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A1 INTRODUCTION

This attachment presents event trees that are derived from the ESDs in Attachment F of the *Wet Handling Facility Event Sequence Development Analysis* (Ref. 2.2.37). All initiator event trees and system response event trees are located at the end of this attachment. Refer to Table A5-1 for the figure locations of specific event and response trees. The event trees are presented in Figures A5-2 through A5-52 according to ordering rules of hierarchy in SAPHIRE. The first rule is that event trees are presented in ESD order. For example, the event trees associated with WHF-ESD01 appear first, and those associated with WHF-ESD02 appear after that, and so on. The second rule is that the first initiator event tree associated with the ESD appears first and the system response event trees are placed immediately following the first initiator event tree followed by the remaining initiator event trees for the ESD. For example, the first initiator event tree (WHF-ESD01-CSNF) associated with the first ESD (WHF-ESD01) is the first event tree figure. Then the system response event tree (RESPONSE-TCASK-CSNF) appears, followed by the remaining initiator event trees for the ESD (CSNF-ROLLOVER, ESD01-CSNF-COLL). The same kind of ordering is done for each group in turn.

A2 READER'S GUIDE TO THE EVENT TREE DESCRIPTIONS

The following sections are organized by ESD. The event trees that correspond to each ESD are presented as follows:

1. The event trees for the waste forms covered are briefly described and listed (initiator and system-response event trees or self contained event trees, as applicable).
2. The initiating events are described and listed. The listing is provided as a table that includes the assignments of fault trees or basic events to the initiating events. The assignments are made in SAPHIRE using basic rules or by fault-tree construction. The goal of the initiating event table is to provide a link to the underlying system fault tree (covered in Section 6.2 and Attachment B) or basic event (covered in Section 6.3 and Attachment C). In a few cases, the assignment is not straightforward and a supplemental fault tree provides a link to the system fault tree or basic event level (covered in Attachment B). Note that the initiating event frequencies are defined on a per-unit-handled basis. Thus, when the initiating event frequencies are multiplied by the number of units handled over the preclosure period, the result is an initiating event frequency over the preclosure period.
3. The system-response event tree that corresponds to the initiator event tree or the system response for a self-contained event tree is covered as follows. Each pivotal event used in an event tree is listed in the event tree description section and summarized in Section A3. Each pivotal event is accompanied by a table that provides a link between the name given to the pivotal event in the event tree and the associated system fault tree or basic event. The goal of the pivotal event table is to provide a link to the underlying system fault tree (covered in Section 6.2) or basic event (covered in Section 6.3). Again, in a few cases, the assignment is not straightforward and a supplemental fault tree provides a link to the system fault tree or basic event level.

A3 SUMMARY OF THE MAJOR PIVOTAL EVENT TYPES

A self-contained event tree or a system response event tree may include pivotal events of following types:

CELL-DOOR. This pivotal event represents the success or failure of the shield door to not fail and damage waste forms.

TRANSCASK. This pivotal event represents the success or failure of the transportation cask to contain radioactive material after the impact caused by the initiating event. The failure of this pivotal event leads to loss of the cask's containment function. The failure probability for this pivotal event is determined by PEFA, and is given in Table 6.3-2 in Section 6.3.2. In accordance with a simplifying approximation, the same failure probability is used for all casks for the various initiating events.

CANISTER. This pivotal event represents the success or failure of the canister to contain radioactive material after the impact caused by the initiating event. Failure of a containment pivotal event means that a release could occur if the canister containment barrier is breached (along with the cask or waste-package containment, as applicable). In accordance with a simplifying approximation, the conditional probability of canister breach given cask breach is taken to be 1.

SHIELDING. Failure of a shielding pivotal event means that a direct exposure could occur. Casks, some canisters, the cask transfer machine shield bell, and the aging overpack include integral shields that could be pierced or degraded in some impact events. In addition, a breach of a container's seal can also result in a loss of shielding. Thus, this pivotal event represents the success or failure of the shielding function of the cask, canister, or aging overpack after the impact caused by the initiating event. Failure of shielding in these instances refers to an unspecified degree of shielding degradation due to the impact. Failure probabilities are given in Table 6.3-3 in Section 6.3.2.2.

CONFINEMENT. This pivotal event represents the success or failure of the HVAC system in continuing to provide HEPA filtration (radiological confinement) after the initiating event. Success of the pivotal event requires the facility structural integrity as well as the functioning of equipment associated with the HVAC system. Failure results in a potential airborne release that is not mitigated by the HEPA filtration system.

MODERATOR. This pivotal event represents the conditional probability of introducing liquid moderator (water or crane gearbox lubricating oil) into a breached canister, given that a breached canister is present. The conditional probability of failure (introduction of liquid moderator) is the same for all waste forms and all initiating events. Failure of a moderator pivotal event results in an end state that may be susceptible to nuclear criticality. The opportunity for criticality also depends on other pivotal events (e.g., loss of containment which may allow liquid moderator into a breached canister) and physical properties of the waste form.

BORON. This pivotal event represents maintaining adequate Boron concentration in the pool to prevent criticality in the event that spent fuel assemblies are exposed to pool water and reach a critical configuration because of a drop of either a cask or spent fuel assembly drop. If adequate

Boron concentration is not achieved, criticality could occur and an unfiltered gaseous radionuclide release could occur.

A4 EVENT TREE DESCRIPTIONS

A4.1 EVENT TREES FOR WHF-ESD01-CSNF

ESD WHF-ESD01-CSNF delineates the event sequences that arise after a structural challenge to a transportation cask with commercial SNF as it is moved from the receipt area into the preparation area. This includes event sequences that arise after the outer vestibule door is closed during movement of a transportation cask into the Cask Preparation Area.

WHF-ESD01-CSNF covers event sequences associated with receipt of a truck trailer. This ESD includes transportation casks containing commercial SNF.

Although the initiator event trees transfer to the same response tree (see Table A4.1-1), 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 A4.1-1. Summary of Event Trees for WHF-ESD01-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-ESD01-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

A4.1.1 Initiating Events for WHF-ESD01-CSNF

The following initiating events are associated with WHF-ESD01-CSNF:

- Truck trailer rollover
- Truck trailer collision.

The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.1-2.

Truck Trailer Rollover. This initiating event accounts for the potential impact to the transportation cask on the truck trailer due to a rollover. The rollover event is modeled as a fault tree and is listed in Table A4.1-2.

Truck Trailer Collision.

This initiating event accounts for the potential impact to the transportation cask on the truck trailer due to a collision. The collision event is modeled as a fault tree and is listed in Table A4.1-2.

Table A4.1-2. Initiating Event Assignments for WHF-ESD01-CSNF

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Truck trailer rollover	TT-Rollover	ESD01-CSNF-ROLLOVER	050-1-SPMTT-ROLLOVER
Truck trailer collision	TT-Collision	ESD01-CSNF-COLL	050-1-SPMTT-COLLISION

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.1.2 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 A4.1-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.1-3. Basic Event Associated with the CASK Pivotal Events of WHF-ESD01-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD01-CSNF	ESD01-CSNF-ROLLOVER	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD01-CSNF-COLL	CASK-IMPACT	CASK-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.1-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.1-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD01-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD01-CSNF	ESD01-CSNF-ROLLOVER	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD01-CSNF-COLL	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.1-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.1-5. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD01-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD01-CSNF	ESD01-CSNF-ROLLOVER	CONFINEMENT	HVAC
	ESD01-CSNF-COLL	CONFINEMENT	

NOTE: ^aThis 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. The conditional probability of failure (introduction of liquid moderator) is shown in Table A4.1-6.

Table A4.1-6. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD01-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD01-CSNF	ESD01-CSNF-ROLLOVER	MODERATOR	MODERATOR
	ESD01-CSNF-COLL	MODERATOR	

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.2 EVENT TREES FOR WHF-ESD02-DPC

WHF-ESD02-DPC covers event sequences that arise after a structural challenge to a transportation cask (rail cask) loaded with a DPC on a railcar that occurs during transfer from the Transportation Cask Vestibule and movement into the Cask Preparation Area after the outer vestibule door is closed.

This ESD covers transportation casks with DPCs. Although the initiator event trees transfer to the same response tree (see Table A4.2-1 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 A4.2-1. Summary of Event Trees for WHF-ESD02-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a DPC	Initiator: WHF-ESD02-DPC DPC Response: RESPONSE-TCASK-DPC	346

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4

A4.2.1 Initiator Events for WHF-ESD02-DPC

The following initiating events are associated with WHF-ESD02-DPC. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.2-2.

Railcar Derailment. This initiating event accounts for the potential impact to the transportation cask on the railcar due to a derailment. The probability of derailment per railcar received is derived from empirical data in Section 6.3 and is modeled as a single-event fault tree. The initiating event is specified as a probability of derailment per cask.

Railcar Collision. This initiating event covers the potential impact to the transportation cask on the conveyance due to a collision with another vehicle. The vehicular collision event is modeled as a fault tree and is listed in Table A4.2-2. The initiating event is specified as a probability of collision per cask.

Table A4.2-2. Initiating Event Assignments for WHF-ESD02-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Railcar derailment	WHF-ESD02-DPC	ESD02-DPC-DERAIL	050-2-SPMRC-DERAIL
Railcar collision	WHF-ESD02-DPC	ESD02-DPC-COLL	050-2-SPMRC-COLLISION

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.2.2 System Response Event Tree RESPONSE-TCASK-DPC

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

CASK. Table A4.2-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.2-3. Basic Event Associated with the CASK Pivotal Events of WHF-ESD02-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD02-DPC	ESD02-DPC-DERAIL	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD02-DPC-COLL	CASK-IMPACT	CASK-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CANISTER. Table A4.2-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.2-4. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD02-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD1-DPC	ESD02-DPC-DERAIL	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD02-DPC-COLL		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.2-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.2-5. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD02-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD02-DPC	ESD02-DPC-DERAIL	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD02-DPC-COLL	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.2-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.2-6. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD02-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD02-DPC	ESD02-DPC-DERAIL	CONFINEMENT	HVAC
	ESD02-DPC-COLL		

NOTE: ^aThis 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 A4.2-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.2-7. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD02-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD02-DPC	ESD02-DPC-DERAIL	MODERATOR	MODERATOR
	ESD02-DPC-COLL		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.3 EVENT TREES FOR WHF-ESD03-AODPC

WHF-ESD03-AODPC delineates the event sequences that arise after a structural challenge to an aging overpack loaded with a DPC on a site transporter that occurs during receipt in the Site Transporter Vestibule. This ESD includes activities that occur after the outer vestibule door is closed.

An initiator event tree and a system response event tree represent this ESD (Table A4.3-1). The system response tree is customized within SAPHIRE for the 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 A4.3-1. Summary of Event Trees for WHF-ESD03-AODPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Aging overpack carrying a DPC	Initiator: WHF-ESD03-AODPC Response: RESPONSE-CANISTER1	346

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4

A4.3.1 Initiator Event Trees for WHF-ESD03-AODPC

The following initiating events are associated with WHF-ESD03-AODPC. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.3-2.

Site Transporter Rollover. This initiating event accounts for the potential impact to the DPC due to a rollover of the site transporter. For a site transporter to roll over, the center of mass would have to shift laterally. This could result from traversing a significantly uneven surface or running over a very large object. There are no significantly uneven surfaces in the WHF Entrance Vestibule or Cask Preparation Area. However, the site transporter rollover could occur if the site transporter loses a track and continues climbing on the failed track. This failure scenario is modeled in Section B6.4.2.

Site Transporter Collision. This initiating event accounts for the potential impact to the DPC due to a collision involving the site transporter. The probability of collision per DPC received is modeled as a fault tree and is listed in Table A4.3-2. The initiating event is specified as a probability of collision per DPC.

Table A4.3-2. Initiating Event Assignments for WHF-ESD03-AODPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Site transporter rollover	WHF-ESD03-AODPC	ESD03-AO-STROLL	050-3-ST-ROLLOVER
Site transporter collision		ESD03-AO-STCOLLIDE	050-3-ST-COLLISION

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.3.2 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 A4.3-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.3-3. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD03-AODPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD03-AODPC	ESD03-AO-STROLL	CANISTER-IN-AO	CANISTER-IN-AO-IMPACT
	ESD03-AO-STCOLLIDE	CANISTER-IN-AO	

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.3-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.3-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD03-AODPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD03-AODPC	ESD03-AO-STROLL	AO-SHIELD-DROP	AO-SHIELD-FAIL-DROP
	ESD03-AO-STCOLLIDE	AO-SHIELD-IMPACT	AO-SHIELD-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.3-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.3-5. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD03-AODPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD03-AODPC	ESD03-AO-STROLL	HVAC-OFF	HVAC-OFF-STVEST
	ESD03-AO-STCOLLIDE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

MODERATOR. Table A4.3-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.3-6. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD03-AODPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD03-AODPC	ESD03-AO-STROLL	MODERATOR	MODERATOR
	ESD03-AO-STCOLLIDE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.4 EVENT TREES FOR WHF-ESD04-DPC

WHF-ESD04-DPC delineates the event sequences that arise after a structural challenge to a horizontal STC/DPC that occurs during receipt in the Transportation Cask Vestibule and movement of the horizontal STC/DPC into the Cask Preparation Area. This ESD includes activities that occur after the outer vestibule door is closed.

As described in Table A4.4-1, there is one response tree assigned to the initiating event. Although the initiator event trees transfer to the same response tree, 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 A4.4-1. Summary of Event Trees for WHF-ESD04-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation casks or horizontal shielded transfer casks containing a dual-purpose canister	Initiator: WHF-ESD04-DPC Response: RESPONSE-STC1	346

Source: Ref. 2.2.26, Table 4

A4.4.1 Initiating Events for WHF-ESD04-DPC

The following initiating events are associated with WHF-ESD04-DPC:

- Truck trailer rollover
- Truck trailer collision.

The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.4-2.

Cask Transfer Truck Trailer Rollover. This initiating event accounts for the potential impact to the transportation cask on the truck trailer due to a rollover. The rollover event is modeled as a fault tree and is listed in Table A4.4-2.

Cask Transfer Truck Trailer Collision

This initiating event accounts for the potential impact to the transportation cask on the truck trailer due to a collision. The collision event is modeled as a fault tree and is listed in Table A4.4-2.

Table A4.4-2. Initiating Event Assignments for WHF-ESD04-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Cask Transfer Truck Trailer Rollover	WHF-ESD04-DPC	ESD04-HDPC-CTROLL	050-OPTTROLLOVER-HFI-NOD
Cask Transfer Truck Trailer Collision	WHF-ESD04-DPC	ESD04-HDPC-CTCOLLIDE	050-HCTT-COLLISION

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.4.2 System Response Event Tree RESPONSE-STC1

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

STC. Table A4.4-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.4-3. Basic Event Associated with the STC Pivotal Events of WHF-ESD04-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD04-DPC	ESD04-HDPC-CTROLL	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD04-HDPC-CTCOLLIDE	CASK-IMPACT	CASK-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

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

Table A4.4-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD04-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD04-DPC	ESD04-HDPC-CTROLL	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD04-HDPC-CTCOLLIDE	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CANISTER. Table A4.4-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.4-5. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD04-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD04-DPC	ESD04-HDPC-CTROLL	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD04-HDPC-CTCOLLIDE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.4-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.4-6. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD04-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD04-DPC	ESD04-HDPC-CTROLL	CONFINEMENT	HVAC
	ESD04-HDPC-CTCOLLIDE		

NOTE: ^aThis 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 A4.4-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.4-7. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD04-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD04-DPC	ESD04-HDPC-CTROLL	MODERATOR	MODERATOR
	ESD04-HDPC-CTCOLLIDE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.5 EVENT TREES FOR WHF-ESD05-CSNF

ESD WHF-ESD05 delineates the event sequences that arise after a structural challenge to a transportation cask with commercial SNF resulting from removal of impact limiters, upending, and removal from conveyance and transfer to a preparation station.

Table A4.5-1 summarizes the event trees for WHF-ESD05-CSNF. Although all of the initiating events in the initiator event tree transfer to the same response tree, the response tree is customized within SAPHIRE for each initiating event 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 A4.5-1. Summary of Event Trees for WHF-ESD05-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-ESD05-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

A4.5.1 Initiating Events for WHF-05-CSNF

The following initiating events are associated with WHF-ESD05. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.5-2.

Transportation Cask Tipover. This initiating event covers the potential impact to the transportation cask due to a tipover. The tipover event is modeled as a single-event fault tree and is listed in Table A4.5-2. The initiating event is specified as a probability of tipover per cask.

Side Impact to Cask. This initiating event covers the potential impact to the transportation cask due to vehicular collision, or impact by crane movement. This event is modeled as a fault tree and is listed in Table A4.5-2.

Object Dropped onto Transportation Cask/Commercial SNF. This initiating event covers the potential impact to the transportation cask due to the drop of a heavy object, such as an impact limiter, on the cask. This event is modeled as a fault tree and is listed in Table A4.5-2. The initiating event is specified as a probability of object drop per cask.

Cask Drop from Operational Height. This initiating event accounts for the potential impact to the transportation cask due to having been dropped from the normal operational height during transfer by the cask handling crane. The probability of drop per transfer is derived from empirical data in Section 6.3 and is modeled as a single-event fault tree and is listed in Table A4.5-2. The initiating event is specified as a probability of a drop per cask.

Cask Drop from Above Operational Height. This initiating event accounts for the potential impact to the transportation cask due to having been dropped from above the normal operational height (for example, due to two-blocking) during transfer by the cask handling crane. The probability of drop per transfer is modeled as a fault tree and is listed in Table A4.5-2. The initiating event is specified as a probability of a drop per cask.

Table A4.5-2. Initiating Event Assignments for WHF-ESD05-CSNF

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Transportation cask tipover	WHF-ESD05-TC	ESD05-UPEND-CASK-TIP	050-OPTIPOVER001-HFI-NOD
Side impact	WHF-ESD05-TC	ESD05-UPEND-SIDE-IMPACT	050-5-CSNF-IMPACT
Object dropped on a cask	WHF-ESD05-TC	ESD05-UPEND-DROPON-CASK	050-5-200T-CRANE-DROPON
Cask drop from operational height	WHF-ESD05-TC	ESD05-UPEND-DROP-OP	050-CHC-CSKDROD-CRN-DRP and 050-TRANSNSCTTLIFTNUMBER
Cask drop from above operational height	WHF-ESD05-TC	ESD05-UPEND-DROP-ABOVE	050-CHC-TWOBLCK-CRN-TBK and 050-TRANSNSCTTLIFTNUMBER

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.5.2 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 A4.5-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.5-3. Basic Event Associated with the CASK Pivotal Events for WHF-ESD05-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD05-CSNF	ESD05-UPEND-CASK-TIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD05-UPEND-SIDE-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD05-UPEND-DROPON-CASK	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD05-UPEND-DROP-OP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD05-UPEND-DROP-ABOVE	CASK-TWOBLOCK	CASK-DROP-TWOBLOCK

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.5-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.5-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD05-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD05-CSNF	ESD05-UPEND-CASK-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD05-UPEND-SIDE-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD05-UPEND-DROPON-CASK	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD05-UPEND-DROP-OP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD05-UPEND-DROP-ABOVE	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

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

Table A4.5-5. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD05-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD05-CSNF	ESD05-UPEND-CASK-TIP	CONFINEMENT	HVAC
	ESD05-UPEND-SIDE-IMPACT		
	ESD05-UPEND-DROPON-CASK		
	ESD05-UPEND-DROP-OP		
	ESD05-UPEND-DROP-ABOVE		

NOTE: ^aThis 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 A4.5-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.5-6. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD05-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD05-CSNF	ESD05-UPEND-CASK-TIP	MODERATOR	MODERATOR
	ESD05-UPEND-SIDE-IMPACT		
	ESD05-UPEND-DROPON-CASK		
	ESD05-UPEND-DROP-OP		
	ESD05-UPEND-DROP-ABOVE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.6 EVENT TREES FOR WHF-ESD06-VTC AND TTC

ESD WHF-ESD06 delineates the event sequences that arise after a structural challenge to a transportation cask/DPC that occurs during removal of impact limiters, upending, and removal of transportation cask from conveyance and transfer to the CTT. For casks with trunnions that can be uprighted on the conveyance, this ESD applies to the following waste forms:

- Commercial SNF in DPCs contained in rail casks (railcar to CTT)
- Commercial SNF in DPCs contained in horizontal STCs (cask tractor trailer to CTT).

For casks without trunnions that must be uprighted with a lifting frame, this ESD applies to commercial SNF in DPCs contained in transportation casks that are upended with a tilting frame (TTC) (railcar, cask stand, then to CTT).

This ESD covers transportation casks with DPCs with and without trunnions. Although the initiator event trees transfer to the same response tree (see Table A4.6-1 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 A4.6-1. Summary of Event Trees for WHF-ESD06

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a DPC (casks contain trunnions)	Initiator: WHF-ESD06-TTC DPC Response: RESPONSE-TCASK	346
Transportation cask containing a DPC (casks do not contain trunnions)	Initiator: WHF-ESD06-VTC DPC Response: RESPONSE-TCASK	346

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4

A4.6.1 Initiating Events for WHF-ESD06 VTC and TTC

The following initiating events are associated with WHF-ESD06 for the two types of transportation casks discussed above. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.6-2.

Cask Drop from Operational Height. This initiating event accounts for the potential impact to the transportation cask due to having been dropped from the normal operational height during transfer by the cask handling crane. The probability of drop per transfer is modeled as a fault tree and is listed in Table A4.6-2. The initiating event is specified as a probability of a drop per cask.

Cask Drop from Above Operational Height. This initiating event accounts for the potential impact to the transportation cask due to having been dropped from above the normal operational height (for example, due to two-blocking) during transfer by the cask handling crane. The probability of drop per transfer is modeled as a fault tree and is listed in Table A4.6-2. The initiating event is specified as a probability of a drop per cask.

Transportation Cask Tipover. This initiating event covers the potential impact to the transportation cask due to a tipover. The tipover event is modeled as a single-event fault tree and is listed in Table A4.6-2. The initiating event is specified as a probability of tipover per cask.

Side Impact to Cask. This initiating event covers the potential impact to the transportation cask due to a vehicular collision, unplanned conveyance movement or (for TTCs) a failure of the tilt frame. This event is modeled as a fault tree and is listed in Table A4.6-2. The initiating event is specified as a probability of impact per cask. 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.

Object Dropped onto Transportation Cask/DPC. This initiating event covers the potential impact to the transportation cask due to the drop of a heavy object, such as an impact limiter, on

the cask. This event is modeled as a fault tree and is listed in Table A4.6-2. The initiating event is specified as a probability of object drop per cask.

Unplanned Carrier Movement. This initiating event accounts for the potential impact to the transportation cask due to unplanned movement of the cask handling crane or CTT. This event is modeled as a fault tree and is listed in Table A4.6-2.

Table A4.6-2. Initiating Event Assignments for WHF-ESD06 TTC and VTC

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-ESD06-TTC	ESD06-TTC-UP-DROP	050-6-HS-CRANE-DROP
Drop of Cask Above Operational Height		ESD06-TTC-UP-TWOBLOCK	050-CHC-TWOBLOCK-CRN-TBK and 050-TRANSCCTLIFTNUMBER
Transportation Cask Tips Over		ESD06-TTC-UP-TIP	050-OPTIPOWER001-HFI-NOD
Side Impact		ESD06-TTC-UP-IMPACT	050-6-HS-TC-IMPACT
Drop on Cask		ESD06-TTC-UP-DROPON	050-6-200T-CRANE-DROPON
Transportation Cask Moves		ESD06-TTC-UP-MOVE	ESD06-TTC-UP-MOVE
Drop of Cask from Operational Height	WHF-ESD06-VTC	ESD06-VTC-UP-DROP	050-CHC-CSKDROPP-CRN-DROP and 050-TRANSCCTLIFTNUMBER
Drop of Cask above Operational Height		ESD06-VTC-UP-TWOBLOCK	050-CHC-TWOBLOCK-CRN-TBK and 050-TRANSCCTLIFTNUMBER
Transportation Cask Tips Over		ESD06-VTC-UP-TIP	050-OPTIPOWER001-HFI-NOD
Side Impact		ESD06-VTC-UP-IMPACT	050-6-VTC-IMPACT
Drop on Cask		ESD06-VTC-UP-DROPON	050-6-200T-CRANE-DROPON
Transportation Cask Moves		ESD06-VTC-UP-MOVE	ESD06-VTC-UP-MOVE

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
TTC = a transportation cask that is upended using a title frame; VTC = a transportation cask that is upended on a railcar.

Source: Original

A4.6.2 System Response Event Tree RESPONSE-TCASK

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

CASK. Table A4.6-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.6-3. Basic Event Associated with the CASK Pivotal Events for WHF-ESD06 TTC and VTC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD06-TTC	ESD06-TTC-UP-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD06-TTC-UP-TWOBLOCK	CASK-TWOBLOCK	CASK-DROP-TWOBLOCK
	ESD06-TTC-UP-TIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD06-TTC-UP-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD06-TTC-UP-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD06-TTC-UP-MOVE	CASK-DROP	CASK-DROP-OPERATIONAL
WHF-ESD06-VTC	ESD06-VTC-UP-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD06-VTC-UP-TWOBLOCK	CASK-TWOBLOCK	CASK-DROP-TWOBLOCK
	ESD06-VTC-UP-TIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD06-VTC-UP-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD06-VTC-UP-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD06-VTC-UP-MOVE	CASK-IMPACT	CASK-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
TTC = a transportation cask that is upended using a title frame; VTC = a transportation cask that is upended on a railcar.

Source: Original

SHIELDING. Table A4.6-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.6-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD06 TTC and VTC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD06-TTC	ESD06-TTC-UP-DROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD06-TTC-UP-TWOBLOCK	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD06-TTC-UP-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD06-TTC-UP-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD06-TTC-UP-DROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD06-TTC-UP-MOVE	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
WHF-ESD06-VTC	ESD06-VTC-UP-DROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD06-VTC-UP-TWOBLOCK	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD06-VTC-UP-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD06-VTC-UP-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD06-VTC-UP-DROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD06-VTC-UP-MOVE	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
TTC = a transportation cask that is upended using a title frame; VTC = a transportation cask that is upended on a railcar.

Source: Original

CANISTER. Table A4.6-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.6-5. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD06 TTC and VTC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD06-TTC	ESD06-TTC-UP-DROP	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD06-TTC-UP-TWOBLOCK		
	ESD06-TTC-UP-TIP		
	ESD06-TTC-UP-IMPACT		
	ESD06-TTC-UP-DROPON		
	ESD06-TTC-UP-MOVE		
	ESD06-VTC-UP-DROP		
	ESD06-VTC-UP-TWOBLOCK		
	ESD06-VTC-UP-TIP		
	ESD06-VTC-UP-IMPACT		
	ESD06-VTC-UP-DROPON		
	ESD06-VTC-UP-MOVE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
TTC = a transportation cask that is upended using a title frame; VTC = a transportation cask that is upended on a railcar.

Source: Original

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

Table A4.6-6. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD06 TTC and VTC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD06-TTC	ESD06-TTC-UP-DROP	CONFINEMENT	HVAC
	ESD06-TTC-UP-TWOBLOCK		
	ESD06-TTC-UP-TIP		
	ESD06-TTC-UP-IMPACT		
	ESD06-TTC-UP-DROPON		
	ESD06-TTC-UP-MOVE		
WHF-ESD06-VTC	ESD06-VTC-UP-DROP	CONFINEMENT	HVAC
	ESD06-VTC-UP-TWOBLOCK		
	ESD06-VTC-UP-TIP		
	ESD06-VTC-UP-IMPACT		
	ESD06-VTC-UP-DROPON		
	ESD06-VTC-UP-MOVE		

NOTE: ^aThis 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; TTC = a transportation cask that is upended using a title frame; VTC = a transportation cask that is upended on a railcar.

Source: Original

MODERATOR. Table A4.6-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.6-7. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD06 TTC and VTC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD06-TTC	ESD06-TTC-UP-DROP	MODERATOR	MODERATOR
	ESD06-TTC-UP-TWOBLOCK		
	ESD06-TTC-UP-TIP		
	ESD06-TTC-UP-IMPACT		
	ESD06-TTC-UP-DROPON		
	ESD06-TTC-UP-MOVE		
WHF-ESD06-VTC	ESD06-VTC-UP-DROP	MODERATOR	MODERATOR
	ESD06-VTC-UP-TWOBLOCK		
	ESD06-VTC-UP-TIP		
	ESD06-VTC-UP-IMPACT		
	ESD06-VTC-UP-DROPON		
	ESD06-VTC-UP-MOVE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.7 EVENT TREES FOR WHF-ESD07-DPC

ESD WHF-ESD07 delineates the event sequences that arise after a structural challenge to a transportation cask with DPC or STC with DPC associated with cask preparation activities (i.e., installation of cask lid lift fixture). This ESD applies to the following waste forms:

- Commercial SNF in DPCs contained in STCs on CTT
- Commercial SNF in DPCs contained in a transportation cask on CTT.

This ESD covers transportation casks with DPCs. Although the initiator event trees transfer to the same response tree (see Table A4.7-1 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 A4.7-1. Summary of Event Trees for WHF-ESD07-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a DPC	Initiator: WHF-ESD07-DPC DPC Response: RESPONSE-TCASK	346

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4

A4.7.1 Initiating Events for WHF-ESD07-DPC

The following initiating events are associated with WHF-ESD07-DPC for transportation casks with DPCs. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.7-2.

Transportation Cask Tipover. This initiating event covers the potential impact to the transportation cask due to a tipover. The tipover event is modeled as a single-event fault tree and is listed in Table A4.7-2. The initiating event is specified as a probability of tipover per cask.

Side Impact to Cask. This initiating event covers the potential impact to the transportation cask due to a vehicular collision, unplanned conveyance movement or (for TTCs) a failure of the tilt frame. This event is modeled as a fault tree and is listed in Table A4.7-2. The initiating event is specified as a probability of impact per cask. 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.

Object Dropped onto Transportation Cask/DPC. This initiating event covers the potential impact to the transportation cask due to the drop of a heavy object such as the lid lift fixture on the cask. This event is modeled as a fault tree and is listed in Table A4.7-2. The initiating event is specified as a probability of object drop per cask.

Cask Drop from Operational Height. This initiating event accounts for the potential impact to the transportation cask due to having been dropped from the normal operational height during transfer by the cask handling crane. The probability of drop per transfer is derived from empirical data in Section 6.3 and is modeled as a single-event fault tree and is listed in Table A4.7-2. The initiating event is specified as a probability of a drop per cask.

Table A4.7-2. Initiating Event Assignments for WHF-ESD07-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Transportation cask tipover	WHF-ESD07-DPC	ESD07-CPREP-CASKTIP	ESD07-CPREP-CASKTIP
Side impact		ESD07-CPREP-SIMPACT	ESD07-CPREP-SIMPACT
Object dropped on a cask		ESD07-CPREP-DROPON	050-JIBCRANE-CRJ-DRP AND 050-DPCPREPLIFTNUMBER
Cask drop from operational height		ESD07-CPREP-CASKDROP	050-OPCASKDROP01-HFI-NOD

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.7.2 System Response Event Tree RESPONSE-TCASK

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

CASK. Table A4.7-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.7-3. Basic Event Associated with the CASK Pivotal Events for WHF-ESD07-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD07-DPC	ESD07-CPREP-CASKTIP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD07-CPREP-SIMPACT	CASK-IMPACT	CASK- FAIL-IMPACT
	ESD07-CPREP-DROPON	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD07-CPREP-CASKDROP	CASK- DROP	CASK-DROP-OPERATIONAL

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.7-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.7-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD07-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELD	Associated Fault Tree or Basic Event ^a
WHF-ESD07-DPC	ESD07-CPREP-CASKTIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD07-CPREP-SIMPACT		CASK-SHIELDING-IMPACT
	ESD07-CPREP-DROPON		CASK-SHIELDING-DROP
	ESD07-CPREP-CASKDROP		CASK-SHIELDING-DROP

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CANISTER. Table A4.7-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.7-5. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD06-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD07-DPC	ESD07-CPREP-CASKTIP	CANISTER-FAIL	CANISTER-IN-CASK-FAIL
	ESD07-CPREP-SIMPACT		
	ESD07-CPREP-DROPON		
	ESD07-CPREP-CASKDROP		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.7-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.7-6. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD07-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD07-DPC	ESD07-CPREP-CASKTIP	CONFINEMENT	HVAC
	ESD07-CPREP-SIMPACT		
	ESD07-CPREP-DROPON		
	ESD07-CPREP-CASKDROP		

NOTE: ^aThis 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 A4.7-7 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.7-7. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD07-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD07-DPC	ESD07-CPREP-CASKTIP	MODERATOR	MODERATOR
	ESD07-CPREP-SIMPACT		
	ESD07-CPREP-DROPON		
	ESD07-CPREP-CASKDROP		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.8 EVENT TREES FOR WHF-ESD08-CSNF

ESD WHF-ESD08-CSNF delineates the event sequences that arise from structural challenges associated with the installation of lid lift fixture on transportation cask/commercial SNF. This ESD applies to uncanistered commercial SNF in a transportation cask or truck trailer.

Although the initiator event trees transfer to the same response tree (see Table A4.8-1), 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 A4.8-1. Summary of Event Trees for WHF-ESD08-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-ESD08-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

A4.8.1 Initiating Events for WHF-ESD08-CSNF

The individual initiating events that were identified in the MLD are indicated on the ESD by their initiating event identifiers and, for quantification purposes, are collected into one of five groups. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.8-2.

Side Impact to Cask. This initiating event covers the potential impact to the transportation cask due to a vehicular collision, unplanned conveyance movement or (for TTCs) a failure of the tilt frame. This event is modeled as a fault tree and is listed in A4.8-2. The initiating event is specified as a probability of impact per cask. 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.

Object Dropped onto Transportation Cask/Commercial SNF. This initiating event covers the potential impact to the transportation cask due to the drop of a heavy object, such on the cask. This event is modeled as a fault tree and is listed in A4.8-2. The initiating event is specified as a probability of object drop per cask.

Cask Drop from Operational Height. This initiating event accounts for the potential impact to the transportation cask due to having been dropped from the normal operational height during transfer by the cask handling crane. The probability of drop per transfer is derived from empirical data in Section 6.3 and is modeled as a single-event fault tree and is listed in A4.8-2. The initiating event is specified as a probability of a drop per cask.

Transportation Cask Tipover. This initiating event covers the potential impact to the transportation cask due to a tipover. The tipover event is modeled as a single-event fault tree and is listed in A4.8-2. The initiating event is specified as a probability of tipover per cask.

Table A4.8-2. Initiating Event Assignments for WHF-ESD08-CSNF

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Impact to cask	WHF-ESD08-CSNF	ESD08-CPREP-IMPACT	ESD08-CPREP-IMPACT
Object dropped on a cask	WHF-ESD08-CSNF	ESD08-CPREP-DROPON	050-JIBCRANE-CRJ-DRP and 050-DPCPREPLIFTNUMBER
Cask drop from operational height	WHF-ESD08-CSNF	ESD08-CPREP-DROP	050-OPCASKDROP01-HFI-NOD
Transportation cask tipover	WHF-ESD08-CSNF	ESD08-CPREP-TIP	ESD08-CPREP-TIP

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.8.2 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 A4.8-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.8-3. Basic Event Associated with the CASK Pivotal Events for WHF-ESD08-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD08-CSNF	ESD08-CPREP-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD08-CPREP-DROPON	CASK- DROP	CASK-DROP-OPERATIONAL
	ESD08-CPREP-DROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD08-CPREP-TIP	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.8-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.8-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD08-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD08-CSNF	ESD08-CPREP-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD08-CPREP-DROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD08-CPREP-DROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD08-CPREP-TIP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.8-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.8-5. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD08-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD08-CSNF	ESD08-CPREP-IMPACT	CONFINEMENT	HVAC
	ESD08-CPREP-DROPON		
	ESD08-CPREP-DROP		
	ESD08-CPREP-TIP		

NOTE: ^aThis 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 A4.8-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.8-6. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD08-CSNF

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD08-CSNF	ESD08-CPREP-IMPACT	MODERATOR	MODERATOR
	ESD08-CPREP-DROPON		
	ESD08-CPREP-DROP		
	ESD08-CPREP-TIP		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.9 EVENT TREES FOR WHF-ESD09-DPC

ESD WHF-ESD09-DPC delineates the event sequences that arise after a structural challenge to a transportation cask with DPC or STC with DPC associated with cask preparation activities (i.e., installation of cask lid lift fixture). This ESD applies to the following waste forms:

- Commercial SNF in DPCs contained in STCs on CTT
- Commercial SNF in DPCs contained in a transportation cask on CTT.

With the lid removed, the cask provides no containment or shielding.

This ESD covers transportation casks or STCs with DPCs. Although the initiator event trees transfer to the same response tree (see Table A4.9-1), 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 A4.9-1. Summary of Event Trees for WHF-ESD09-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a DPC	Initiator: WHF-ESD09-DPC DPC Response: RESPONSE-CANISTER1	346

NOTE: DPC = dual-purpose container.

Source: Ref. 2.2.26, Table 4

A4.9.1 Initiating Events for WHF-ESD09-DPC

The following initiating events are associated with WHF-ESD09-DPC for transportation casks with DPCs. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.9-2.

Cask Drop from Operational Height. This initiating event accounts for the potential impact to the transportation cask due to having been dropped from the normal operational height during transfer by the cask handling crane. The probability of drop per transfer is derived from empirical data in Section 6.3 and is modeled as a single-event fault tree and is listed in Table A4.9-2. The initiating event is specified as a probability of a drop per cask.

Side Impact to STC. This initiating event covers the potential impact to the STC due to collision between the CTT and another moving vehicle, facility structures, or facility equipment. This event is modeled as a fault tree and is listed in Table A4.9-2. The initiating event is specified as a probability of impact per cask. 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.

Object Dropped onto DPC. This initiating event covers the potential impact to the transportation cask due to the drop of a heavy object such as the lid lift fixture on the cask. This

event is modeled as a fault tree and is listed in Table A4.9-2. The initiating event is specified as a probability of object drop per cask.

Table A4.9-2. Initiating Event Assignments for WHF-ESD09-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Drop of Cask	WHF-ESD09-DPC	ESD09-DPREP-CASKDROP	050-OPCASKDROP01-HFI-NOD
Impact to cask	WHF-ESD09-DPC	ESD09-DPREP-IMPACT	ESD09-DPREP-IMPACT
Object dropped on cask	WHF-ESD09-DPC	ESD09-DPREP-DROPON	050-JIBCRANE-CRJ-DRP and 050-DPCPREPLIFTNUMBER

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.9.2 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 A4.9-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.9-3. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD09-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD09-DPC	ESD09-DPREP-CASKDROP	CASK-DROP	CASK-DROP-OPERATIONAL
	ESD09-DPREP-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD09-DPREP-CASKDROPON	CASK-DROP	CASK-DROP-OPERATIONAL

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.9-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.9-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD09-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD09-DPC	ESD09-DPREP-CASKDROP	SHIELD-CASK-DROP	CASK-SHIELDING-DROP
	ESD09-DPREP-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD09-DPREP-CASKDROPON	SHIELD-CASK-DROP	CASK-SHIELDING-DROP

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.9-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.9-5. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD09-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD09-DPC	ESD09-DPREP-CASKDROP	CONFINEMENT	HVAC
	ESD09-DPREP-IMPACT		
	ESD09-DPREP-CASKDROPON		

NOTE: ^aThis 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 A4.9-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.9-6. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD09-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD09-DPC	ESD09-DPREP-CASKDROP	MODERATOR	MODERATOR
	ESD09-DPREP-IMPACT		
	ESD09-DPREP-CASKDROPON		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.10 EVENT TREES FOR WHF-ESD10-DPC

ESD WHF-ESD10-DPC delineates the event sequences that arise after a structural challenge to a transportation cask that contains a DPC. This includes transfer of the transportation cask/DPC from Cask Preparation Area to Cask Unloading Room. With the lid lifting fixture on, the transportation cask provides shielding but does not provide containment since the transportation cask lid is unbolted. This ESD applies to commercial SNF in DPCs contained in transportation casks on CTT.

This ESD covers transportation casks with DPCs. Although the initiator event trees transfer to the same response tree (see Table A4.10-1), 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 A4.10-1. Summary of Event Trees for WHF-ESD10-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Transportation cask containing a DPC	Initiator: WHF-ESD10-DPC DPC Response: RESPONSE-CANISTER1	346

NOTE: DPC = dual-purpose container.

Source: Ref. 2.2.26, Table 4

A4.10.1 Initiating Events for WHF-ESD10-DPC

The following initiating events are associated with WHF-ESD10-DPC for transportation casks with DPCs. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.10-2 and listed below.

- CTT collision with facility structures or equipment
- CTT or cask catches crane hook/rigging resulting in impact.

The initiating event is specified as a probability of object drop per cask is modeled as a fault tree as listed in A4.10-2.

Table A4.10-2. Initiating Event Assignments for WHF-ESD10-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
CTT impact	WHF-ESD10-DPC	ESD10-CTT-IMPACT	050-OPIMPACT0000-HFI-NOD
CTT collision	WHF-ESD10-DPC	ESD10-CTT-COLLIDE	050-CTT-COLLIDE

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
CTT = cask transfer trolley.

Source: Original

A4.10.2 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 A4.10-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.10-3. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD10-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD10-DPC	ESD10-CTT-IMPACT	CASK-IMPACT	CASK-FAIL-IMPACT
	ESD10-CTT-COLLIDE	CASK-IMPACT	CASK-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.10-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.10-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD10-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD10-DPC	ESD10-CTT-IMPACT	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT
	ESD10-CTT-COLLIDE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.10-5 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.10-5. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD10-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD10-DPC	ESD10-CTT-IMPACT	CONFINEMENT	HVAC
	ESD10-CTT-COLLIDE		

NOTE: ^aThis 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 A4.10-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.10-6. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD10-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD10-DPC	ESD10-CTT-IMPACT	MODERATOR	MODERATOR
	ESD10-CTT-COLLIDE		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.11 EVENT TREES FOR WHF-ESD11-AODPC

A4.11.1 Event Trees for WHF-ESD11 (Site Transporter with Aging Overpack/DPC)

This ESD delineates the event sequences that arise after a structural challenge to an aging overpack during transfer of an aging overpack/DPC or aging overpack/TAD canister on a site transporter, through the Site Transporter Vestibule, aging overpack access platform, and Loading Room (receipt or export). This ESD applies to commercial SNF in DPCs contained in aging overpacks on site transporters.

An initiator event tree and a system response event tree represent this ESD (Table A4.11-1). The system response tree is customized within SAPHIRE for the 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 A4.11-1. Summary of Event Trees for WHF-ESD11-AODPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Aging overpack carrying a DPC	Initiator: WHF-ESD11-AODPC Response: RESPONSE-CANISTER1	346

NOTE: DPC = dual-purpose container.

Source: Ref. 2.2.26, Table 4

A4.11.1.1 Initiator Event Trees for WHF-ESD11 (Site Transporter with Aging Overpack/DPC)

The following initiating events are associated with WHF-ESD11-AODPC. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.11-2.

Site Transporter Collision. This initiating event accounts for the potential impact to the DPC due to a collision involving the site transporter. The probability of collision per DPC received is modeled as a fault tree as listed in Table A4.11-2. The initiating event is specified as a probability of collision per DPC.

Object Dropped onto Aging Overpack/DPC. This initiating event covers the potential impact to the DPC due to the drop of a heavy object on the aging overpack. This event is modeled as a fault tree as listed in Table A4.11-2. The initiating event is specified as a probability of object drop per DPC.

Aging Overpack/DPC Rollover. This initiating event covers the potential impact to the DPC due to a site transporter rollover. The rollover event is modeled as a single-event fault tree as listed in Table A4.11-2. The initiating event is specified as a probability of rollover per DPC.

Side Impact. This initiating event covers the potential impact to the DPC due to a crane or forklift impact or an unplanned movement of the site transporter. This event is modeled as a fault tree and is listed in Table A4.11-2. The initiating event is specified as a probability of impact per DPC.

Table A4.11-2. Initiating Event Assignments for WHF-ESD11-AODPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Site transporter collision	WHF-ESD11-AODPC	ESD11-DPC-COLLIDE	050-11-ST-COLLISION
Drop on aging overpack		ESD11-DPC-DROP	050-JIBCRANE-CRJ-DRP
Aging overpack/DPC rollover		ESD11-DPC-TIP	050-11-ST-ROLLOVER
Side impact		ESD11-DPC-IMPACT	ESD11-DPC-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
DPC = dual-purpose canister.

Source: Original

A4.11.1.2 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 A4.11-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.11-3. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD11-AODPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD11-AODPC	ESD11-DPC-COLLIDE	CANISTER-AO-IMPACT	CANISTER-AO-IMPACT-FAIL
	ESD11-DPC-DROP	CANISTER-AO-DROP	CANISTER-AO-DROP-FAIL
	ESD11-DPC-TIP	CANISTER-AO-DROP	CANISTER-AO-DROP-FAIL
	ESD11-DPC-IMPACT	CANISTER-AO-IMPACT	CANISTER-AO-IMPACT-FAIL

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.11-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.11-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD11-AODPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD11-AODPC	ESD11-DPC-COLLIDE	AO-SHIELD-IMPACT	AO-SHIELD-FAIL-IMPACT
	ESD11-DPC-DROP	AO-SHIELD-DROP	AO-SHIELD-FAIL-DROP
	ESD11-DPC-TIP	AO-SHIELD-DROP	AO-SHIELD-FAIL-DROP
	ESD11-DPC-IMPACT	AO-SHIELD-IMPACT	AO-SHIELD-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

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

Table A4.11-5. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD11-AODPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD03-AODPC	ESD11-DPC-COLLIDE	CONFINEMENT	HVAC
	ESD11-DPC-DROP		
	ESD11-DPC-TIP		
	ESD11-DPC-IMPACT		

NOTE: ^aThis 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 A4.11-6 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.11-6. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD11-AODPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD03-AODPC	ESD11-DPC-COLLIDE	MODERATOR	MODERATOR
	ESD11-DPC-DROP		
	ESD11-DPC-TIP		
	ESD11-DPC-IMPACT		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.11.2 Event Trees for WHF-ESD11-AOTAD (Site Transporter with Aging Overpack/TAD Canister)

This ESD delineates the event sequences that arise after a structural challenge to an aging overpack during transfer aging overpack/TAD canister on a site transporter, through the Site Transporter Vestibule, aging overpack access platform, and Loading Room (receipt or export). This ESD applies to commercial SNF in TAD canisters contained in aging overpacks on site transporters.

An initiator event tree and a system response event tree represent this ESD (Table A4.11-7). The system response tree is customized within SAPHIRE for the 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 A4.11-7. Summary of Event Trees for WHF-ESD11-AOTAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Aging overpacks containing a TAD canister	Initiator: WHF-ESD11-AOTAD Response: RESPONSE-CANISTER1	1,165

NOTE: TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.11.2.1 Initiator Event Trees for WHF-ESD11 (Site Transporter with Aging Overpack/TAD Canister)

The following initiating events are associated with WHF-ESD11. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.11-8.

Site Transporter Collision. This initiating event accounts for the potential impact to the TAD canister due to a collision involving the site transporter. The probability of collision per TAD

canister received is modeled as a fault tree as listed in Table A4.11-8. The initiating event is specified as a probability of collision per TAD canister.

Object Dropped onto Aging Overpack/TAD Canister. This initiating event covers the potential impact to the TAD canister due to the drop of a heavy object on the aging overpack. This event is modeled as a fault tree and is listed in Table A4.11-8. The initiating event is specified as a probability of object drop per TAD canister.

Aging Overpack/TAD Canister Rollover. This initiating event covers the potential impact to the TAD canister due to a site transporter rollover. The rollover event is modeled as a single-event fault tree and is listed in Table A4.11-8. The initiating event is specified as a probability of rollover per TAD canister.

Side Impact. This initiating event covers the potential impact to the TAD canister due to a crane or forklift impact or an unplanned movement of the site transporter. This event is modeled as a fault tree and is listed in Table A4.11-8. The initiating event is specified as a probability of impact per TAD canister.

Table A4.11-8. Initiating Event Assignments for WHF-ESD11-AOTAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Site transporter collision	WHF-ESD11-AOTAD	ESD11-TAD-COLLIDE	050-11-ST-COLLISION
Drop on aging overpack		ESD11-TAD-DROP	050-JIBCRANE-CRJ-DRP
Aging overpack/TAD canister rollover		ESD11-TAD-TIP	050-11-ST-ROLLOVER
Side Impact		ESD11-TAD-IMPACT	ESD11-TAD-IMPACT

NOTE: ^aThis 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

A4.11.2.2 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 A4.11-9 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.11-9. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD11-AOTAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD11-AOTAD	ESD11-TAD-COLLIDE	CANISTER-AO-IMPACT	CANISTER-AO-IMPACT-FAIL
	ESD11-TAD-DROP	CANISTER-AO-DROP	CANISTER-AO-DROP-FAIL
	ESD11-TAD-TIP	CANISTER-AO-DROP	CANISTER-AO-DROP-FAIL
	ESD11-TAD-IMPACT	CANISTER-AO-IMPACT	CANISTER-AO-IMPACT-FAIL

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.11-10 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.11-10. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD11-AOTAD

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD11-AOTAD	ESD11-TAD-COLLIDE	AO-SHIELD-IMPACT	AO-SHIELD-FAIL-IMPACT
	ESD11-TAD-DROP	AO-SHIELD-DROP	AO-SHIELD-FAIL-DROP
	ESD11-TAD-TIP	AO-SHIELD-DROP	AO-SHIELD-FAIL-DROP
	ESD11-TAD-IMPACT	AO-SHIELD-IMPACT	AO-SHIELD-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

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

Table A4.11-11. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD11-AOTAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD11-AOTAD	ESD11-TAD-COLLIDE	CONFINEMENT	HVAC
	ESD11-TAD-DROP		
	ESD11-TAD-TIP		
	ESD11-TAD-IMPACT		

NOTE: ^aThis 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 A4.11-12 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.11-12. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD11-AOTAD

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD11-AOTAD	ESD11-TAD-COLLIDE	MODERATOR	MODERATOR
	ESD11-TAD-DROP		
	ESD11-TAD-TIP		
	ESD11-TAD-IMPACT		

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.12 EVENT TREES FOR WHF-ESD12-DPC

A4.12.1 Event Trees for WHF-ESD12 (Aging Overpack/DPC on Site Transporter)

This ESD delineates the event sequences that arise after a structural challenge from an aging overpack/DPC collision with Cask Loading Room shield door.

The initiating event and number of waste forms is given in Table A4.12-1.

Table A4.12-1. Summary of Event Trees for WHF-ESD12-DPC

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Aging overpack carrying a DPC	Initiator: WHF-ESD12-DPC	346

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4

A4.12.1.1 Initiator Event Trees for WHF-ESD12 (Site Transporter with Aging Overpack/DPC/DPC)

There is one initiating event associated with WHF-ESD12 described below and the SAPHIRE assignments are given in Table A4.12-2.

Collision with Cask Loading Shield Door. This initiating event describes collision with the cask loading room shield door while the aging overpack/DPC is on the site transporter.

Table A4.12-2. Initiating Event Assignments for WHF-ESD12-DPC

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Site transporter collision with shield door	WHF-ESD12-DPC	ESD12-DPC-DOOR	ESD12-DPC-DOOR

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.12.1.2 Pivotal Events

The pivotal events for site transporter collision with the shield door are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CELL DOOR. Table A4.12-3 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.12-3. Basic Event Associated with the CELL DOOR pivotal event for WHF-ESD12-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CELL DOOR	Associated Fault Tree or Basic Event ^a
WHF-ESD12-DPC	ESD12-DPC-DOOR	CELL-DOOR	SHIELD-DOOR-FAILURE

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CASK. Table A4.12-4 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.12-4. Basic Event Associated with the CASK pivotal event for WHF-ESD12-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CASK	Associated Fault Tree or Basic Event ^a
WHF-ESD12-DPC	ESD12-DPC-DOOR	CASK-IMPACT	CASK-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.12-5 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.12-5. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD12-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD12-DPC	ESD12-DPC-DOOR	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CONFINEMENT. Table A4.12-6 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.12-6. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD12-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD12-DPC	ESD12-DPC-DOOR	CONFINEMENT	HVAC

NOTE: ^aThis 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 A4.12-7 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.12-7. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD12-DPC

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD12-DPC	ESD12-DPC-DOOR	MODERATOR	MODERATOR

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.12.2 Event Trees for WHF-ESD12-TAD (Aging Overpack/Site Transporter or STC/CTT containing a TAD Canister)

This ESD delineates the event sequences that arise after a structural challenge from aging overpack/site transporter containing a TAD canister colliding with the cask loading shield door or the STC/CTT containing a TAD canister colliding with the cask unloading door.

Table A4.12-8. Summary of Event Trees for WHF-ESD12-TAD

Waste Form Unit	Associated Event Trees	Number of Waste Form Units
Aging overpacks or STCs containing a TAD canister	Initiator: WHF-ESD12-TAD	1,165

NOTE: STC = shielded transfer cask; TAD = transportation, aging, and disposal.

Source: Ref. 2.2.26, Table 4

A4.12.2.1 Initiator Event Trees for WHF-ESD12 (Aging Overpack/Site Transporter or STC/CTT containing a TAD Canister)

There is one initiating event associated with WHF-ESD12-TAD described below and the SAPHIRE assignments are given in Table A4.12-9.

Collision with Cask Loading or Cask Unloading Shield Door. This initiating event describes aging overpack/site transporter collision with the cask unloading shield door or the STC/CTT collision with the cask unloading shield door.

Table A4.12-9. Initiating Event Assignments for WHF-ESD12-TAD

Initiating Event Description	Initiator Event Tree	SAPHIRE Assignment by Basic Rules	SAPHIRE Assignment at Fault Tree Level ^a
Site transporter or CTT collision with shield door	WHF-ESD12-TAD	ESD12-TAD-DOOR	ESD12-TAD-DOOR

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.
CTT = cask transfer trolley.

Source: Original

A4.12.2.2 Pivotal Events

The pivotal events for site transporter collision with the shield door are summarized below. The accompanying tables show the association of pivotal event names with basic event or fault tree names.

CELL DOOR. Table A4.12-10 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.12-10. Basic Event Associated with the CELL DOOR Pivotal Event for WHF-ESD12-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CELL DOOR	Associated Fault Tree or Basic Event ^a
WHF-ESD12-TAD	ESD12-TAD-DOOR	CELL-DOOR	SHIELD-DOOR-FAILURE

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

CASK. Table A4.12-11 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.12-11. Basic Events Associated with the CASK Pivotal Events of WHF-ESD12-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CANISTER	Associated Fault Tree or Basic Event ^a
WHF-ESD12-TAD	ESD12-TAD-DOOR	CASK-IMPACT	CASK-FAIL-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

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

Table A4.12-12. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD12-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to SHIELDING	Associated Fault Tree or Basic Event ^a
WHF-ESD12-TAD	ESD12-TAD-DOOR	SHIELD-CASK-IMPACT	CASK-SHIELDING-IMPACT

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

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

Table A4.12-13. Basic Event Associated with the CONFINEMENT Pivotal Events of WHF-ESD12-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to CONFINEMENT	Associated Fault Tree or Basic Event ^a
WHF-ESD12-TAD	ESD12-TAD-DOOR	CONFINEMENT	HVAC

NOTE: ^aThis 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 A4.12-14 indicates the basic event that is associated with this pivotal event for the initiating event.

Table A4.12-14. Basic Event Associated with the MODERATOR Pivotal Events of WHF-ESD12-TAD

Initiator Event Tree	Initiating Event Name	Name Assigned to MODERATOR	Associated Fault Tree or Basic Event ^a
WHF-ESD12-TAD	ESD12-TAD-DOOR	MODERATOR	MODERATOR

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.13 EVENT TREES FOR WHF-ESD13

A4.13.1 Event Trees for WHF-ESD13 (DPC Transfer with CTM)

This ESD delineates the event sequences that arise after a structural challenge resulting from transfer of a DPC from a transportation cask to STC within the CTM.

Although the initiator event trees transfer to the same response tree (see Table A4.13-1 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 A4.13-1. Summary of Event Trees for WHF-ESD13-DPC

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

NOTE: DPC = dual-purpose canister.

Source: Ref. 2.2.26, Table 4

A4.13.1.1 Initiating Events for WHF-ESD13-DPC

The following initiating events are associated with WHF-ESD13-DPC involving CTM operation. The assignments made within SAPHIRE for quantification of these initiating events are indicated in Table A4.13-2.

Canister Drop from Operational Height. This initiating event accounts for the potential impact to the DPC 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 A4.13-2. 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 DPC 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 A4.13-2. 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 DPC as it being lifted and transferred by the CTM. This event is modeled as a fault tree and is listed in Table A4.13-2. 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.

Drop on Canister. This initiating event covers the potential impact to the DPC 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 A4.13-2. The initiating event is specified as a probability of object drop per canister.

Spurious movement of DPC. This initiating event results from spurious site transporter movement or CTM bell movement and is modeled as a fault tree as listed in Table A4.13-2.

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 A4.13-2.

Table A4.13-2. Initiating Event Assignments for WHF-ESD13-DPC

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-DPC	ESD13-DPC-DROP	CTM-DROP---ALL-HEIGHTS and 050-LIFTS-PER-DPC-CAN
Drop of cask above operational height	WHF-ESD13-DPC	ESD13-DPC-TWOBLOCK	CTM-2-BLOCK and 050-LIFTS-PER-DPC-CAN
Side impact of canister	WHF-ESD13-DPC	ESD13-DPC-SIDEIMPACT	ESD13-DPC-SIDEIMPACT
Drop on canister	WHF-ESD13-DPC	ESD13-DPC-DROPON	CTM-DROP-ONTO-CASK and 050-CTMOBJLIFTNUMBERD
Spurious movement	WHF-ESD13-DPC	ESD13-DPC-SPURMOVE	ESD13-DPC-SPURMOVE
Canister drop inside bell	WHF-ESD13-DPC	ESD13-DPC-DROPBELL	CTM-DROP-IN-SHIELD-BELL and 050-LIFTS-PER-DPC-CAN

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

A4.13.1.2 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 A4.13-3 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.13-3. Basic Events Associated with the CANISTER Pivotal Events of WHF-ESD13-DPC

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

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original

SHIELDING. Table A4.13-4 indicates the basic event that is associated with this pivotal event for each initiating event.

Table A4.13-4. Basic Event Associated with the SHIELDING Pivotal Events of WHF-ESD13-DPC

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

NOTE: ^aThis column may contain fault trees and basic events. See Attachment B for fault trees and Attachment C for basic events.

Source: Original