCO because of collision between the crane and cask–MCO as the MCO is lowered into the cask receiving pit	No	Demonstrate that, in this accident, the shear forces not sufficient to breach transportation cask	Identify and confirm calculation	Design Authority	SSCs - Cask (SS) for confinement DID Interlock P5 (SS) to inhibit receiving crane and MHM interaction	SSCs Cask (SC) barrier to exclude moderator	
Cask yoke removal	11	Drop yoke onto cask lid	No	Demonstrate drop of yoke onto cask will not breach the cask	Define and analyze bounding drop of object onto cask	WMNW	SSCs - Cask (SS) for confinement TSRs Control for using proper yoke	SSCs Cask (SC) barrier to exclude moderator TSRs Control for using proper yoke	
Cask lid removal using gantry hoist	12	Drop cask lid onto MCO	Yes	Demonstrate that MCO confinement is not breached by this drop	Identify and confirm calculation	Technical Operations	SSCs MCO (SS) for confinement TSRs Control for maximum lift height of cask lid with double verification	SSCs MCO (SC) barrier to exclude moderator TSRs Control for maximum lift height of cask lid with double verification	
Seismic event	13	CSB facility structure falls on MCO	Yes	The CSB facility is seismically qualified	None	NA	CSB seismic design (SC)		
MCO retrieved from cask in cask receiving pit into the MHM	14	Drop cask receiving pit plug onto MCO	No	Confirm that the design of plug and pit shield make it geometrically impossible for this drop to impact the MCO	Issue letter report	Design Authority	Plug and pit shield (design features)		

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 5 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO retrieved from cask in cask receiving pit into the MHM (continued)	15	Drop MCO onto edge of cask (eccentric drop at cask receiving pit)	No	Demonstrate that the structural containment of the MCO is not breached by this drop	Issue analysis report	FDNW Technical Operations	SSCs MCO (SS) for confinement Shield hatch and MHM centering guide (SS) to protect MCO confinement function TSRs Control for verification of installation of MHM centering guide DID - MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS)	SSCs - MCO (SC) barrier to exclude moderator Shield hatch and MHM centering guide (SC) to protect MCO integrity TSRs - Control for verification of installation of MHM centering guide	
	16	Drop MCO back into cask (concentric drop at cask receiving pit)	No	Demonstrate that MCO confinement is not breached by this drop	Issue analysis report	FDNW Technical Operations	SSCs MCO (SS) for confinement Cask receiving pit impact absorber (SS) to protect MCO confinement function TSRs Control for verification of cask receiving pit impact absorber presence before startup and after replacement DID - MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS)	SSCs MCO (SC) barrier to exclude moderator -Cask receiving pit impact absorber (SC) to protect MCO integrity TSRs Control for verification of cask receiving pit impact absorber presence before startup and after replacement	
	17a	Shear MCO by turret rotation with MCO only partially retrieved into the MHM cask	No	Show shear is not possible with turret	Review and issue report	Technical Operations	SSCs MCO (SS) for confinement	SSCs -MCO (SC) barrier to exclude moderator	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 6 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO retrieved from cask in cask receiving pit into the MHM (continued)	17b	Shear MCO by moving MHM with MCO only partially retrieved into the MHM cask	Yes	Show shear is not possible (trolley and bridge) or define value of force or torque at which MCO fails New design to support slip coupling	Prepare and issue report Issue DCN	Technical Operations Design Authority	SSCs - MCO (SS) for confinement - Redundant mechanical slip coupling (SS) to limit torque and exclude damage to MCO TSRs Control for verification that the MCO grapple is up before MHM movement from each respective location DID - MHM interlocks (P3 P6 P8 P9 P80) (SS) to protect MCO confinement integrity	SSCs - MCO (SC) barrier to exclude moderator - Redundant mechanical slip coupling (SC) to limit torque and exclude damage to MCO TSRs Moderator control achieved through compliance with pre-fire plan Control for verification that the MCO grapple is up before MHM movement from each respective location	
Seismic event	18	Shear MCO while MCO is partially inserted into cask receiving pit, weld station, or storage tube during DBE	Yes	Define magnitude of seismic event that shears MCO to reduce conservatism in frequency estimate of seismic event (may be too difficult to quantify the magnitude of this event) New design for indication to support verification of seismic restraints	Issue letter report Issue DCN	Design Authority Design Authority	SSCs - MHM seismic restraints (trolley turret and bridge) (SS) to limit MHM movement during seismic event - MHM rails and rail frog (SS) - Seismic detection and MHM power-disconnect (SS) to prevent defeating seismic protection features TSRs - Control to verify seismic restraints are applied - Control for verification of rail frog bolt torque DID MHM seismic interlocks (P3 P6 P8 P9 P21 and P80) (SS) to prevent MHM movement during MCO lift	SSCs MHM seismic restraints (trolley turret and bridge) (SC) to limit MHM movement during seismic event MHM rails and rail frogs (SC) Seismic detection and MHM power-disconnect (SC) to prevent defeating seismic protection features TSRs Control for visual verification of MHM seismic restraints - Moderator control achieved through compliance with pre-fire plan - Control for verification of rail frog bolt torque	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 7 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
Seismic event (continued)	19	MHM fall onto operating deck, resulting in major structural damage to deck	No	Demonstrate that MCO confinement is not breached	Identify and confirm calculation	Technical Operations	SSCs - Seismic detection and MHM power-disconnect (SS) to limit MHM movement	SSCs - Seismic detection and MHM power-disconnect (SC) to limit MHM travel TSRs Moderator control achieved through compliance with pre-fire plan	
MCO transported to storage tube or sampling/weld station	20	Shear MCO by rotating turret with MCO only partially retracted into MHM cask	Yes	Show shear is not possible with turret	Review and issue report	Technical Operations	SSCs - MCO (SS) for confinement	SSCs MCO (SC) barrier to exclude moderator	
	21	Drop MCO within MHM MCO cask tube onto MHM turret deck	No	Approved calculation showing that the MCO does not breach for "two-blocked" condition Verify height ("two-blocked") used in calculations	Prepare and issue calculation Verify and issue FDNW bounding height survey	FDNW Technical Operations Design Authority Technical Operations	SSCs - MCO (SS) for confinement DID MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS) to protect loss of MCO confinement function	SSCs MCO (SC) barrier to exclude moderator	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios (page 8 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO transported to storage tube or sampling/weld station (continued)	22	Drop MCO onto CSB operating floor	Yes	Design for the new MHM interlock P99 upgrade to safety class Evaluate level of nuclear safety credit that can be taken for procedures and accountability	Issue DCN Revise SNF-3328	Design Authority Nuclear Safety	SSCs - MHM interlock (P99) (SS) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity TSRs Control for verification that the tube plug, sampling/weld station cover plug or shield hatch center plate is in place before MHM movement from each respective location DID MHM interlock (P2) (SS) to prevent MHM movement with tube plug in tube plug cavity MHM interlocks (P57 P61 P62 P63 P65 P66) and grapple design (SS) to protect MCO confinement function	SSCs MHM interlock (P99) (SC) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity TSRs Moderator control achieved through compliance with pre-fire plan Control for verification that the tube plug, sampling/weld station cover plug, or shield hatch center plate is in place before MHM movement from each respective location	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 9 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO transported to storage tube or sampling/weld station (continued)	23	Drop MCO onto storage covers for CSB vaults 2 or 3	Yes	Design for the new MHM interlock P99 upgrade to safety class Evaluate level of nuclear safety credit that can be taken for procedures and accountability	Issue DCN Revise SNF-3328	Design Authority Nuclear Safety	SSCs MHM interlock (P99) (SS) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity TSRs Control for verification that the tube plug, sampling/weld station cover plug, or shield hatch center plate is in place before MHM movement from each respective location DID MHM interlock (P2) (SS) to prevent MHM movement with tube plug in tube plug cavity MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS) to protect against loss of MCO confinement function	SSCs - MHM interlock (P99) (SC) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity TSRs Moderator control achieved through compliance with pre-fire plan Control for verification that the tube plug, sampling/weld station cover plug, or shield hatch center plate is in place before MHM movement from each respective location	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 10 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO transported to storage tube or sampling/weld station (continued)	24	Drop MCO onto or into maintenance pit or tube plug exchange facility	Yes	Design for the new MHM interlock P99 upgrade to safety class Evaluate level of nuclear safety credit that can be taken for procedures and accountability	Issue DCN Revise SNF-3328	Design Authority Nuclear Safety	TSRs Control for supervisory hold point before the MHM cask enters the "red zone" with double verification that no MCO is in the MHM DID - MHM interlock (P2) (SS) to prevent MHM movement with tube plug in tube plug cavity MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS) to protect against loss of MCO confinement function MHM interlocks (P26 P85) (SS) to prevent turret rotation to MCO hoist position at tube plug exchange facility MHM interlock (P99) (SS) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity	TSRs Moderator control achieved through compliance with pre-fire plan - Control for supervisory hold point before the MHM cask enters the "red zone" with double verification that no MCO is in the MHM DID MHM interlock (P99) (SS) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios (page 11 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO transported to storage tube or sampling/weld station (continued)	25	Drop MCO onto or into FFTF maintenance pit	Yes	Design for the new MHM interlock P99 upgrade to safety class Evaluate level of nuclear safety credit that can be taken for procedures and accountability	Issue DCN Revise SNF-3328	Design Authority Nuclear Safety	SSCs - MHM interlock (P99) (SS) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity TSRs - Control for supervisory hold point before the MHM cask enters the "red zone" with double verification that no MCO is in the MHM DID MHM interlock (P2) (SS) to prevent MHM movement with tube plug in tube plug cavity - MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS) to protect against loss of MCO confinement function	SSCs - MHM interlock (P99) (SC) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity TSRs Moderator control achieved through compliance with pre-fire plan - Control for supervisory hold point before the MHM cask enters the red zone" with double verification that no MCO is in the MHM	
Intermediate impact absorber installed on MCO	26	Drop intermediate impact absorber on MCO damaging MCO	No	Approved calculation note showing that a drop of the intermediate impact limiter does not breech the MCO confinement boundary (show bounded by item 31)	Prepare and issue calculation	WMNW Technical Operations	SSCs - MCO (SS) for confinement DID MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS) to protect against loss of MCO confinement function	SSCs -MCO (SC) barrier to exclude moderator	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 12 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO placed in storage tube or sampling/weld station	27	Shear MCO by moving MHM with MCO only partially retrieved into the MHM cask	Yes	Show shear is not possible (trolley and bridge) or define value of force or torque at which MCO fails New design to support slip coupling	Prepare and issue calculation Issue DCN	WSMS Technical Operations Design Authority	SSCs MCO (SS) for confinement Redundant mechanical slip coupling (SS) to limit torque and exclude damage to MCO TSRs Control for verification that the MCO grapple is up before MHM movement from each respective location Control to require rotation to camera position to verify tube plug is in storage tube DID MHM interlocks (P3 P6 P8 P9 and P80) (SS) to protect MCO confinement function	SSCs - MCO (SC) barrier to exclude moderator ingress - Redundant mechanical slip coupling (SC) to limit torque and exclude damage to MCO TSRs Moderator control achieved through compliance with pre-fire plan Control for verification that the MCO grapple is up before MHM movement from each respective location Control to require rotation to camera position to verify tube plug is in storage tube	
	28	Shear MCO by rotating turret with MCO only partially retracted into MHM cask	Yes	Show shear is not possible with turret	Review and issue report	Technical Operations	SSCs MCO (SS) for confinement	SSCs MCO (SC) barrier to exclude moderator	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 13 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO placed in storage tube or sampling/weld station (continued)	29	Drop MCO onto impact absorber in storage tube or sampling/weld station	No	Approved calculation showing no confinement loss for MCO following drop onto impact absorber	Identify design calculation and confirm result	Design Authority	SSCs - MCO (SS) for confinement Bottom storage tube and sampling/weld station impact absorbers (SS) to protect MCO confinement function TSRs Control for program to ensure bottom storage tube and sampling/weld station impact absorber in place with double verification DID - MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS)	SSCs Bottom storage tube and sampling/weld station impact absorbers (SC) barrier to exclude moderator ingress - MCO (SC) barrier to exclude moderator TSRs Control for program to ensure bottom storage tube and sampling/weld station impact absorber in place with double verification	
	30	Combined							
	31	Drop MCO onto another MCO in storage tube (no intermediate impact absorber)	No	Approved calculation showing no confinement loss following drop of second MCO onto first MCO	Identify design calculation and confirm result	Design Authority	SSCs Bottom impact absorber (SS) to protect MCO confinement function MCO (SS) for confinement Intermediate impact absorber (SS) for ITS TSRs Control for program to ensure bottom impact absorber in place with double verification DID MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS)	SSCs Bottom impact absorber (SC) barrier to exclude moderator - MCO (SC) barrier to exclude moderator ingress TSRs - Control for program to ensure bottom impact absorber in place with double verification	
	32	Combined							

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios. (page 14 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO placed in storage tube or sampling/weld station (continued)	33	Drop MCO onto storage tube plug because of inadvertent turret rotation	Yes	Design for the new MHM interlock P99 Evaluate level of nuclear safety credit that can be taken for procedures and accountability	Issue DCN Revise SNF 3328	Design Authority Nuclear Safety	SSCs - MHM interlock (P99) (SS) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity DID MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS) to protect against loss of MCO confinement function	SSCs MHM interlock (P99) (SC) prevents turret rotation to MCO hoist position without tube plug in tube plug cavity TSRs Moderator control achieved through compliance with pre-fire plan	
	34	Drop MCO onto edge of storage tube(eccentric drop)	No	Demonstrate that MCO confinement is not breached by this drop	Calculation is complete and report issued	Technical Operations	SSCs MCO (SS) for confinement Storage tube upper flange MHM centering guide (SS) to protect MCO confinement TSRs Control for verification of installation of MHM centering guide DID Interface guide ring - MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design(SS)	SSCs MCO (SC) barrier to exclude moderator Storage tube upper flange MHM centering guide (SC) barrier to exclude moderator TSRs Control for verification of installation of MHM centering guide	

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios (page 15 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	
MCO placed in storage tube or sampling/weld station (continued)	35	Drop MCO onto edge of sampling/weld station (eccentric drop)	No	Demonstrate that MCO confinement is not breached by this drop	Calculation is complete and report issued	Technical Operations	SSCs - MCO (SS) for confinement - Upper temporary shield, MHM centering guide (SS) to protect MCO confinement TSRs - Control for verification of installation of MHM centering guide DID Interface guide ring - MHM interlocks (P57 P61 P62 P63 P65 and P66) and grapple design (SS)	SSCs MCO (SC) barrier to exclude moderator - Upper temporary shield, MHM centering guide (SC) barrier to exclude moderator TSRs - Control for verification of installation of MHM centering guide	
	36	Drop storage tube plug onto MCO	No	Confirm assumption that the design of plug makes it geometrically impossible for this drop to impact the MCO	Confirm assumption and issue analysis	Design Authority	Plug and tube embed (SS) to protect MCO confinement function (design feature)		
	37	MHM collision with sampling/weld station	Yes	Revisit dose consequence calculations potential to reduce onsite dose	Revise SNF 3328	Nuclear Safety	SSCs - MHM interlock (P10) (SS) to protect MCO confinement function		

Table 2-1 Multi-Canister Overpack Process Steps and Possible Drop, Shear, or Impact Scenarios (page 16 of 16)

Process step or event	Drop shear*	Drop shear or impact description	Breach (without controls)	Safety analysis needs	Action needed	Responsible party	Controls for safety basis		Concurrence documentation
							Chapter 3 0	Chapter 6 0	

Notes Assuming the offsite consequences for a criticality scenario are < 0 5 rem, but exceed onsite guidelines What criteria must be applied to classify the facility features used to protect criticality contingencies? (i.e If a probabilistic argument demonstrates that violation of two criticality contingencies is <<1 E-06/yr are the additional controls used to derive this frequency considered to be safety class vs safety significant?

To develop the justification for requesting a deviation from DOE Order 6430 1A related to safety-class designation for criticality contingency violations a consequence analysis of a criticality should be calculated. If results are less than 0 5 rem offsite the loss of criticality contingency could be argued to not be a safety-class function.

*Numbers in this column correspond to a previous set of drop identified in SNF 3328 *Cold Vacuum Drying Facility Design Basis Accident Analysis Documentation* Rev 2 Fluor Daniel Hanford, Incorporated, Richland, Washington.

Control = Administrative Control.
CSB = Canister Storage Building.
DBE = design basis earthquake
DID = defense in depth
DCN = Design Change Notice
FFTF = Fast Flux Test Facility
ITS = important to safety
MCO = multi-canister overpack.
MHM = multi-canister overpack handling machine
SARP = safety analysis report for packaging
SC = safety class
SS = safety significant.
SSC = structure system, or component.
WMNW = Waste Management Northwest.
WSMS = Westinghouse Safety Management Solutions