CONFINEMENT. Table A4.13-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.13-5. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD13-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD13-DPC	ESD13-DPC-DROP	CONFINEMENT	HVAC
	ESD13-DPC-TWOBLOCK		
	ESD13-DPC-SIDEIMPACT		
	ESD13-DPC-DROPON		
	ESD13-DPC-SPURMOVE		
	ESD13-DPC-DROPBELL		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
HVAC = heating, ventilation, and air conditioning.

Source: Original

MODERATOR. Table A4.13-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.13-6. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD13-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD13-DPC	ESD13-DPC-DROP	MODERATOR	MODERATOR
	ESD13-DPC-TWOBLOCK		
	ESD13-DPC-SIDEIMPACT		
	ESD13-DPC-DROPON		
	ESD13-DPC-SPURMOVE		
	ESD13-DPC-DROPBELL		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.13.2 Event Trees for WHF-ESD13 (TAD Canister Transfer with CTM)

This ESD delineates the event sequences that arise after a structural challenge resulting from transfer of a TAD canister from a STC to aging overpack within the CTM.

Although the initiator event trees transfer to the same response tree (see Table A4.13-7), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.13-7. Summary of Event Trees for WHF-ESD13-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a TAD canister	Initiator: WHF-ESD13-TAD TAD Response: RESPONSE-CANISTER1	346

NOTE: TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.13.2.1 Initiating Events for WHF-ESD13-TAD

The following initiating events are associated with WHF-ESD13-TAD involving CTM operation. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.13-8.

Canister Drop from Operational Height. This initiating event accounts for the potential impact to the TAD canister due to having been dropped from the normal operational height during transfer by the CTM. The probability of drop per transfer is derived from empirical data in Section 6.3 and is modeled as a single-event fault tree as listed in Table A4.13-8. The initiating event is specified as a probability of a drop per canister.

Canister Drop from Above Operational Height. This initiating event accounts for the potential impact to the TAD canister due to having been dropped from above the normal operational height (for example, due to two-blocking) during transfer by the CTM. The probability of drop per transfer is modeled as a fault tree as listed in Table A4.13-8. The initiating event is specified as a probability of a drop per canister.

Side Impact to Canister. This initiating event covers the potential side impact to the TAD canister as it being lifted and transferred by the CTM. This event is modeled as a fault tree and is listed in Table A4.13-8. The initiating event is specified as a probability of impact per canister. The following initiating event name is assigned in the SAPHIRE rules file associated with the initiating event. The following two fault trees are linked to the initiating event with an OR gate at the fault-tree level in SAPHIRE.

Canister Drop inside CTM Shielding Bell. This initiating event covers the potential impact to the TAD canister due to the drop of a heavy object such as the CTM bell. This event is modeled as a fault tree and is listed in Table A4.13-8. The initiating event is specified as a probability of object drop per canister.

Spurious Movement of TAD Canister. This initiating event results from spurious site transporter movement or CTM bell movement and is modeled as a fault tree as listed in Table A4.13-8.

Canister Drop Inside Bell. This initiating event describes a drop inside the CTM bell due to either human or mechanical failures and is described in Table A4.13-8.

Table A4.13-8. Initiating Event Assignments for WHF-ESD13-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Drop of Cask From Operational Height	WHF-ESD13-TAD	ESD13-TAD-DROP	CTM-DROP---ALL-HEIGHTS and 050-LIFTS-PER-TAD-CAN
Drop of Cask Above Operational Height	WHF-ESD13-TAD	ESD13-TAD-TWOBLOCK	CTM-2-BLOCK and 050-LIFTS-PER-TAD-CAN
Side Impact of Canister	WHF-ESD13-TAD	ESD13-TAD-SIDEIMPACT	ESD13-TAD-SIDEIMPACT
Drop on Canister	WHF-ESD13-TAD	ESD13-TAD-DROPON	CTM-DROP-ONTO-CASK and 050-CTMOBJLIFTNUMBERD
Spurious Movement	WHF-ESD13-TAD	ESD13-TAD-SPURMOVE	ESD13-TAD-SPURMOVE
Canister Drop Inside Bell	WHF-ESD13-TAD	ESD13-TAD-DROPBELL	CTM-DROP-IN-SHIELD-BELL and 050-LIFTS-PER-TAD-CAN

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.13.2.2 System Response Event Tree RESPONSE-CANISTER1

The pivotal events that appear in RESPONSE-CANISTER1 are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CANISTER. Table A4.13-9 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.13-9. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD13-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event[a]
WHF-ESD13-TAD	ESD13-TAD-DROP	CANISTER-DROP	CANISTER-FAILS-DROP
	ESD13-TAD-TWOBLOCK	CANISTER-TWOBLOCK	CANISTER-FAIL-TWOBLOCK
	ESD13-TAD-SIDEIMPACT	CANISTER-IMPACT	CANISTER-FAIL-IMPACT
	ESD13-TAD-DROPON	CANISTER-DROP	CANISTER-FAILS-DROP
	ESD13-TAD-SPURMOVE	CANISTER-SHEAR	CANISTER-SHEAR-CTM
	ESD13-TAD-DROPBELL	CANISTER-DROP	CANISTER-FAILS-DROP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.13-10 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.13-10. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD13-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event[a]
WHF-ESD13-TAD	ESD13-TAD-DROP	SHIELD-CTM	SHIELD-FAIL-CTM
	ESD13-TAD-TWOBLOCK	SHIELD-CTM	SHIELD-FAIL-CTM
	ESD13-TAD-SIDEIMPACT	SHIELD-CTM	SHIELD-FAIL-CTM
	ESD13-TAD-DROPON	SHIELD-CTM	SHIELD-FAIL-CTM
	ESD13-TAD-SPURMOVE	SHIELD-LOSS	SHIELD-TOTAL-LOSS
	ESD13-TAD-DROPBELL	SHIELD-CTM	SHIELD-FAIL-CTM

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.13-11 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.13-11. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD13-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD13-TAD	ESD13-TAD-DROP	CONFINEMENT	HVAC
	ESD13-TAD-TWOBLOCK		
	ESD13-TAD-SIDEIMPACT		
	ESD13-TAD-DROPON		
	ESD13-TAD-SPURMOVE		
	ESD13-TAD-DROPBELL		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
HVAC = heating, ventilation, and air conditioning.

Source: Original

MODERATOR. Table A4.13-12 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.13-12. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD13-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD13-TAD	ESD13-TAD-DROP	MODERATOR	MODERATOR
	ESD13-TAD-TWOBLOCK		
	ESD13-TAD-SIDEIMPACT		
	ESD13-TAD-DROPON		
	ESD13-TAD-SPURMOVE		
	ESD13-TAD-DROPBELL		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.14 EVENT TREES FOR WHF-ESD14-DPC

This ESD delineates the event sequences that arise after a structural challenge during movement of transportation cask/DPC on CTT from the Cask Unloading Room to the preparation station.

The STC is bolted and provides confinement.

Although the initiator event trees transfer to the same response tree (see Table A4.14-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.14-1. Summary of Event Trees for WHF-ESD14-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
STC containing a DPC	Initiator: WHF-ESD14-DPC TAD Response: RESPONSE-STC1	346

NOTE: DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Ref. 2.2.26, Table 4

A4.14.1   Initiating Events for WHF-ESD14-DPC

The following initiating events are associated with WHF-ESD14-DPC involving movement from the cask unloading room to the preparation station. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.14-2.

Side Impact to CTT-Transportation Cask/DPC. This initiating event describes a collision of the CTT with a WHF structure and is listed in Table A4.14-2.

CTT or Transportation Cask/DPC Catches Crane Hook/Rigging Leading to Tipover. This
initiating event describes CTT tipover due to a human error event and is listed in Table A4.14-2.

Table A4.14-2. Initiating Event Assignments for WHF-ESD14

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Side impact to CTT-transportation cask/DPC	WHF-ESD14-DPC	ESD14-DPC-IMPACT	050-CTT-COLLIDE
CTT or transportation cask/DPC catches crane hook/rigging leading to tip over	WHF-ESD14-DPC	ESD14-DPC-TIP	050-OPTIPOVER3-HFI-NOD

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
CTT = cask transfer trolley; DPC = dual-purpose canister.

Source: Original

A4.14.2 System Response Event Tree RESPONSE-STC1

The pivotal events that appear in RESPONSE-STC1 are summarized below. The accompanying
tables show the association of pivotal event names with basic event or fault tree names.

STC. Table A4.14-3 indicates the basic event that is associated with this pivotal event for each
initiating event.

Table A4.14-3. Basic Event Associated with the STC Pivotal Events of WHF-ESD14-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD14-DPC	ESD14-DPC-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD14-DPC-TIP	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CANISTER. Table A4.14-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.14-4. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD14-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event[a]
WHF-ESD14-DPC	ESD14-DPC-IMPACT	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD14-DPC-TIP	CANISTER-FAIL	

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.11-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.14-5. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD14-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event[a]
WHF-ESD14-DPC	ESD14-DPC-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD14-DPC-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.14-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.14-6. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD14-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD14-DPC	ESD14-DPC-IMPACT	CONFINEMENT	HVAC
	ESD14-DPC-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

MODERATOR. Table A4.14-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.14-7. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD14-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD14-DPC	ESD14-DPC-IMPACT	MODERATOR	MODERATOR
	ESD14-DPC-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.15 EVENT TREES FOR WHF-ESD15-DPC

This ESD delineates the event sequences that arise from structural challenges during movement of STC/DPC from the preparation station to the DPC cutting station.

The STC is bolted and provides confinement.

Although the initiator event trees transfer to the same response tree (see Table A4.15-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.15-1. Summary of Event Trees for WHF-ESD15-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
STC containing a DPC	Initiator: WHF-ESD15-DPC STC Response: RESPONSE-STC1	346

NOTE: DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Ref. 2.2.26, Table 4

A4.15.1 Initiating Events for WHF-ESD15-DPC

The following initiating events are associated with WHF-ESD15-DPC involving movement from the cask unloading room to the preparation station. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.15-2.

Table A4.15-2. Initiating Event Assignments for WHF-ESD15-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Side impact to STC/DPC	WHF-ESD15-DPC	ESD15-PREP-SIMPACT	050-OPCTCOLLIDE3-HFI-NOD
Drop of heavy load on STC/DPC	WHF-ESD15-DPC	ESD15-PREP-DROPON	050-JIBCRANE-CRJ-DRP and 050-OBJLIFT-DPC-CUT-TRAN
Drop of STC/DPC at operational height	WHF-ESD15-DPC	ESD15-PREP-DROP	050-CHC-CSKDROP-CRN-DRP and 050-STCLIFTS-DPC-CUT
Drop of STC/DPC above operational height	WHF-ESD15-DPC	ESD15-PREP-TWOBLOCK	050-CHC-TWOBLCK-CRN-TBK and 050-STCLIFTS-DPC-CUT
STC/DPC tips over after being in placed in DPC cutting station	WHF-ESD15-DPC	ESD15-PREP-TIP	050-OPTIPOVER006-HFI-NOD

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and
Attachment C for basic events.
DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Original

A4.15.2 System Response Event Tree RESPONSE-STC1

The pivotal events that appear in RESPONSE-STC1 are summarized below. The accompanying
tables show the association of pivotal event names with basic event or fault tree names.

STC. Table A4.15-3 indicates the basic event that is associated with this pivotal event for each
initiating event.

Table A4.15-3. Basic Event Associated with the STC Pivotal Events of WHF-ESD15-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD15-DPC	ESD15-PREP-SIMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD15-PREP-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD15-PREP-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD15-PREP-TWOBLOCK	CASK-TWOBLOCK	CASK-DROP-TWOBLOCK
	ESD15-PREP-TIP	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and
Attachment C for basic events.

Source: Original

CANISTER. Table A4.15-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.15-4. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD15-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event[a]
WHF-ESD15-DPC	ESD15-PREP-SIMPACT	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD15-PREP-DROPON		
	ESD15-PREP-DROP		
	ESD15-PREP-TWOBLOCK		
	ESD15-PREP-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.15-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.15-5. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD15-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event[a]
WHF-ESD15-DPC	ESD15-PREP-SIMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD15-PREP-DROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD15-PREP-DROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD15-PREP-TWOBLOCK	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD15-PREP-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.15-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.15-6. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD15-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD15-DPC	ESD15-PREP-SIMPACT	CONFINEMENT	HVAC
	ESD15-PREP-DROPON		
	ESD15-PREP-DROP		
	ESD15-PREP-TWOBLOCK		
	ESD15-PREP-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
         HVAC = heating, ventilation, and air conditioning.

Source: Original

MODERATOR. Table A4.15-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.15-7. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD15-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD15-DPC	ESD15-PREP-SIMPACT	MODERATOR	MODERATOR
	ESD15-PREP-DROPON		
	ESD15-PREP-DROP		
	ESD15-PREP-TWOBLOCK		
	ESD15-PREP-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.16 EVENT TREES FOR WHF-ESD16-CSNF

This ESD delineates the event sequences that arise after a structural challenge during transportation cask/commercial SNF preparation activities prior to moving to pool.

Although the initiator event trees transfer to the same response tree (see Table A4.16-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.16-1. Summary of Event Trees for WHF-ESD16-CSNF

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation casks containing bare SNF assemblies (9 BWR or 4 PWR SNF assemblies per cask)	Initiator: WHF-ESD16-CSNF STC Response: RESPONSE-PREPSTATION	3,775

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF = spent nuclear fuel.

Source: Ref. 2.2.26, Table 4

A4.16.1 Initiating Events for WHF-ESD16-CSNF

The following initiating events are associated with WHF-ESD16 involving movement from the cask unloading room to the preparation station. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.16-2.

Table A4.16-2. Initiating Event Assignments for WHF-ESD16-CSNF

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Impact to transportation cask valve	WHF-ESD16-CSNF	ESD16-PREP-VALVEIMP	ESD16-PREP-VALVEIMP
Sampling line break	WHF-ESD16-CSNF	ESD16-PREP-SAMPLE	ESD16-PREP-SAMPLE
Cask overpressure	WHF-ESD16-CSNF	ESD16-PREP-OVERPRESSURE	OVERPRESSURIZATION

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.16.2 System Response Event Tree PREPSTATION

The pivotal events that appear in PREPSTATION are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CONFINEMENT. Table A4.16-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.16-3. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD16-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD16-CSNF	ESD16-PREP-VAVEIMP	HVAC-PREP	HVAC-FAIL-DURING-PREP
	ESD16-PREP-SAMPLE		
	ESD16-PREP-OVERPRESSURE		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

MODERATOR. Table A4.16-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.16-4. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD16-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD16-CSNF	ESD16-PREP-SIMPACT	MODERATOR-SAMPLING	MODERATOR-NONE
	ESD16-PREP-DROPON		
	ESD16-PREP-OVERPRESSURE		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.17 EVENT TREES FOR WHF-ESD17-DPC

This ESD delineates the event sequences that arise from structural challenges during transportation cask/DPC preparation activities prior to DPC lid cutting.

Although the initiator event trees transfer to the same response tree (see Table A4.17-1 below), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.17-1. Summary of Event Trees for WHF-ESD17-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
STC containing a DPC	Initiator: WHF-ESD17-DPC STC Response: RESPONSE-PREPSTATION	346

NOTE: DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Ref. 2.2.26, Table 4

A4.17.1 Initiating Events for WHF-ESD17-DPC

The following initiating events are associated with WHF-ESD17-DPC involving movement from the cask unloading room to the preparation station. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.17-2.

Table A4.17-2. Initiating Event Assignments for WHF-ESD17-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Impact to canister valves	WHF-ESD17-DPC	ESD17-PREP-VALVEIMP	ESD17-PREP-VALVEIMP
Sampling line break	WHF-ESD17-DPC	ESD17-PREP-SAMPLE	ESD17-PREP-SAMPLE
Overpressurization of canister	WHF-ESD17-DPC	ESD17-PREP-OVERPRESSURE	OVERPRESURIZATION

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.17.2 System Response Event Tree PREPSTATION

The pivotal events that appear in PREPSTATION are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CONFINEMENT. Table A4.17-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.17-3. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD17-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD17-DPC	ESD17-PREP-VALVEIMP	HVAC-PREP	HVAC-FAIL-DURING-PREP
	ESD17-PREP-SAMPLE		
	ESD17-PREP-OVERPRESSURE		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

MODERATOR. Table A4.17-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.17-4. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD17-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD17-DPC	ESD17-PREP-SIMPACT	MODERATOR-SAMPLING	MODERATOR-NONE
	ESD17-PREP-DROPON		
	ESD17-PREP-OVERPRESSURE		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.18 EVENT TREES FOR WHF-ESD18-DPC

This ESD delineates the event sequences that arise from structural challenges with the STC/DPC preparation activities at the DPC cutting station.

Although the initiator event trees transfer to the same response tree (see Table A4.18-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.18-1. Summary of Event Trees for WHF-ESD18-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
STC containing a DPC	Initiator: WHF-ESD18-DPC STC Response: RESPONSE-PREPSTATION	346

NOTE: DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Ref. 2.2.26, Table 4

A4.18.1 Initiating Events for WHF-ESD18-DPC

The following one initiating event is associated with WHF-ESD18-DPC involving STC/DPC preparation activities at the DPC cutting station. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.18-2.

Table A4.18-2. Initiating Event Assignments for WHF-ESD18-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Drop of heavy load on canister vent or port line	WHF-ESD18-DPC	ESD18-DPC-DROPON	050-JIBCRANE-CRJ-DRP and 050-OBJLIFT-DPC-CUT-TRAN

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.18.2 System Response Event Tree PREPSTATION

The pivotal events that appear in PREPSTATION are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CONFINEMENT. Table A4.18-3 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.18-3. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD18-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD18-DPC	ESD18-DPC-DROPON	HVAC-PREP	HVAC-FAIL-DURING-PREP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

MODERATOR. Table A4.18-4 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.18-4. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD18-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD18-DPC	ESD18-DPC-DROPON	MODERATOR-SAMPLING	MODERATOR-NONE

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.19 EVENT TREES FOR WHF-ESD19-DPC

A4.19.1 Event Trees for WHF-ESD19 (Drop in Pool)

This ESD delineates the event sequences that arise after a structural challenge to a STC with a DPC during the transfer from the DPC cutting station to the pool ledge. This ESD considers drops in the pool.

Although the initiator event trees transfer to the same response tree (see Table A4.19-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.19-1. Summary of Event Trees for WHF-ESD19-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
STC containing a DPC	Initiator: WHF-ESD19-DPC STC Response: RESPONSE-POOLMOVE	346

NOTE: DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Ref. 2.2.26, Table 4

A4.19.1.1 Initiating Events for WHF-ESD19 (Drop in Pool)

The following initiating events are associated with WHF-ESD19-DPC involving transfer of STC/DPC from the DPC cutting station to the pool ledge that lead to a drop in the pool. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.19-2.

Table A4.19-2. Initiating Event Assignments for WHF-ESD19-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Side impact to cask	WHF-ESD19-DPC	ESD19-POOL-IMPACT	050-OPTCIMPACT06-HFI-NOD and TIME-OVER-POOL-TO-POOL
Drop of heavy load on cask	WHF-ESD19-DPC	ESD19-POOL-DROPON	POOL-OBJDROPON
Drop of cask at operational height	WHF-ESD19-DPC	ESD19-POOL-DROP	050-CHC-CSKDROP-CRN-DRP and TIME-OVER-POOL-TO-POOL
Drop of cask above operational height	WHF-ESD19-DPC	ESD19-POOL-TWOBLOCK	050-CHC-TWOBLCK-CRN-TBK and TIME-OVER-POOL-TO-POOL
Cask tips over	WHF-ESD19-DPC	ESD19-POOL-TIP	050-OPTIPOVER007-HFI-NOD and TIME-OVER-POOL-TO-POOL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.19.1.2 System Response Event Tree RESPONSE-POOLMOVE

The pivotal events that appear in POOLMOVE are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CASK. Table A4.19-3 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.19-3. Basic Event Associated with the CASK Pivotal Events of WHF-ESD19-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD19-DPC	ESD19-POOL-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
WHF-ESD19-DPC	ESD19-POOL-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
WHF-ESD19-DPC	ESD19-POOL-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
WHF-ESD19-DPC	ESD19-POOL-TWOBLOCK	CASK-FAIL	CASK-FAILS
WHF-ESD19-DPC	ESD19-POOL-TIP	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

BORON. Table A4.19-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.19-4. Basic Event Associated with the BORON Pivotal Events of WHF-ESD19-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to BORON	Associated Fault Tree or Basic Event[a]
WHF-ESD19-DPC	ESD19-POOL-IMPACT	BORON	BORON-SYSTEM-FAILS
WHF-ESD19-DPC	ESD19-POOL-DROPON	BORON	
WHF-ESD19-DPC	ESD19-POOL-DROP	BORON	
WHF-ESD19-DPC	ESD19-POOL-TWOBLOCK	BORON	
WHF-ESD19-DPC	ESD19-POOL-TIP	BORON	

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.19.2 Event Trees for WHF-ESD19-DPC (Drop on Floor)

This ESD delineates the event sequences that arise after a structural challenge to a STC with a DPC during the transfer from the DPC cutting station to the pool ledge. This ESD considers drops on WHF floor.

Although the initiator event trees transfer to the same response tree (see Table A4.19-5 below), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.19-5. Summary of Event Trees for WHF-ESD19-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
STC containing a DPC	Initiator: WHF-ESD19-DPC STC Response: RESPONSE-STC1	346

NOTE   DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Ref. 2.2.26, Table 4

A4.19.2.1 Initiating Events for WHF-ESD19 (Drop on Floor)

The following initiating events are associated with WHF-ESD19-DPC involving transfer of the STC/DPC from the DPC cutting station to the pool ledge that lead to a drop on the floor. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.19-6.

Table A4.19-6. Initiating Event Assignments for WHF-ESD19-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Side impact to cask	WHF-ESD19-DPC	ESD19-FLOOR-IMPACT	050-OPTCIMPACT06-HFI-NOD and TIME-OVER-FLOOR-TO-POOL
Drop of heavy load on cask	WHF-ESD19-DPC	ESD19-FLOOR-DROPON	050-JIBCRANE-CRJ-DRP and 050-OBJLIFT-POOL-TRANS
Drop of cask at operational height	WHF-ESD19-DPC	ESD19-FLOOR-DROP	050-CHC-CSKDROP-CRN-DRP and TIME-OVER-FLOOR-TO-POOL
Drop of cask above operational height	WHF-ESD19-DPC	ESD19-FLOOR-TWOBLOCK	050-CHC-TWOBLCK-CRN-TBK and TIME-OVER-FLOOR-TO-POOL
Cask tips over	WHF-ESD19-DPC	ESD19-FLOOR-TIP	050-OPTIPOVER007-HFI-NOD and TIME-OVER-FLOOR-TO-POOL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.19.2.2 System Response Event Tree RESPONSE-STC1

The pivotal events that appear in RESPONSE-STC1 are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

STC. Table A4.19-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.19-7. Basic Event Associated with the CASK Pivotal Events of WHF-ESD19-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD19-DPC	ESD19-FLOOR-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD19-FLOOR-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD19-FLOOR-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD19-FLOOR-TWOBLOCK	CASK-TWOBLOCK	CASK-DROP-TWOBLOCK
	ESD19-FLOOR-TIP	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CANISTER. Table A4.19-8 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.19-8. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD19-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event[a]
WHF-ESD19-DPC	ESD19-FLOOR-IMPACT	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD19-FLOOR-DROPON		
	ESD19-FLOOR-DROP		
	ESD19-FLOOR-TWOBLOCK		
	ESD19-FLOOR-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.19-9 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.19-9. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD19-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event[a]
WHF-ESD19-DPC	ESD19-FLOOR-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD19-FLOOR-DROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD19-FLOOR-DROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD19-FLOOR-TWOBLOCK	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD19-FLOOR-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.19-10 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.19-10. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD19-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD19-DPC	ESD19-FLOOR-IMPACT	CONFINEMENT	HVAC
	ESD19-FLOOR-DROPON		
	ESD19-FLOOR-DROP		
	ESD19-FLOOR-TWOBLOCK		
	ESD19-FLOOR-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
       HVAC = heating, ventilation, and air conditioning.

Source: Original

MODERATOR. Table A4.19-11 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.19-11. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD19-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD19-DPC	ESD19-FLOOR-IMPACT	MODERATOR	MODERATOR
	ESD19-FLOOR-DROPON		
	ESD19-FLOOR-DROP		
	ESD19-FLOOR-TWOBLOCK		
	ESD19-FLOOR-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.20 EVENT TREES FOR WHF-ESD20

A4.20.1 Event Trees for WHF-ESD20-CSNF (Drop in Pool)

This ESD delineates the event sequences that arise after a structural challenge to a transportation cask with bare commercial SNF during the transfer from the preparation station to the pool ledge. This ESD considers drops in the pool.

Although the initiator event trees transfer to the same response tree (see Table A4.20-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.20-1. Summary of Event Trees for WHF-ESD20-CSNF

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation casks containing bare SNF assemblies (9 BWR or 4 PWR SNF assemblies per cask)	Initiator: WHF-ESD20-CSNF Response: RESPONSE-POOLMOVE	3,775

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF = spent nuclear fuel.

Source: Ref. 2.2.26, Table 4

A4.20.1.1 Initiating Events for WHF-ESD20-CSNF

The following initiating events shown in Table A4.20-2 are associated with WHF-ESD20-CSNF involving transportation cask with bare commercial SNF during the transfer from the preparation station to the pool ledge.

Table A4.20-2. Initiating Event Assignments for WHF-ESD20-CSNF

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Side impact to cask	WHF-ESD20-DPC	ESD20-POOL-IMPACT	050-OPTCIMPACT06-HFI-NOD and TIME-OVER-POOL-TO-POOL
Drop of cask at operational height		ESD20-POOL-DROP	050-CHC-CSKDROP-CRN-DRP and TIME-OVER-POOL-TO-POOL
Drop of cask above operational height		ESD20-POOL-TWOBLOCK	050-CHC-TWOBLCK-CRN-TBK and TIME-OVER-POOL-TO-POOL
Cask tips over		ESD20-POOL-TIP	050-OPTIPOVER007-HFI-NOD and TIME-OVER-POOL-TO-POOL
Drop of heavy load on cask		ESD20-POOL-DROPON	POOL-OBJDROPON

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.20.1.2 System Response Event Tree RESPONSE-POOLMOVE

The pivotal events that appear in POOLMOVE are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CASK. Table A4.20-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.20-3. Basic Event Associated with the CASK Pivotal Events of WHF-ESD20-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD20- CSNF	ESD20-POOL-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD20-POOL-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD20-POOL-TWOBLOCK	CASK-FAIL	CASK-FAILS
	ESD20-POOL-TIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD20-POOL-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

BORON. Table A4.20-4 indicates the basic event that is associated with this pivotal event for each initiating event t.

Table A4.20-4. Basic Event Associated with the BORON Pivotal Events of WHF-ESD20-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to BORON	Associated Fault Tree or Basic Event[a]
WHF-ESD20- CSNF	ESD20-POOL-IMPACT	BORON	BORON-SYSTEM-FAILS
	ESD20-POOL-DROP		
	ESD20-POOL-TWOBLOCK		
	ESD20-POOL-TIP		
	ESD20-POOL-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.20.2 Event Trees for WHF-ESD20 (Drop on Floor)

This ESD delineates the event sequences that arise after a structural challenge to a transportation cask with bare commercial SNF during the transfer from the preparation station to the pool ledge. This ESD considers drops in the pool.

Although the initiator event trees transfer to the same response tree (see Table A4.20-5 below), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.20-5. Summary of Event Trees for WHF-ESD20-CSNF

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation casks containing bare SNF assemblies (9 BWR or 4 PWR SNF assemblies per cask)	Initiator: WHF-ESD20-CSNF Response: RESPONSE-TCASK-CSNF	3,775

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF spent nuclear fuel.

Source: Ref. 2.2.26, Table 4

A4.20.2.1 Initiating Events for WHF-ESD20-CSNF

The following initiating events shown in Table A4.20-6 are associated with WHF-ESD20 involving transfer transportation cask with bare commercial SNF during the transfer from the preparation station to the pool ledge.

Table A4.20-6. Initiating Event Assignments for WHF-ESD20-CSNF

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Side impact to cask	WHF-ESD20-CSNF	ESD20-FLOOR-IMPACT	050-OPTCIMPACT06-HFI-NOD and TIME-OVER-FLOOR-TO-POOL
Drop of cask at operational height		ESD20-FLOOR-DROP	050-CHC-CSKDROP-CRN-DRP and TIME-OVER-FLOOR-TO-POOL
Drop of cask above operational height		ESD20-FLOOR-TWOBLOCK	050-CHC-TWOBLCK-CRN-TBK and TIME-OVER-FLOOR-TO-POOL
Cask tips over		ESD20-FLOOR-TIP	050-OPTIPOVER007-HFI-NOD and TIME-OVER-FLOOR-TO-POOL
Drop of heavy load on cask		ESD20-FLOOR-DROPON	050-JIBCRANE-CRJ-DRP and 050-OBJLIFT-POOL-TRANS

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.20.2.2 System Response Event Tree RESPONSE-TCASK-CSNF

The pivotal events that appear in RESPONSE-TCASK-CSNF are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CASK. Table A4.20-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.20-7. Basic Event Associated with the CASK Pivotal Events for WHF-ESD20-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD20-CSNF	ESD20-FLOOR-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD20-FLOOR-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD20-FLOOR-TWOBLOCK	CASK- TWOBLOCK	CASK-DROP-TWOBLOCK
	ESD20-FLOOR-TIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD20-FLOOR-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.20-8 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.20-8. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD20-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD20-CSNF	ESD20-FLOOR-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD20-FLOOR-DROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD20-FLOOR-TWOBLOCK	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD20-FLOOR-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD20-FLOOR-DROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.20-9 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.20-9. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD20-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD20-CSNF	ESD20-FLOOR-IMPACT	CONFINEMENT	HVAC
	ESD20-FLOOR-DROP		
	ESD20-FLOOR-TWOBLOCK		
	ESD20-FLOOR-TIP		
	ESD20-FLOOR-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
HVAC = heating, ventilation, and air conditioning.

Source: Original

MODERATOR. Table A4.20-10 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.20-10. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD20-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD20-CSNF	ESD20-FLOOR-IMPACT	MODERATOR	MODERATOR
	ESD20-FLOOR-DROP		
	ESD20-FLOOR-TWOBLOCK		
	ESD20-FLOOR-TIP		
	ESD20-FLOOR-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.21 EVENT TREES FOR WHF-ESD21

This ESD delineates the event sequences that arise after a structural challenge to a cask that occurs during lowering of the cask to the pool floor. This ESD applies to two waste forms:

- Uncanistered commercial SNF in a transportation cask (section A4.21.1)

- DPCs contained in STCs (section A4.21.2).

A4.21.1 Event Trees for WHF-ESD21-TC/CSNF

Release into the pool is considered a filtered release. Because of the potential drop height, the ability of the cask to maintain integrity is not included in this event sequence. In effect, this means that the cask is modeled as failing open in this ESD.

Although the initiator event trees transfer to the same response tree (see Table A4.21-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.21-1. Summary of Event Trees for WHF-ESD21-CSNF

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation casks containing bare SNF assemblies (9 BWR or 4 PWR SNF assemblies per cask)	Initiator: WHF-ESD21-CSNF Response: RESPONSE-POOLMOVE	3,775

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF spent nuclear fuel.

Source: Ref. 2.2.26, Table 4

A4.21.1.1   Initiating Events for WHF-ESD21-CSNF

The following initiating events shown in Table A4.21-2 are associated with WHF-ESD21-CSNF involving transportation cask with bare commercial SNF to the pool floor.

Table A4.21-2. Initiating Event Assignments for WHF-ESD21-CSNF

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Drop of transportation cask	WHF-ESD21-CSNF	ESD21-CSNF-LOWER-DROP	050-CHC-CSKDROP-CRN-DRP
Impact to transportation cask		ESD21-CSNF-LOWER-IMPACT	050-OPTCIMPACT07-HFI-NOD
Tipover of transportation cask		ESD21-CSNF-LOWER-TIP	050-OPTIPOVER-HFI-NOD
Drop onto transportation cask		ESD21-CSNF-LOWER-DROPON	ESD21-CSNF-LOWER-DROPON

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.21.1.2 System Response Event Tree RESPONSE-POOLMOVE

The pivotal events that appear in RESPONSE-POOLMOVE are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CASK. Table A4.21-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.21-3. Basic Event Associated with the CASK Pivotal Events of WHF-ESD21-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD21-CSNF	ESD21-CSNF-LOWER-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD21-CSNF-LOWER-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD21-CSNF-LOWER-TIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD21-CSNF-LOWER-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

BORON. Table A4.21-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.21-4. Basic Event Associated with the BORON Pivotal Events of WHF-ESD21-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to BORON	Associated Fault Tree or Basic Event[a]
WHF-ESD21-CSNF	ESD21-CSNF-LOWER-DROP	BORON	BORON-SYSTEM-FAILS
	ESD21-CSNF-LOWER-IMPACT		
	ESD21-CSNF-LOWER-TIP		
	ESD21-CSNF-LOWER-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.21.2 Event Trees for WHF-ESD21 (STC/DPC)

This ESD delineates the event sequences that arise after a structural challenge to a cask that occurs during lowering of the cask to the pool floor. This ESD applies to DPCs contained in STCs.

Release into the pool is considered a filtered release. Because of the potential drop height, the ability of the cask to maintain integrity is not included in this event sequence. In effect, this means that the cask is modeled as failing open in this ESD.

Although the initiator event trees transfer to the same response tree (see Table A4.21-5), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.21-5. Summary of Event Trees for WHF-ESD21-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
STC containing a DPC	Initiator: WHF-ESD21-DPC STC Response: RESPONSE-POOLMOVE	346

NOTE: DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Ref. 2.2.26, Table 4

A4.21.2.1 Initiating Events for WHF-ESD21-DPC

The following initiating events shown in Table A4.21-6 are associated with WHF-ESD21-DPC involving transfer of an STC containing a DPC to the pool floor.

Table A4.21-6. Initiating Event Assignments for WHF-ESD21-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Drop of shielded transfer cask	WHF-ESD21-DPC	ESD21-DPC-LOWER-DROP	050-CHC-CSKDROP-CRN-DRP
Impact to shielded transfer cask		ESD21-DPC-LOWER-IMPACT	050-OPTCIMPACT07-HFI-NOD
Drop onto shielded transfer cask		ESD21-DPC-LOWER-DROPON	ESD21-DPC-LOWER-DROPON
Tipover of shielded transfer cask		ESD21-DPC-LOWER-TIP	050-OPTIPOVER008-HFI-NOD

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.21.2.2 System Response Event Tree RESPONSE-POOLMOVE

The pivotal events that appear in RESPONSE-POOLMOVE are summarized below.   The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CASK.   Table A4.21-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.21-7. Basic Event Associated with the CASK Pivotal Events of WHF-ESD21-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD21-DPC	ESD21-DPC-LOWER-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD21-DPC-LOWER-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD21-DPC-LOWER-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD21-DPC-LOWER-TIP	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

BORON. Table A4.21-8 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.21-8. Basic Event Associated with the BORON Pivotal Events of WHF-ESD21-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to BORON	Associated Fault Tree or Basic Event[a]
WHF-ESD21-DPC	ESD21-DPC-LOWER-DROP	BORON	BORON-SYSTEM-FAILS
WHF-ESD21-DPC	ESD21-DPC-LOWER-IMPACT	BORON	
WHF-ESD21-DPC	ESD21-DPC-LOWER-TIP	BORON	
WHF-ESD21-DPC	ESD21-DPC-LOWER-DROPON	BORON	

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.21.3   Event Trees for WHF-ESD21-TAD

This sequence represents a structural challenge to a TAD canister resulting in an unfiltered radionuclide release due to an impact to a cask, a drop of a heavy object onto the cask a tip over, or a cask drop. In this sequence the TAD canister falls on the pool floor. The TAD canister is contained in an STC that is bolted.

Release into the pool is considered a filtered release. Because of the potential drop height in the pool, drop of the cask into the bottom of the pool is believed to have a probability of one.

Although the initiator event trees transfer to the same response tree (see Table A4.21-9 below), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.21-9. Summary of Event Trees for WHF-ESD21-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
TAD canisters produced at repository (44 BWR or 21 PWR SNF assemblies per canister)	Initiator: WHF-ESD21-TAD STC Response: RESPONSE-POOLMOVE	1,165

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF = spent nuclear fuel; TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.21.3.1 Initiating Events for WHF-ESD21-TAD

The following initiating events shown in Table A5.21-10 are associated with WHF-ESD21-TAD involving transfer of an STC containing a TAD canister out of the pool.

Table A4.21-10. Initiating Event Assignments for WHF-ESD21-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Drop of STC	WHF-ESD21-TAD	ESD21-TAD-LOWER-DROP	050-CHC-CSKDROP-CRN-DRP
Impact to STC	WHF-ESD21-TAD	ESD21-TAD-LOWER-IMPACT	050-OPTCIMPACT08-HFI-COD
Drop onto STC	WHF-ESD21-TAD	ESD21-TAD-LOWER-DROPON	050-PHC-OBJDROP-CRN-DRP and 050-OBJLIFT-POOL-FLOOR
Tipover of STC	WHF-ESD21-TAD	ESD21-TAD-LOWER-TIP	050-OPTIPOVER009-HFI-COD

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
STC = shielded transfer cask.

Source: Original

A4.21.3.2 System Response Event Tree RESPONSE-POOLMOVE

The pivotal events that appear in RESPONSE-POOLMOVE are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CASK. Table A4.21-11 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.21-11. Basic Event Associated with the CASK Pivotal Events of WHF-ESD21-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD21-TAD	ESD21-TAD-LOWER-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD21-TAD-LOWER-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD21-TAD-LOWER-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD21-TAD-LOWER-TIP	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

BORON. Table A4.21-12 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.21-12. Basic Event Associated with the BORON Pivotal Events of WHF-ESD21-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to BORON	Associated Fault Tree or Basic Event[a]
WHF-ESD21-TAD	ESD21-TAD-LOWER-DROP	BORON	BORON-SYSTEM-FAILS
	ESD21-TAD-LOWER-IMPACT		
	ESD21-TAD-LOWER-TIP		
	ESD21-TAD-LOWER-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.22 EVENT TREES FOR WHF-ESD22-FUEL

This sequence represents a structural challenge to a fuel assembly in the pool resulting in an unfiltered gaseous radionuclide release due to a drop of the assembly at the operational height.

Although the initiator event trees transfer to the same response tree (see Table A4.22-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.22-1. Summary of Event Trees for WHF-ESD22-FUEL

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
CSNF	Initiator: WHF-ESD22-FUEL STC Response: RESPONSE-POOLCONFINE	66,000

NOTE: CSNF = commercial spent nuclear fuel.

Source: Ref. 2.2.26, Table 4

A4.22.1 Initiating Events for WHF-ESD22-FUEL

The following initiating events shown in Table A4.22-2 are associated with WHF-ESD22-FUEL involving transfer of spent fuel assemblies to either a TAD canister or staging rack.

Table A4.22-2. Initiating Event Assignments for WHF-ESD22-FUEL

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Drop on Rack	WHF-ESD22-FUEL	ESD22-FUEL-DROPRACK	050-SFTM-FUELDRP-RACK
Drop of Bundle		ESD22-FUEL- DROP	050-SFTM-FUELDRP-SFT-DPR

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.22.2 System Response Event Tree RESPONSE-POOLCONFINE

The pivotal events that appear in RESPONSE-POOLMOVE are summarized below. With drop of the spent fuel assembly, the only issue is whether Boron concentration is maintained.

BORON. Table A4.22-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.22-3. Basic Event Associated with the BORON Pivotal Events of WHF-ESD22-FUEL

Initiator Event Tree	Initiating Event Name	Name Assigned to BORON	Associated Fault Tree or Basic Event[a]
WHF-ESD22-FUEL	ESD22-FUEL-DROPRACK	BORON	BORON-SYSTEM-FAILS
	ESD22-FUEL-DROP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.23 EVENT TREES FOR WHF-ESD23-POOL

This ESD delineates the event sequences that arise after a spill of contaminated water due to a mishandling of low level liquid waste during pool operations.

The assignment for initiating events for this sequence is given in Table A4.23-4.

Table A4.23-4. Summary of Event Trees for WHF-ESD23-POOL

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Low-level liquid waste	Initiator: WHF-ESD23-POOL	Low-level liquid waste

Source: Ref. 2.2.26, Table 4

A4.23.1 Initiating Events for WHF-ESD23-POOL

The following initiating events shown in Table A4.23-5 are associated with WHF-ESD23-POOL involving mishandling of low level liquid waste during pool operations. All end states result in direct exposure.

Table A4.23-5. Initiating Event Assignments for WHF-ESD23-POOL

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Mishap in pool cleanup	WHF-ESD23-POOL	ESD23-LLW-CLEANUP	050-LLW-CLEANUP
Mishap in pool recirculation		ESD23-LLW-RECIRC	050-LLW-RECIRC-PPM-RUP
Drop of pool filters		ESD23-LLW-DROP	050-OP-FILTER-EXPOSE and FILTER-NUMBER
Improper decontamination of DPC/STC		ESD23-LLW-DECON	050-LLW-DECON-FAIL
Spill of pool water from collision		ESD23-LLW-COLLISION	050-LLW-COLLISION

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
DPC = dual-purpose canister; STC = shielded transfer cask.

Source: Original

A4.23.2 System Response Event Tree

There is no response tree since the above events result in direct exposure.

A4.24 EVENT TREES FOR WHF-ESD24-TAD

A4.24.1 Event Trees for WHF-ESD24-TAD (Drop in Pool)

This ESD delineates the event sequences that arise after a structural challenge resulting from collisions of the STC/TAD canister with structure or equipment. This includes events that occur while the TAD canister is not closed and the STC/TAD canister being transferred from the pool ledge to the TAD canister closure station. The STC is bolted. This ESD considers drops in the pool.

Although the initiator event trees transfer to the same response tree (see Table A4.24-1 below), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.24-1. Summary of Event Trees for WHF-ESD24-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
TAD canisters produced at repository (44 BWR or 21 PWR SNF assemblies per canister)	Initiator: WHF-ESD24-TAD STC Response: RESPONSE-POOLMOVE	1,165

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF = spent nuclear fuel; TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.24.1.1 Initiating Events for WHF-ESD24-TAD

The following initiating events are associated with WHF-ESD24-TAD involving transfer of the STC/TAD canister being transferred from the pool ledge to the TAD canister closure station that lead to a drop in the pool. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.24-2.

Table A4.24-2. Initiating Event Assignments for WHF-ESD24-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Impact of STC/TAD canister - pool	WHF-ESD24-TAD	ESD24-POOL-IMPACT	050-OPTCIMPACT09-HFI-NOD and TIME-OVER-POOL-TO-CLOSE
Drop at operational height - pool		ESD24-POOL-DROP	050-CHC-CSKDROP-CRN-DRP and TIME-OVER-POOL-TO-CLOSE
Drop above operational height - pool		ESD24-POOL-TWOBLOCK	050-CHC-TWOBLCK-CRN-TBK and TIME-OVER-POOL-TO-CLOSE
Tip over of STC/TAD canister - pool		ESD24-POOL-TIP	050-OPTIPOVER010-HFI-NOD and TIME-OVER-POOL-TO-CLOSE
Drop on STC/TAD canister - pool		ESD24-POOL-DROPON	POOL-OBJDROPON

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
STC = shielded transfer cask; TAD = transportation, aging, and disposal.

Source: Original

A4.24.1.2 System Response Event Tree RESPONSE-POOLMOVE

The pivotal events that appear in POOLMOVE are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CASK. Table A4.24-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.24-3. Basic Event Associated with the CASK Pivotal Events of WHF-ESD24-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event[a]
WHF-ESD24-TAD	ESD24-POOL-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD24-POOL-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD24-POOL-TWOBLOCK	CASK-FAIL	CASK-FAILS
	ESD24-POOL-TIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD24-POOL-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

BORON. Table A4.24-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.24-4. Basic Event Associated with the BORON Pivotal Events of WHF-ESD24-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to BORON	Associated Fault Tree or Basic Event[a]
WHF-ESD24-TAD	ESD24-POOL-IMPACT	BORON	BORON-SYSTEM-FAILS
WHF-ESD24-TAD	ESD24-POOL-DROP		
WHF-ESD24-TAD	ESD24-POOL-TWOBLOCK		
WHF-ESD24-TAD	ESD24-POOL-TIP		
WHF-ESD24-TAD	ESD24-POOL-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.24.2 Event Trees for WHF-ESD24-TAD (Drop on Floor)

This ESD delineates the event sequences that arise after a structural challenge resulting from collisions of the STC/TAD canister with structure or equipment. This includes events that occur while the TAD canister is not closed and the STC/TAD canister being transferred from the pool ledge to the TAD canister closure station. This ESD considers drops on floor.

Although the initiator event trees transfer to the same response tree (see Table A4.24-5), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.24-5. Summary of Event Trees for WHF-ESD24-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
TAD canisters produced at repository (44 BWR or 21 PWR SNF assemblies per canister)	Initiator: WHF-ESD24-TAD STC Response: RESPONSE-STC1	1,165

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF = spent nuclear fuel; TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.24.2.1 Initiating Events for WHF-ESD24-TAD

The following initiating events are associated with WHF-ESD24-TAD involving transfer of the STC/TAD canister being transferred from the pool ledge to the TAD canister closure station that lead to a drop on the floor. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.24-6.

Table A4.24-6. Initiating Event Assignments for WHF-ESD24-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Impact of STC/TAD canister - pool	WHF-ESD24-TAD	ESD24-FLOOR-IMPACT	050-OPTCIMPACT09-HFI-NOD AND TIME-OVER-FLOOR-TO-CLOSE
Drop at operational height - pool	WHF-ESD24-TAD	ESD24-FLOOR-DROP	050-CHC-CSKDROP-CRN-DRP and TIME-OVER-FLOOR-TO-CLOSE
Drop above operational height - pool	WHF-ESD24-TAD	ESD24-FLOOR-TWOBLOCK	050-CHC-TWOBLCK-CRN-TBK and TIME-OVER-FLOOR-TO-CLOSE
Tip over of STC/TAD canister - pool	WHF-ESD24-TAD	ESD24-FLOOR-TIP	050-OPTIPOVER010-HFI-NOD AND TIME-OVER-FLOOR-TO-CLOSE
Drop on STC/TAD canister - pool	WHF-ESD24-TAD	ESD24-FLOOR-DROPON	050-JIBCRANE-CRJ-DRP and TIME-OVER-FLOOR-TO-CLOSE

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
STC = shielded transfer cask; TAD = transportation, aging, and disposal.

Source: Original

A4.24.2.2 System Response Event Tree RESPONSE-STC1

The pivotal events that appear in RESPONSE-STC1 are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

STC. Table A4.24-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.24-7. Basic Event Associated with the STC Pivotal Events of WHF-ESD24-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to STC	Associated Fault Tree or Basic Event[a]
WHF-ESD24-TAD	ESD24-FLOOR-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD24-FLOOR-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD24-FLOOR-TWOBLOCK	CASK-TWOBLOCK	CASK-DROP-TWOBLOCK
	ESD24-FLOOR-TIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD24-FLOOR-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CANISTER. Table A4.24-8 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.24-8. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD24-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event[a]
WHF-ESD24-TAD	ESD24-FLOOR-IMPACT	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD24-FLOOR-DROP		
	ESD24-FLOOR-TWOBLOCK		
	ESD24-FLOOR-TIP		
	ESD24-FLOOR-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.24-9 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.24-9. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD24-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event[a]
WHF-ESD24-TAD	ESD24-FLOOR-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD24-FLOOR-DROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD24-FLOOR-TWOBLOCK	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD24-FLOOR-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD24-FLOOR-DROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.24-10 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.24-10. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD24-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD24-TAD	ESD24-FLOOR-IMPACT	CONFINEMENT	HVAC
	ESD24-FLOOR-DROP		
	ESD24-FLOOR-TWOBLOCK		
	ESD24-FLOOR-TIP		
	ESD24-FLOOR-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

MODERATOR. Table A4.24-11 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.24-11. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD24-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD24-TAD	ESD24-FLOOR-IMPACT	MODERATOR	MODERATOR
	ESD24-FLOOR-DROP		
	ESD24-FLOOR-TWOBLOCK		
	ESD24-FLOOR-TIP		
	ESD24-FLOOR-DROPON		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.25 EVENT TREES FOR WHF-ESD25-TAD

This ESD delineates the event sequences that arise after a structural challenge that occurs during the assembly and closure of the STC/TAD canister.

Although the initiator event trees transfer to the same response tree (see Table A4.25-1 below), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.25-1. Summary of Event Trees for WHF-ESD25-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
TAD canisters produced at repository (44 BWR or 21 PWR SNF assemblies per canister)	Initiator: WHF-ESD25-TAD STC Response: RESPONSE-TAD	1,165

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF = spent nuclear fuel; TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.25.1 Initiating Events for WHF-ESD25-TAD

The following initiating events are associated with WHF-ESD25-TAD involving assembly and closure of the STC/TAD. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.25-2.

Table A4.25-2. Initiating Event Assignments for WHF-ESD25-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Object dropped onto TAD canister	WHF-ESD25-TAD	ESD25-TAD-DROPON	050-JIBCRANE-CRJ-DRP and 050-OBJLIFT-TAD-CLOSE
Side impact to TAD canister	WHF-ESD25-TAD	ESD25-TAD-IMPACT	ESD25-TAD-IMPACT

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
TAD = transportation, aging, and disposal.

Source: Original

A4.25.2 System Response Event Tree RESPONSE-TAD

The pivotal events that appear in RESPONSE-TAD are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

TAD. Table A4.25-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.25-3. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD25-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event[a]
WHF-ESD25-TAD	ESD25-TAD-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD25-TAD-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.25-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.25-4. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD25-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD25-TAD	ESD25-TAD-DROPON	CONFINEMENT	HVAC
	ESD25-TAD-IMPACT		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
HVAC = heating, ventilation, and air conditioning.

Source: Original

MODERATOR. Table A4.25-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.25-5. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD25-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD25-TAD	ESD25-TAD-DROPON	MODERATOR	MODERATOR
	ESD25-TAD-IMPACT		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.26 EVENT TREES FOR WHF-ESD26-TAD

This ESD delineates the event sequences that arise after a structural challenge that occurs during the assembly and closure of the STC/TAD canister.

Although the initiator event trees transfer to the same response tree (see Table A4.26-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.26-1. Summary of Event Trees for WHF-ESD26-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
TAD canisters produced at repository (44 BWR or 21 PWR SNF assemblies per canister)	Initiator: WHF-ESD26-TAD STC Response: RESPONSE-TADDRY	1,165

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF = spent nuclear fuel; TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.26.1 Initiating Events for WHF-ESD26-TAD

The following initiating events are associated with WHF-ESD26-TAD involving TAD canister drying and inerting. The assignments made within SAPHIRE for quantification of one initiating event is indicated in Table A4.26-2.

Table A4.26-2. Initiating Event Assignments for WHF-ESD26-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Failure to dry TAD canister	WHF-ESD26-TAD	ESD26-TAD-DRYFAIL	050-TADDRY-FAIL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
TAD = transportation, aging, and disposal.

Source: Original

A4.26.2 System Response Event Tree RESPONSE-TAD

The pivotal events that appear in RESPONSE-TAD are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

DRYING. Table A4.26-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.26-3. Basic Events Associated with the DRYING Pivotal Events of WHF-ESD26-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to DRYING	Associated Fault Tree or Basic Event[a]
WHF-ESD26-TAD	ESD26-TAD-DRYFAIL	050-TADDRY-FAIL	050-TADDRY-FAIL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

OVERPRESSURE. Table A4.26-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.26-4. Basic Event Associated with the OVERPRESSURE Pivotal Events of WHF-ESD26-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to OVERPRESSURE	Associated Fault Tree or Basic Event[a]
WHF-ESD26-TAD	ESD26-TAD-DRYFAIL	OVERPRESSURE	050-OVERPRESSURE

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.27 EVENT TREES FOR WHF-ESD27-TAD

This ESD delineates the event sequences that arise after a structural challenge resulting from the welding, drying, and inerting activities associated with TAD canister closure.

Although the initiator event trees transfer to the same response tree (see Table A4.27-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.27-1. Summary of Event Trees for WHF-ESD27-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
TAD canisters produced at repository (44 BWR or 21 PWR SNF assemblies per canister)	Initiator: WHF-ESD27-TAD STC Response: RESPONSE-PREPSTATION	1,165

NOTE: BWR = boiling water reactor; PWR = pressurized water reactor; SNF = spent nuclear fuel; TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.27.1 Initiating Events for WHF-ESD27-TAD

The following initiating events are associated with WHF-ESD27-TAD involving TAD canister drying and inerting. The assignments made within SAPHIRE for quantification of one initiating event is indicated in Table A4.27-2.

Table A4.27-2. Initiating Event Assignments for WHF-ESD27-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Bad weld – improper or cracked	WHF-ESD27-TAD	ESD27-TAD-BADWELD	050-OPWELDDETECT-FAIL
Line break	WHF-ESD27-TAD	ESD27-TAD-LINE	050-TADDRY-HOS-RUP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.27.2 System Response Event Tree RESPONSE-PREPSTATION

The pivotal events that appear in PREPSTATION are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CONFINEMENT. Table A4.27-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.27-3. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD27-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD27-TAD	ESD27-TAD-BADWELD	HVAC-PREP	HVAC-FAIL-DURING-PREP
	ESD27-TAD-LINE		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

MODERATOR. Table A4.27-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.27-4. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD27-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD27-TAD	ESD27-TAD-BADWELD	MODERATOR-SAMPLING	MODERATOR-NONE
	ESD27-TAD-LINE		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.28 EVENT TREES FOR WHF-ESD28-TAD

This ESD delineates the event sequences that arise after a structural challenge to a STC that contains a TAD canister during exporting activities.

Although the initiator event trees transfer to the same response tree (see Table A4.28-1), the response tree is customized within SAPHIRE for each initiator event tree by the use of basic rules. The rules instruct SAPHIRE where to look for the fault tree that models each pivotal event. The assignments made in the rules files are indicated in this section.

Table A4.28-1. Summary of Event Trees for WHF-ESD28-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a DPC	Initiator: WHF-ESD28-TAD DPC Response: RESPONSE-CANISTER1	346

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4

A4.28.1 Initiating Events for WHF-ESD28

The following initiating events are associated with WHF-ESD28-TAD during TAD canister exporting activities. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.28-2.

Table A4.28-2. Initiating Event Assignments for WHF-ESD28-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Drop on TAD canister	WHF-ESD28-TAD	ESD28-TAD-DROPON	050-JIBCRANE-CRJ-DRP and 050-OBJLIFT-TAD-EXPORT
Drop at operational height		ESD28-TAD-DROP	050-CHC-CSKDROP-CRN-DRP and 050-TADLIFT-TAD-EXPORT
Drop above operational height		ESD28-TAD-TWOBLOCK	050-CHC-TWOBLCK-CRN-TBK and 050-TADLIFT-TAD-EXPORT
Impact to TAD canister		ESD28-TAD-IMPACT	050-OPCTCOLLIDE4-HFI-NOD
TAD canister tipover		ESD28-TAD-TIP	050-OPTIPOVER011-HFI-NOD

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
TAD = transportation, aging, and disposal.

Source: Original

A4.28.2 System Response Event Tree RESPONSE-CANISTER1

The pivotal events that appear in RESPONSE-CANISTER1 are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

STC. Table A4.28-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.28-3. Basic Events Associated with the STC Pivotal Events of WHF-ESD28-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to STC	Associated Fault Tree or Basic Event[a]
WHF-ESD28-TAD	ESD28-TAD-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD28-TAD-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD28-TAD-TWOBLOCK	CASK-TWOBLOCK	CASK-DROP-TWOBLOCK
	ESD28-TAD-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD28-TAD-TIP	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CANISTER. Table A4.28-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.28-4. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD28-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event[a]
WHF-ESD28-TAD	ESD28-TAD-DROPON	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD28-TAD-DROP		
	ESD28-TAD-TWOBLOCK		
	ESD28-TAD-IMPACT		
	ESD28-TAD-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.28-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.28-5. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD28-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event[a]
WHF-ESD28-TAD	ESD28-TAD-DROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD28-TAD-DROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD28-TAD-TWOBLOCK	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD28-TAD-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD28-TAD-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.28-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.28-6. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD28-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event[a]
WHF-ESD28-TAD	ESD28-TAD-DROPON	CONFINEMENT	HVAC
	ESD28-TAD-DROP		
	ESD28-TAD-TWOBLOCK		
	ESD28-TAD-IMPACT		
	ESD28-TAD-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
                HVAC = heating, ventilation, and air conditioning.

Source: Original

MODERATOR. Table A4.28-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.28-7. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD28-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event[a]
WHF-ESD28-TAD	ESD28-TAD-DROPON	MODERATOR	MODERATOR
	ESD28-TAD-DROP		
	ESD28-TAD-TWOBLOCK		
	ESD28-TAD-IMPACT		
	ESD28-TAD-TIP		

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.29 EVENT TREES FOR WHF-ESD29-DPC

This ESD delineates the event sequences that result in direct exposures from cask preparation activities and CTM movement. The initiating event assigned in SAPHIRE is assigned in Table A4.29-1.

Table A4.29-1. Summary of Event Trees for WHF-ESD29-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a DPC	Initiator: WHF-ESD29-DPC	346

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4

A4.29.1 Initiating Events for WHF-ESD29

The following initiating events are associated with WHF-ESD29-DPC during cask preparation activities and CTM movement. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.29-2.

Table A4.29-2. Initiating Event Assignments for WHF-ESD29-DPC and -TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level[a]
Failure to install shield ring	WHF-ESD29-DPC	ESD29-EXPOSURE-RING	050-OPDPCSHIELD2-HFI-NOW
Loss of CTM shielding during lift	WHF-ESD29-DPC	ESD29-EXPOSURE-CTM	ESD29-EXPOSURE-CTM
DPC lift fixture installed properly	WHF-ESD29-DPC	ESD29-EXPOSURE-LIFT	050-LIDDISPLACE1-HFI-NOD OR 050-OPDPCSHIELD1-HFI-NOW or 050-OPDPCSHIELD3-HFI-NOW
Failure to install shield ring	WHF-ESD29-TAD	ESD29-TAD-RING	050-OPSTCSHIELD1-HFI-COD
Loss of CTM shielding during lift	WHF-ESD29-TAD	ESD29-TAD-CTM	ESD29-TAD-CTM

NOTE: [a]This column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
CTM = canister transfer machine; DPC = dual-purpose canister.

Source: Original

A4.29.2 System Response Event Tree

There is no response tree since the above events result in direct exposure.

A4.30 EVENT TREES FOR WHF-ESD30 (POOL ACTIVITIES)

A4.30.1 Event Trees for WHF-ESD30-DPC

This ESD delineates the event sequences that result in direct exposures due to pool operations. The initiating event assigned in SAPHIRE is assigned in Table A4.30-1.

Table A4.30-1. Summary of Event Trees for WHF-ESD30-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a DPC	Initiator: WHF-ESD30-DPC	346

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4