Table G-2. Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD31-CSNF-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a thermal challenge to a transportation cask with uncanistered SNF assemblies, due to a fire, resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator is excluded from entering the cask. | 1 transportation cask with uncanistered SNF assemblies | 3.E-03 | 3.E-03 | 1.E-03 | Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-CSNF-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a transportation cask with uncanistered SNF assemblies, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ2-DEL | Direct exposure, loss of shielding | This event sequence represents a thermal challenge to a DPC inside a transportation cask or an STC, due to a fire, resulting in a direct exposure from loss of shielding. In this sequence the canister remains intact, and the shielding fails. | 1 DPC | 5.E-02 | 4.E-02 | 2.E-02 | Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 1.E-08 | 1.E-08 | 5.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 1.E-08 | 1.E-08 | 5.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 9.E-08 | 8.E-08 | 4.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-08 | 8.E-08 | 4.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ2-DEL | Direct exposure, loss of shielding | This event sequence represents a thermal challenge to a TAD canister inside an STC, due to a fire, resulting in a direct exposure from loss of shielding. In this sequence the canister remains intact, and the shielding fails. | 1 TAD canister | 1.E-01 | 1.E-01 | 4.E-02 | Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 TAD canister | 1.E-08 | 1.E-08 | 6.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 1.E-08 | 1.E-08 | 6.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 2.E-07 | 2.E-07 | 9.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 2.E-07 | 2.E-07 | 9.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

NOTE: [1]The material at risk is, as relevant, based upon the nominal capacity of the waste form container involved in the event sequence under consideration, or accounts for the specific operation covered by the event sequence.
[2]The mean, median, and standard deviation displayed are for the number of occurrences, over the preclosure period, of the event sequence under consideration.

Cat. = category; CTM = canister transfer machine; CTT = cask transfer trolley; DPC = dual-purpose canister; ID = identification; SNF = spent nuclear fuel; STC = shielded transfer cask; Std Dev = standard deviation; TAD = transportation, aging, and disposal.

Source: Original

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Table G-3. Beyond Category 2 Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD19-DPC-SEQ6P-GRRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in an unfiltered radionuclide release. In this sequence the STC fails, and an adequate boron concentration is maintained. This sequence occurs inside the pool. | 1 DPC | 7.E-05 | 2.E-05 | 2.E-04 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence near a category threshold. Categorization confirmed by alternative distribution |
| ESD11-DPC-SEQ2-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside an aging overpack, during site transporter transfer to the Loading Room, resulting in a direct exposure from loss of shielding. In this sequence the canister remains intact, and the shielding fails. | 1 DPC | 4.E-05 | 3.E-05 | 5.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence near a category threshold. Categorization confirmed by alternative distribution |
| ESD18-DPC-SEQ3-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC, during DPC cutting activities, resulting in an unfiltered radionuclide release. In this sequence the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 2.E-05 | 1.E-05 | 3.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence near a category threshold. Categorization confirmed by alternative distribution |
| ESD21-DPC-SEQ2P-GRRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool floor, resulting in an unfiltered radionuclide release. In this sequence the STC fails, and an adequate boron concentration is maintained. This sequence occurs inside the pool. | 1 DPC | 2.E-05 | 1.E-05 | 2.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence near a category threshold. Categorization confirmed by alternative distribution |
| ESD03-DPC-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an aging overpack, during receipt activities, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 2.E-05 | 8.E-06 | 6.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence near a category threshold. Categorization confirmed by alternative distribution |
| ESD03-DPC-SEQ2-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside an aging overpack, during receipt activities, resulting in a direct exposure from loss of shielding. In this sequence the canister remains intact, and the shielding fails. | 1 DPC | 2.E-05 | 8.E-06 | 6.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence near a category threshold. Categorization confirmed by alternative distribution |
| ESD08-CSNF-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a direct exposure from degradation of shielding. In this sequence the transportation cask containment function remains intact, and the shielding fails. | 1 transportation cask with uncanistered SNF assemblies | 1.E-05 | 9.E-06 | 8.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD08-CSNF-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a filtered radionuclide release. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator is excluded from entering the cask. | 1 transportation cask with uncanistered SNF assemblies | 1.E-05 | 9.E-06 | 8.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD17-DPC-SEQ3-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC, during preparation activities (sampling, gas cooling, water filling), resulting in an unfiltered radionuclide release. In this sequence the confinement boundary fails, and no condition important to criticality occurs. | 1 DPC | 9.E-06 | 3.E-06 | 3.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-TAD-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a TAD canister, during canister transfer by the CTM, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 TAD canister | 8.E-06 | 4.E-06 | 2.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-TAD-SEQ2-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a TAD canister, during canister transfer by the CTM, resulting in a direct exposure from loss of shielding. In this sequence the canister remains intact, and the shielding fails. | 1 TAD canister | 8.E-06 | 4.E-06 | 2.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD24-TAD-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in a direct exposure from degradation of shielding. In this sequence the STC containment function remains intact, and the shielding fails. This sequence occurs outside the pool. | 1 TAD canister | 7.E-06 | 5.E-06 | 9.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD24-TAD-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in a filtered radionuclide release. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary remains intact, and a moderator is excluded from entering the canister. This sequence occurs outside the pool. | 1 TAD canister | 7.E-06 | 5.E-06 | 9.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD23-POOL-SEQ2P-DEL | Direct exposure, loss of shielding | This event sequence represents a direct exposure during handling of liquid LLW from the WHF pool. In this sequence there are no pivotal events. | liquid LLW | 7.E-06 | 1.E-06 | 2.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD05-CSNF-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during removal of impact limiters, upending, and transfer to preparation station, resulting in a direct exposure from degradation of shielding. In this sequence the transportation cask containment function remains intact, and the shielding fails. | 1 transportation cask with uncanistered SNF assemblies | 7.E-06 | 3.E-06 | 3.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD05-CSNF-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during removal of impact limiters, upending, and transfer to preparation station, resulting in a filtered radionuclide release. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator is excluded from entering the cask. | 1 transportation cask with uncanistered SNF assemblies | 7.E-06 | 3.E-06 | 3.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD19-DPC-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in a direct exposure from degradation of shielding. In this sequence the STC containment function remains intact, and the shielding fails. This sequence occurs outside the pool. | 1 DPC | 6.E-06 | 4.E-06 | 8.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD19-DPC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in a filtered radionuclide release. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary remains intact, and a moderator is excluded from entering the canister. This sequence occurs outside the pool. | 1 DPC | 6.E-06 | 4.E-06 | 8.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD28-TAD-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from closure station to a CTT, resulting in a direct exposure from degradation of shielding. In this sequence the STC containment function remains intact, and the shielding fails. | 1 TAD canister | 3.E-06 | 2.E-06 | 9.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD28-TAD-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from closure station to a CTT, resulting in a filtered radionuclide release. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 TAD canister | 3.E-06 | 2.E-06 | 9.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD25-TAD-SEQ2-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC, during TAD canister assembly and closure, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 TAD canister | 2.E-06 | 2.E-06 | 2.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-DPC-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC, during canister transfer by the CTM, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 2.E-06 | 1.E-06 | 5.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD20-CSNF-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool, resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator is excluded from entering the cask. This sequence occurs outside the pool. | 1 transportation cask with uncanistered SNF assemblies | 2.E-06 | 7.E-07 | 6.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD13-DPC-SEQ2-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC, during canister transfer by the CTM, resulting in a direct exposure from loss of shielding. In this sequence the canister remains intact, and the shielding fails. | 1 DPC | 2.E-06 | 1.E-06 | 5.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD27-TAD-SEQ3-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister, during TAD canister drying and inerting activities, resulting in an unfiltered radionuclide release. In this sequence the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 2.E-06 | 2.E-07 | 1.E-05 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-TTC-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask upended with a tilting frame, during removal of impact limiters, upending, and transfer to a CTT, resulting in a direct exposure from degradation of shielding. In this sequence the transportation cask containment function remains intact, and the shielding fails. | 1 DPC | 1.E-06 | 1.E-06 | 2.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-TTC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask upended with a tilting frame, during removal of impact limiters, upending, and transfer to a CTT, resulting in a filtered radionuclide release. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 1.E-06 | 1.E-06 | 2.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD07-DPC-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a direct exposure from degradation of shielding. In this sequence the transportation cask containment function remains intact, and the shielding fails. | 1 DPC | 1.E-06 | 8.E-07 | 8.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD07-DPC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a filtered radionuclide release. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 1.E-06 | 8.E-07 | 8.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD11-TAD-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an aging overpack, during export activities, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 TAD canister | 9.E-07 | 9.E-07 | 2.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD09-DPC-SEQ2-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (transportation cask lid removal, DPC lid adapter installation), resulting in a direct exposure from loss of shielding. In this sequence the canister remains intact, and the shielding fails. | 1 DPC | 7.E-07 | 7.E-07 | 9.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD09-DPC-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (transportation cask lid removal, DPC lid adapter installation), resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 7.E-07 | 7.E-07 | 9.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD15-DPC-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from preparation station to DPC cutting station, resulting in a direct exposure from degradation of shielding. In this sequence the STC containment function remains intact, and the shielding fails. | 1 DPC | 7.E-07 | 4.E-07 | 3.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD15-DPC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from preparation station to DPC cutting station, resulting in a filtered radionuclide release. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 7.E-07 | 4.E-07 | 3.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD06-VTC-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask, during removal of impact limiters, upending, and transfer to a CTT, resulting in a direct exposure from degradation of shielding. In this sequence the transportation cask containment function remains intact, and the shielding fails. | 1 DPC | 6.E-07 | 2.E-07 | 1.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-VTC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during removal of impact limiters, upending, and transfer to a CTT, resulting in a filtered radionuclide release. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 6.E-07 | 2.E-07 | 1.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD08-CSNF-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator is excluded from entering the cask. | 1 transportation cask with uncanistered SNF assemblies | 4.E-07 | 2.E-07 | 9.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD11-DPC-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside an aging overpack, during site transporter transfer to the Loading Room, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 3.E-07 | 3.E-07 | 6.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD22-FUEL-SEQ2P-GRRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to SNF assemblies, during fuel transfer activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 2 SNF assemblies | 3.E-07 | 3.E-07 | 2.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-TAD-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister, during canister transfer by the CTM, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 3.E-07 | 6.E-08 | 1.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD24-TAD-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in an unfiltered radionuclide release. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary fails, and a moderator is excluded from entering the canister. This sequence occurs outside the pool. | 1 TAD canister | 2.E-07 | 7.E-08 | 7.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD05-CSNF-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during removal of impact limiters, upending, and transfer to preparation station, resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator is excluded from entering the cask. | 1 transportation cask with uncanistered SNF assemblies | 2.E-07 | 4.E-08 | 1.E-06 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD19-DPC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in an unfiltered radionuclide release. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary fails, and a moderator is excluded from entering the canister. This sequence occurs outside the pool. | 1 DPC | 2.E-07 | 7.E-08 | 6.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 2.E-07 | 2.E-07 | 9.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 2.E-07 | 2.E-07 | 9.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD01-CSNF-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during receipt activities, resulting in a direct exposure from degradation of shielding. In this sequence the transportation cask containment function remains intact, and the shielding fails. | 1 transportation cask with uncanistered SNF assemblies | 2.E-07 | 9.E-08 | 4.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD01-CSNF-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during receipt activities, resulting in a filtered radionuclide release. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator is excluded from entering the cask. | 1 transportation cask with uncanistered SNF assemblies | 2.E-07 | 9.E-08 | 4.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD28-TAD-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from closure station to a CTT, resulting in an unfiltered radionuclide release. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 1.E-07 | 4.E-08 | 3.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 9.E-08 | 8.E-08 | 4.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-08 | 8.E-08 | 4.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-DPC-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC, during canister transfer by the CTM, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 9.E-08 | 2.E-08 | 3.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD25-TAD-SEQ4-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC, during TAD canister assembly and closure, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 6.E-08 | 3.E-08 | 9.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-TTC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask upended with a tilting frame, during removal of impact limiters, upending, and transfer to a CTT, resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 5.E-08 | 2.E-08 | 2.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD07-DPC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 4.E-08 | 2.E-08 | 8.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD11-TAD-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an aging overpack, during export activities, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 3.E-08 | 1.E-08 | 6.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-VTC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during removal of impact limiters, upending, and transfer to a CTT, resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 2.E-08 | 4.E-09 | 1.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD15-DPC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from preparation station to DPC cutting station, resulting in an unfiltered radionuclide release. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 2.E-08 | 8.E-09 | 9.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD02-DPC-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask, during receipt activities, resulting in a direct exposure from degradation of shielding. In this sequence the transportation cask containment function remains intact, and the shielding fails. | 1 DPC | 2.E-08 | 1.E-08 | 6.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD02-DPC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during receipt activities, resulting in a filtered radionuclide release. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 2.E-08 | 1.E-08 | 6.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD04-DPC-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a horizontal DPC inside an STC, during receipt activities, resulting in a direct exposure from degradation of shielding. In this sequence the STC containment function remains intact, and the shielding fails. | 1 DPC | 2.E-08 | 7.E-09 | 6.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD04-DPC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a horizontal DPC inside an STC, during receipt activities, resulting in a filtered radionuclide release. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 2.E-08 | 7.E-09 | 6.E-07 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD09-DPC-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (transportation cask lid removal, DPC lid adapter installation), resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 2.E-08 | 1.E-08 | 4.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 1.E-08 | 1.E-08 | 5.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-DPC-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 1.E-08 | 1.E-08 | 5.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 TAD canister | 1.E-08 | 1.E-08 | 6.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-TAD-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 1.E-08 | 1.E-08 | 6.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD11-DPC-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an aging overpack, during site transporter transfer to the Loading Room, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 9.E-09 | 4.E-09 | 2.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD20-CSNF-SEQ4-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. This sequence occurs outside the pool. | 1 transportation cask with uncanistered SNF assemblies | 8.E-09 | 3.E-09 | 2.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD01-CSNF-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during receipt activities, resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator is excluded from entering the cask. | 1 transportation cask with uncanistered SNF assemblies | 6.E-09 | 1.E-09 | 3.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD10-DPC-SEQ2-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask, during CTT transfer to Cask Unloading Room, resulting in a direct exposure from loss of shielding. In this sequence the canister remains intact, and the shielding fails. | 1 DPC | 3.E-09 | 2.E-09 | 4.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD10-DPC-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during CTT transfer to Cask Unloading Room, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 3.E-09 | 2.E-09 | 4.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD14-DPC-SEQ2-DED | Direct exposure, degradation of shielding | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from Cask Unloading Room to preparation station, resulting in a direct exposure from degradation of shielding. In this sequence the STC containment function remains intact, and the shielding fails. | 1 DPC | 3.E-09 | 2.E-09 | 4.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD14-DPC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from Cask Unloading Room to preparation station, resulting in a filtered radionuclide release. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 3.E-09 | 2.E-09 | 4.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD03-DPC-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an aging overpack, during receipt activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 2.E-09 | 6.E-10 | 1.E-08 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD08-CSNF-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 1.E-09 | 7.E-10 | 2.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-TAD-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister, during canister transfer by the CTM, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 9.E-10 | 3.E-10 | 3.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD24-TAD-SEQ5-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary remains intact, and a moderator enters the canister. This sequence occurs outside the pool. | 1 TAD canister | 8.E-10 | 3.E-10 | 2.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD20-CSNF-SEQ6P-GRRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 transportation cask with uncanistered SNF assemblies | 7.E-10 | 3.E-10 | 2.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD19-DPC-SEQ5-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary remains intact, and a moderator enters the canister. This sequence occurs outside the pool. | 1 DPC | 7.E-10 | 3.E-10 | 2.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD04-DPC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a horizontal DPC inside an STC, during receipt activities, resulting in an unfiltered radionuclide release. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 7.E-10 | 1.E-10 | 9.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD05-CSNF-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during removal of impact limiters, upending, and transfer to preparation station, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 6.E-10 | 2.E-10 | 2.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD02-DPC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during receipt activities, resulting in an unfiltered radionuclide release. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 6.E-10 | 2.E-10 | 2.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD24-TAD-SEQ7P-GRRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 TAD canister | 5.E-10 | 2.E-10 | 1.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD28-TAD-SEQ5-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from closure station to a CTT, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 3.E-10 | 2.E-10 | 6.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-DPC-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC, during canister transfer by the CTM, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 3.E-10 | 9.E-11 | 9.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD20-CSNF-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. This sequence occurs outside the pool. | 1 transportation cask with uncanistered SNF assemblies | 2.E-10 | 5.E-11 | 8.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD21-CSNF-SEQ3P-GRRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool floor, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 transportation cask with uncanistered SNF assemblies | 2.E-10 | 1.E-10 | 3.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD25-TAD-SEQ3-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC, during TAD canister assembly and closure, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 2.E-10 | 1.E-10 | 2.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-TTC-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask upended with a tilting frame, during removal of impact limiters, upending, and transfer to a CTT, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 2.E-10 | 8.E-11 | 2.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD07-DPC-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 1.E-10 | 7.E-11 | 2.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD10-DPC-SEQ5-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside a transportation cask, during CTT transfer to Cask Unloading Room, resulting in an unfiltered radionuclide release. In this sequence the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 1.E-10 | 3.E-11 | 3.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD14-DPC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from Cask Unloading Room to preparation station, resulting in an unfiltered radionuclide release. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 1.E-10 | 3.E-11 | 3.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD11-TAD-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an aging overpack, during export activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 9.E-11 | 6.E-11 | 1.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD09-DPC-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (transportation cask lid removal, DPC lid adapter installation), resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 7.E-11 | 5.E-11 | 9.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD21-TAD-SEQ3P-GRRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool floor, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 TAD canister | 7.E-11 | 4.E-11 | 8.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD15-DPC-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from preparation station to DPC cutting station, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 7.E-11 | 3.E-11 | 2.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD19-DPC-SEQ7P-GRRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 DPC | 7.E-11 | 2.E-11 | 2.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-VTC-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during removal of impact limiters, upending, and transfer to a CTT, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 6.E-11 | 2.E-11 | 2.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD08-CSNF-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 4.E-11 | 1.E-11 | 1.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-TAD-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister, during canister transfer by the CTM, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 3.E-11 | 4.E-12 | 1.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD11-DPC-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an aging overpack, during site transporter transfer to the Loading Room, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 3.E-11 | 2.E-11 | 3.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD05-CSNF-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during removal of impact limiters, upending, and transfer to preparation station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 3.E-11 | 3.E-12 | 1.E-09 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD24-TAD-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary fails, and a moderator enters the canister. This sequence occurs outside the pool. | 1 TAD canister | 2.E-11 | 5.E-12 | 8.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD19-DPC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary fails, and a moderator enters the canister. This sequence occurs outside the pool. | 1 DPC | 2.E-11 | 5.E-12 | 7.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD21-DPC-SEQ3P-GRRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool floor, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 DPC | 2.E-11 | 1.E-11 | 2.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD01-CSNF-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during receipt activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 2.E-11 | 6.E-12 | 1.E-10 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in a direct exposure from loss of shielding. In this sequence the cell door structure remains intact, the canister remains intact, and the shielding fails. | 1 TAD canister | 1.E-11 | 5.E-12 | 3.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in a filtered radionuclide release. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 TAD canister | 1.E-11 | 5.E-12 | 3.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD28-TAD-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from closure station to a CTT, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 1.E-11 | 3.E-12 | 4.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD13-DPC-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC, during canister transfer by the CTM, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-12 | 1.E-12 | 4.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD25-TAD-SEQ5-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC, during TAD canister assembly and closure, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 6.E-12 | 2.E-12 | 1.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-TTC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask upended with a tilting frame, during removal of impact limiters, upending, and transfer to a CTT, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 5.E-12 | 1.E-12 | 2.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD07-DPC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 4.E-12 | 1.E-12 | 1.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD12-DPC-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in a direct exposure from loss of shielding. In this sequence the cell door structure remains intact, the canister remains intact, and the shielding fails. | 1 DPC | 4.E-12 | 1.E-12 | 9.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ4-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in a filtered radionuclide release. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 4.E-12 | 1.E-12 | 9.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD11-TAD-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an aging overpack, during export activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 3.E-12 | 9.E-13 | 1.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD09-DPC-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (transportation cask lid removal, DPC lid adapter installation), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 3.E-12 | 8.E-13 | 8.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD04-DPC-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a horizontal DPC inside an STC, during receipt activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 3.E-12 | 5.E-13 | 8.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD15-DPC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from preparation station to DPC cutting station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 2.E-12 | 5.E-13 | 9.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-VTC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during removal of impact limiters, upending, and transfer to a CTT, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 2.E-12 | 3.E-13 | 2.E-11 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD02-DPC-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during receipt activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 2.E-12 | 7.E-13 | 6.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD11-DPC-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an aging overpack, during site transporter transfer to the Loading Room, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 1.E-12 | 3.E-13 | 3.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD01-CSNF-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during receipt activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 6.E-13 | 0.E+00 | 4.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in an unfiltered radionuclide release. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 5.E-13 | 0.E+00 | 2.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD10-DPC-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during CTT transfer to Cask Unloading Room, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 4.E-13 | 2.E-13 | 8.E-13 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD14-DPC-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from Cask Unloading Room to preparation station, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 4.E-13 | 2.E-13 | 8.E-13 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ6-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in an unfiltered radionuclide release. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 1.E-13 | 0.E+00 | 6.E-13 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD04-DPC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a horizontal DPC inside an STC, during receipt activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 6.E-14 | 0.E+00 | 1.E-12 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD02-DPC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during receipt activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 5.E-14 | 0.E+00 | 3.E-13 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD10-DPC-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside a transportation cask, during CTT transfer to Cask Unloading Room, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-15 | 0.E+00 | 5.E-14 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD14-DPC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from Cask Unloading Room to preparation station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-15 | 0.E+00 | 5.E-14 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in a filtered radionuclide release also important to criticality. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 3.E-17 | 0.E+00 | 2.E-15 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ5-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in a filtered radionuclide release also important to criticality. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 8.E-18 | 0.E+00 | 5.E-16 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD19-DPC-SEQ3-DEL | N/A | This event sequence, where a structural challenge to a DPC inside an STC, during transfer to pool, causes the STC to fail and the canister to remain intact, is not applicable to DPCs because their lid is cut. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | N/A |
| ESD24-TAD-SEQ3-DEL | N/A | This event sequence, where a structural challenge to a TAD canister inside an STC, during transfer from pool, causes the STC to fail and the canister to remain intact, is not applicable to TAD canisters because they are not sealed. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | N/A |
| ESD02-DPC-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask, during receipt activities, resulting in a direct exposure from loss of shielding. In this sequence the transportation cask fails, and the canister remains intact. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD03-DPC-SEQ3-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside an aging overpack, during receipt activities, resulting in a filtered radionuclide release. In this sequence the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD03-DPC-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an aging overpack, during receipt activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD04-DPC-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a horizontal DPC inside an STC, during receipt activities, resulting in a direct exposure from loss of shielding. In this sequence the STC fails, and the canister remains intact. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-TTC-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask upended with a tilting frame, during removal of impact limiters, upending, and transfer to a CTT, resulting in a direct exposure from loss of shielding. In this sequence the transportation cask fails, and the canister remains intact. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD06-VTC-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask, during removal of impact limiters, upending, and transfer to a CTT, resulting in a direct exposure from loss of shielding. In this sequence the transportation cask fails, and the canister remains intact. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD07-DPC-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a direct exposure from loss of shielding. In this sequence the transportation cask fails, and the canister remains intact. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ10-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in a filtered radionuclide release. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ11-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in a filtered radionuclide release also important to criticality. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ12-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in an unfiltered radionuclide release. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ13-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-DPC-SEQ9-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in a direct exposure from loss of shielding. In this sequence the cell door fails and impacts the waste form, the canister remains intact, and the shielding fails. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD12-TAD-SEQ10-RRF | Filtered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in a filtered radionuclide release. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ11-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in a filtered radionuclide release also important to criticality. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ12-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in an unfiltered radionuclide release. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ13-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ7-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD12-TAD-SEQ9-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in a direct exposure from loss of shielding. In this sequence the cell door fails and impacts the waste form, the canister remains intact, and the shielding fails. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD14-DPC-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from Cask Unloading Room to preparation station, resulting in a direct exposure from loss of shielding. In this sequence the STC fails, and the canister remains intact. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD15-DPC-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from preparation station to DPC cutting station, resulting in a direct exposure from loss of shielding. In this sequence the STC fails, and the canister remains intact. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD16-CSNF-SEQ2-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (sampling, gas cooling, water filling), resulting in a filtered radionuclide release also important to criticality. In this sequence the confinement boundary remains intact, and unborated water enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD16-CSNF-SEQ4-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (sampling, gas cooling, water filling), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the confinement boundary fails, and unborated water enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD17-DPC-SEQ2-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC, during preparation activities (sampling, gas cooling, water filling), resulting in a filtered radionuclide release also important to criticality. In this sequence the confinement boundary remains intact, and unborated water enters the cask. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

| Event Sequence Group ID | End State | Description | Material-At-Risk[1] | Mean[2] | Median[2] | Std Dev[2] | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD17-DPC-SEQ4-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC, during preparation activities (sampling, gas cooling, water filling), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the confinement boundary fails, and unborated water enters the cask. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD18-DPC-SEQ2-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC, during DPC cutting activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD18-DPC-SEQ4-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a DPC, during DPC cutting activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD26-TAD-SEQ3-RRU | Unfiltered radionuclide release | This event sequence represents a structural challenge to a TAD canister, due to insufficient drying, resulting in an unfiltered radionuclide release. In this sequence the pressure builds up in the canister, leading to its failure, postulated to be outside a waste-handling surface facility. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD27-TAD-SEQ2-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister, during TAD canister drying and inerting activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD27-TAD-SEQ4-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a structural challenge to a TAD canister, during TAD canister drying and inerting activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the confinement boundary fails, and a moderator enters the canister. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD28-TAD-SEQ3-DEL | Direct exposure, loss of shielding | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from closure station to a CTT, resulting in a direct exposure from loss of shielding. In this sequence the STC fails, and the canister remains intact. | 1 TAD canister | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-CSNF-SEQ4-RRC | Filtered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a transportation cask with uncanistered SNF assemblies, due to a fire, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |
| ESD31-CSNF-SEQ6-RRC | Unfiltered radionuclide release, important to criticality | This event sequence represents a thermal challenge to a transportation cask with uncanistered SNF assemblies, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 transportation cask with uncanistered SNF assemblies | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Mean of distribution for number of occurrences of event sequence |

NOTE: [1]The material at risk is, as relevant, based upon the nominal capacity of the waste form container involved in the event sequence under consideration, or accounts for the specific operation covered by the event sequence.
[2]The mean, median, and standard deviation displayed are for the number of occurrences, over the preclosure period, of the event sequence under consideration.

Cat. = category; CTM = canister transfer machine; CTT = cask transfer trolley; DPC = dual-purpose canister; ID = identification; LLW = low-level radioactive waste; SNF = spent nuclear fuel; STC = shielded transfer cask; Std Dev = standard deviation; TAD = transportation, aging, and disposal.

Source: Original

Table G-4. Important to Criticality Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk | Mean | Median | Std Dev | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD01-CSNF-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during receipt activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. | 1 cask of CSNF | 2.E-11 | 6.E-12 | 1.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD01-CSNF-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during receipt activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 cask of CSNF | 6.E-13 | 0.E+00 | 4.E-12 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD02-DPC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during receipt activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 2.E-12 | 7.E-13 | 6.E-12 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD02-DPC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during receipt activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 5.E-14 | 0.E+00 | 3.E-13 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD03-DPC-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an aging overpack, during receipt activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD03-DPC-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an aging overpack, during receipt activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 2.E-09 | 6.E-10 | 1.E-08 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD04-DPC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a horizontal DPC inside an STC, during receipt activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 3.E-12 | 5.E-13 | 8.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD04-DPC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a horizontal DPC inside an STC, during receipt activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 6.E-14 | 0.E+00 | 1.E-12 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD05-CSNF-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during removal of impact limiters, upending, and transfer to preparation station, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. | 1 cask of CSNF | 6.E-10 | 2.E-10 | 2.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |

Table G-4. Important to Criticality Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk | Mean | Median | Std Dev | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD05-CSNF-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during removal of impact limiters, upending, and transfer to preparation station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 cask of CSNF | 3.E-11 | 3.E-12 | 1.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD06-TTC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask upended with a tilting frame, during removal of impact limiters, upending, and transfer to a CTT, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TTC | 2.E-10 | 8.E-11 | 2.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD06-TTC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask upended with a tilting frame, during removal of impact limiters, upending, and transfer to a CTT, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TTC | 5.E-12 | 1.E-12 | 2.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD06-VTC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during removal of impact limiters, upending, and transfer to a CTT, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 VTC | 6.E-11 | 2.E-11 | 2.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD06-VTC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during removal of impact limiters, upending, and transfer to a CTT, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 VTC | 2.E-12 | 3.E-13 | 2.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD07-DPC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 1.E-10 | 7.E-11 | 2.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD07-DPC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 4.E-12 | 1.E-12 | 1.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD08-CSNF-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. | 1 cask of CSNF | 1.E-09 | 7.E-10 | 2.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD08-CSNF-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (unbolting, transportation cask lid adapter installation), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 cask of CSNF | 4.E-11 | 1.E-11 | 1.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |

Table G-4. Important to Criticality Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk | Mean | Median | Std Dev | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD09-DPC-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (transportation cask lid removal, DPC lid adapter installation), resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 7.E-11 | 5.E-11 | 9.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD09-DPC-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during preparation activities (transportation cask lid removal, DPC lid adapter installation), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 3.E-12 | 8.E-13 | 8.E-12 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD10-DPC-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during CTT transfer to Cask Unloading Room, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 4.E-13 | 2.E-13 | 8.E-13 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD10-DPC-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside a transportation cask, during CTT transfer to Cask Unloading Room, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-15 | 0.E+00 | 5.E-14 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD11-DPC-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an aging overpack, during site transporter transfer to the Loading Room, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 3.E-11 | 2.E-11 | 3.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD11-DPC-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an aging overpack, during site transporter transfer to the Loading Room, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 1.E-12 | 3.E-13 | 3.E-12 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD11-TAD-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an aging overpack, during export activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD | 9.E-11 | 6.E-11 | 1.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD11-TAD-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an aging overpack, during export activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD | 3.E-12 | 9.E-13 | 1.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD12-DPC-SEQ11-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in a filtered radionuclide release also important to criticality. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD12-DPC-SEQ13-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |

Table G-4. Important to Criticality Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk | Mean | Median | Std Dev | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD12-DPC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in a filtered radionuclide release also important to criticality. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 8.E-18 | 0.E+00 | 5.E-16 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD12-DPC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an aging overpack, due to site transporter collision with shield door, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD12-TAD-SEQ11-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in a filtered radionuclide release also important to criticality. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD12-TAD-SEQ13-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the cell door fails and impacts the waste form, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD12-TAD-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in a filtered radionuclide release also important to criticality. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD | 3.E-17 | 0.E+00 | 2.E-15 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD12-TAD-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC or aging overpack, due to CTT or site transporter collision with shield door, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the cell door structure remains intact, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD13-DPC-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC, during canister transfer by the CTM, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 3.E-10 | 9.E-11 | 9.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD13-DPC-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC, during canister transfer by the CTM, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-12 | 1.E-12 | 4.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD13-TAD-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a TAD canister, during canister transfer by the CTM, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD | 9.E-10 | 3.E-10 | 3.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD13-TAD-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister, during canister transfer by the CTM, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD | 3.E-11 | 4.E-12 | 1.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |

Table G-4. Important to Criticality Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk | Mean | Median | Std Dev | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD14-DPC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from Cask Unloading Room to preparation station, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 4.E-13 | 2.E-13 | 8.E-13 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD14-DPC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from Cask Unloading Room to preparation station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-15 | 0.E+00 | 5.E-14 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD15-DPC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from preparation station to DPC cutting station, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 7.E-11 | 3.E-11 | 2.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD15-DPC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an STC, during STC transfer from preparation station to DPC cutting station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 2.E-12 | 5.E-13 | 9.E-12 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD16-CSNF-SEQ2-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (sampling, gas cooling, water filling), resulting in a filtered radionuclide release also important to criticality. In this sequence the confinement boundary remains intact, and unborated water enters the cask. | 1 cask of CSNF | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD16-CSNF-SEQ4-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during preparation activities (sampling, gas cooling, water filling), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the confinement boundary fails, and unborated water enters the cask. | 1 cask of CSNF | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD17-DPC-SEQ2-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC, during preparation activities (sampling, gas cooling, water filling), resulting in a filtered radionuclide release also important to criticality. In this sequence the confinement boundary remains intact, and unborated water enters the cask. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD17-DPC-SEQ4-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC, during preparation activities (sampling, gas cooling, water filling), resulting in an unfiltered radionuclide release also important to criticality. In this sequence the confinement boundary fails, and unborated water enters the cask. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD18-DPC-SEQ2-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC, during DPC cutting activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD18-DPC-SEQ4-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC, during DPC cutting activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |

Table G-4. Important to Criticality Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk | Mean | Median | Std Dev | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD19-DPC-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary remains intact, and a moderator enters the canister. This sequence occurs outside the pool. | 1 DPC | 7.E-10 | 3.E-10 | 2.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD19-DPC-SEQ7P-GRRC | RR-GAS-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 DPC | 7.E-11 | 2.E-11 | 2.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD19-DPC-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary fails, and a moderator enters the canister. This sequence occurs outside the pool. | 1 DPC | 2.E-11 | 5.E-12 | 7.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD20-CSNF-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. This sequence occurs outside the pool. | 1 cask of CSNF | 8.E-09 | 3.E-09 | 2.E-08 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD20-CSNF-SEQ6P-GRRC | RR-GAS-UNFILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 cask of CSNF | 7.E-10 | 3.E-10 | 2.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD20-CSNF-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. This sequence occurs outside the pool. | 1 cask of CSNF | 2.E-10 | 5.E-11 | 8.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD21-CSNF-SEQ3P-GRRC | RR-GAS-UNFILTERED-ITC | This event sequence represents a structural challenge to a transportation cask with uncanistered SNF assemblies, during transfer to pool floor, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 cask of CSNF | 2.E-10 | 1.E-10 | 3.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD21-DPC-SEQ3P-GRRC | RR-GAS-UNFILTERED-ITC | This event sequence represents a structural challenge to a DPC inside an STC, during transfer to pool floor, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 DPC | 2.E-11 | 1.E-11 | 2.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD21-TAD-SEQ3P-GRRC | RR-GAS-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool floor, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 TAD | 7.E-11 | 4.E-11 | 8.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD22-FUEL-SEQ2P-GRRC | RR-GAS-UNFILTERED-ITC | This event sequence represents a structural challenge to SNF assemblies, during fuel transfer activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 Fuel Assembly | 3.E-07 | 3.E-07 | 2.E-07 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |

Table G-4. Important to Criticality Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk | Mean | Median | Std Dev | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD24-TAD-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in a filtered radionuclide release also important to criticality. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary remains intact, and a moderator enters the canister. This sequence occurs outside the pool. | 1 TAD | 8.E-10 | 3.E-10 | 2.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD24-TAD-SEQ7P-GRRC | RR-GAS-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, and the boron concentration drops to an unallowable level. This sequence occurs inside the pool. | 1 TAD | 5.E-10 | 2.E-10 | 1.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD24-TAD-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from pool to closure station, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, there is no canister containment (canister is not sealed), the confinement boundary fails, and a moderator enters the canister. This sequence occurs outside the pool. | 1 TAD | 2.E-11 | 5.E-12 | 8.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD25-TAD-SEQ3-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC, during TAD canister assembly and closure, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD | 2.E-10 | 1.E-10 | 2.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD25-TAD-SEQ5-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC, during TAD canister assembly and closure, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD | 6.E-12 | 2.E-12 | 1.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD27-TAD-SEQ2-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a TAD canister, during TAD canister drying and inerting activities, resulting in a filtered radionuclide release also important to criticality. In this sequence the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD27-TAD-SEQ4-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister, during TAD canister drying and inerting activities, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the confinement boundary fails, and a moderator enters the canister. | 1 TAD | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD28-TAD-SEQ5-RRC | RR-FILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from closure station to a CTT, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD | 3.E-10 | 2.E-10 | 6.E-10 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD28-TAD-SEQ7-RRC | RR-UNFILTERED-ITC | This event sequence represents a structural challenge to a TAD canister inside an STC, during transfer from closure station to a CTT, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the STC fails, the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD | 1.E-11 | 3.E-12 | 4.E-11 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD31-CSNF-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a thermal challenge to a transportation cask with uncanistered SNF assemblies, due to a fire, resulting in a filtered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary remains intact, and a moderator enters the cask. | 1 cask of CSNF | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |

Table G-4. Important to Criticality Final Event Sequences Summary

| Event Sequence Group ID | End State | Description | Material-At-Risk | Mean | Median | Std Dev | Event Sequence Cat. | Basis for Categorization |
|---|---|---|---|---|---|---|---|---|
| ESD31-CSNF-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a thermal challenge to a transportation cask with uncanistered SNF assemblies, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the transportation cask fails, the confinement boundary fails, and a moderator enters the cask. | 1 cask of CSNF | 0.E+00 | 0.E+00 | 0.E+00 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD31-DPC-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 DPC | 1.E-08 | 1.E-08 | 5.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD31-DPC-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a thermal challenge to a DPC, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 DPC | 9.E-08 | 8.E-08 | 4.E-08 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD31-TAD-SEQ4-RRC | RR-FILTERED-ITC | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in a filtered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary remains intact, and a moderator enters the canister. | 1 TAD | 1.E-08 | 1.E-08 | 6.E-09 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |
| ESD31-TAD-SEQ6-RRC | RR-UNFILTERED-ITC | This event sequence represents a thermal challenge to a TAD canister, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence the canister fails, the confinement boundary fails, and a moderator enters the canister. | 1 TAD | 2.E-07 | 2.E-07 | 9.E-08 | Beyond Category 2 | Categorization by mean frequency and grouping by sequences |

NOTE: Cat. = category; CSNF = commercial spent nuclear fuel; CTM = canister transfer machine; CTT = cask transfer trolley; DPC = dual-purpose canister; ID = identification; SNF = spent nuclear fuel; STC = shielded transfer cask; Std Dev = standard deviation; TAD = transportation, aging, and disposal (canister); TTC = a transportation cask that is upended using a tilt frame; VTC = a transportation cask that is upended on a railcar.

Source: Original

# ATTACHMENT H
# SAPHIRE MODEL AND SUPPORTING FILES

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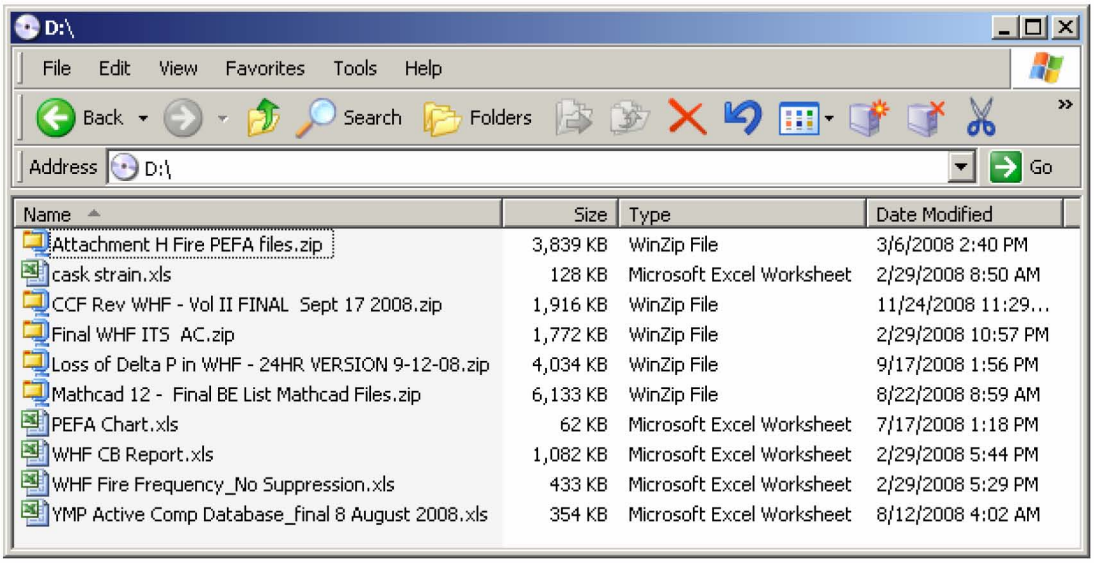
# ATTACHMENT H
# SAPHIRE MODEL AND SUPPORTING FILES

This attachment is the CD containing the SAPHIRE model and supporting files. The electronic files contained on the CD are identified below.




| Name | Size | Type | Date Modified |
|---|---|---|---|
| Attachment H Fire PEFA files.zip | 3,839 KB | WinZip File | 3/6/2008 2:40 PM |
| cask strain.xls | 128 KB | Microsoft Excel Worksheet | 2/29/2008 8:50 AM |
| CCF Rev WHF - Vol II FINAL Sept 17 2008.zip | 1,916 KB | WinZip File | 11/24/2008 11:29... |
| Final WHF ITS AC.zip | 1,772 KB | WinZip File | 2/29/2008 10:57 PM |
| Loss of Delta P in WHF - 24HR VERSION 9-12-08.zip | 4,034 KB | WinZip File | 9/17/2008 1:56 PM |
| Mathcad 12 - Final BE List Mathcad Files.zip | 6,133 KB | WinZip File | 8/22/2008 8:59 AM |
| PEFA Chart.xls | 62 KB | Microsoft Excel Worksheet | 7/17/2008 1:18 PM |
| WHF CB Report.xls | 1,082 KB | Microsoft Excel Worksheet | 2/29/2008 5:44 PM |
| WHF Fire Frequency_No Suppression.xls | 433 KB | Microsoft Excel Worksheet | 2/29/2008 5:29 PM |
| YMP Active Comp Database_final 8 August 2008.xls | 354 KB | Microsoft Excel Worksheet | 8/12/2008 4:02 AM |

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**BSC**

# Calculation/Analysis Change Notice

*Complete only applicable items.*



| 3. Document Identifier: Reference Document 050-PSA-WH00-00200-000-00B | 4. Rev.: 00B | 5. CACN: 001 |
|---|---|---|

6. Title:

Wet Handling Facility Reliability and Event Sequence Categorization Analysis

7. Reason for Change:

- Fault Tree Model for inadvertent movement of the canister transfer machine while the canister is being lifted and moved between floors. This advertent movement can cause shearing of a canister while it is being lifted and is an initiating event in the event tree shown in Figure A5-23. The CTM shield skirt position switch 0112 is verified to work prior to lift. This switch would prevent movement of the CTM shield bell if a spurious signal is produced. The failure mode of this event is a mission time failure (failure to remain functional during required time frame) instead of a demand failure. The failure mode for the switch is erroneously given as failure per demand, "-FOD" in the basic event coding in SAPHIRE with a demand failure probability as 2.93E-04 per demand. The correct failure mode is failure during the time of the lift, which is modeled as "-FOH" in the basic event coding in SAHIRE (time related failure probability as the product of lambda and time). The hourly failure rate is 7.23E-06 and by estimating 6 minutes (0.1 hour) for the lift results in a probability of 7.23E-07.
- Fault Tree Model for loss of ITS electric power coded as an OR gate (ITS-EP-FAILURE) with two inputs: (1) Loss of AC power at Load Center A for the Wet Handling Facility (EP-WHF-A4) and (2) Loss of AC power at Load Center B for the WHF (EP-WHF-B4). The OR gate should be an AND gate. This fault tree does not appear in the write-up presented in the Wet Handling Facility Reliability and Event Sequence Categorization Analysis (050-PSA-WH00-00200-000-00B); however, it is documented in the SAPHIRE model provided in the attached CD.
- Fault Tree Model for loss of ITS distribution electric power for the 720 hrs is different than that of the 24 hrs. The event is coded as NSDB-ITS-DISTRIBUTION. The 720 hrs tree includes extra basic events that the 24 hrs tree does not and should be removed. This fault tree does not appear in the Wet Handling Facility Reliability and Event Sequence Categorization Analysis (050-PSA-WH00-00200-000-00B); however, it is documented in the SAPHIRE model provided in the attached CD..
- Mention of the 24 hour mission time for AC power and HVAC in table 6.9.1 is deleted since the 720 hour mission time is a more restrictive requirement.

| 8. Supersedes Change Notice: | ☐ Yes | If Yes, CACN No.: _____ | ☒ No |
|---|---|---|---|

9. Change Impact:

| | | | | | |
|---|---|---|---|---|---|
| Inputs Changed: | ☐ Yes | ☒ No | Results Impacted: | ☐ Yes | ☒ No |
| Assumptions Changed: | ☐ Yes | ☒ No | Design Impacted: | ☐ Yes | ☒ No |

10. Description of Change:

1. The fault tree model for inadvertent movement of the CTM contains basic event 050-CTM-#ZSH0112-1ZS-FOD that should be coded as 050-CTM-#ZSH0112-1ZS-FOH with a hourly failure rate of 7.23E-06 with a mission time of 6 minutes (0.1 hour). The tables and figures that are impacted are:

   Table 6.3-1 – page 170
   Table B4.4-1 on page B4-23
   Table B4.4-6 on page B4-72
   Figure B4.4-21 on page B4-76
   Figure B4.4-26 on page B4-85
   Figure B4.4-36 on page B4-105
   Figure B4.4-44 – page B4-127
   Table B4.4-12 – page B4-126
   Table B4.4-13 – pages B4-128 and B4-129
   Figure B4.4-47 – page B4-134.

2. Fault Tree Model for loss of ITS electric power coded as an OR gate (ITS-EP-FAILURE) with two inputs: (1) Loss of AC power at Load Center A for the WHF (EP-WHF-A4) and (2) Loss of AC power at Load Center B for the WHF (EP-WHF-B4). The OR gate should be an AND gate. The following fault tree is modified in the attached CD that contains WHF SAPHIRE model.

   Fault Tree entitled "ITS-EP-FAILURE – Loss of AC power on both WHF load centers A and B."
   This fault tree does not appear in the write-up of 050-PSA-WH00-00200-000-00B.

3. Fault Tree Model for loss of ITS distribution electric power for the 720 hrs is different than that of the 24 hrs. The two fault trees should be consistent in logic. The event is coded as NSDB-ITS-DISTRIBUTION. The 720 hrs fault tree includes extra basic events that the 24 hrs tree does not and should be removed from the 720 hrs fault tree. The following fault trees are modified in the attached CD that contains WHF SAPHIRE model:

   Fault Trees Entitled –

   "EP-WHF-A41 – Loss of AC power at Load Center A for the WHF"
   "EP-WHF-COOL-1 – Loss of WHF ventilation to ITS El and Bat Room A"
   "EP-WHF-B41 – Loss of AC power at Load Center B for the WHF"
   "EP-WHF-COOL-2 – Loss of WHF ventilation to ITS El and Bat Room B."

   These fault trees do not appear in the write-up of 050-PSA-WH00-00200-000-00B.

4. In Table 6.9.1, mention of 24 hours is deleted in the following three rows since the 720 hour mission time is a more restrictive requirement:

   Page 260 row 25 controlling parameter
   Page 261 row 26 controlling parameter
   Page 274 row 78 controlling parameter.

**11. REVIEWS AND APPROVAL**

| Printed Name | Signature | Date |
|---|---|---|
| 11a. Originator: H. E. Lambert HOWARD LAMBERT | | 3-20-09 |
| 11b. Checker: N.L. Graves NORMAN L. GRAVES | | 3/20/2009 |
| 11c. EGS: P.T. Le P.T. Le | | 3/20/2009 |
| 11d. DEM: M.V. Frank | M. V. FRANK | 3/20/09 |
| 11e. Design Authority: R.J. Tosetti R.J. Tosetti | | 3/23/09 |

Table 6.3-1. Active Component Reliability Data Summary (Continued)

| Basic Event Name | Basic Event Description | Calc. Type[a] | Basic Event Mean Probability[b] | Mean Failure Rate | Mission Time (Hours) |
|---|---|---|---|---|---|
| 050-CRWT-TRD0003-TRD-FOH | Front Starboard Track Failure | 3 | 5.89E-07 | 5.89E-07 | 1.00E+00 |
| 050-CRWT-TRD0004-TRD-FOH | Rear Starboard Track Failure | 3 | 5.89E-07 | 5.89E-07 | 1.00E+00 |
| 050-CRWT-TRLR-STEER-FAIL | Trailer Steering System Failure | 1 | 1.84E-05 | — | — |
| 050-CTM-##ZE0133-ECP-FOH | Bell/Grapple/Canister Alignment Position Encoder Fails | 3 | 1.43E-05 | 1.79E-06 | 8.00E+00 |
| 050-CTM-##ZI0133-ALM-SPO | Bell/Grapple/Canister Alignment Position Ind Alarm Fails | 3 | 4.74E-07 | 4.74E-07 | 1.00E+00 |
| 050-CTM-##ZS0133-#ZS-FOD | Bell/Grapple/Canister Alignment Limit Switch Fails | 1 | 2.93E-04 | — | — |
| 050-CTM-#ZSH0112-1ZS-FOH | CTM Shield skirt position switch 0112 fails | 3 | 7.23E-07 | 7.23E-06 | 1.00E-01 |
| 050-CTM--121122-ZS--CCF | CCF CTM Upper Limit Position Switches | C | 1.38E-05 | — | — |
| 050-CTM--330121--ZS--FOD | CTM Hoist First Upper Limit Switch 0121 Failure on Demand | 1 | 2.93E-04 | — | — |
| 050-CTM--330122--ZS--FOD | CTM Final Hoist Upper Limit Switch 0122 Failure on Demand | 1 | 2.93E-04 | — | — |
| 050-CTM--CBL0001-WNE-BRK | CTM Hoist Wire Rope Breaks | 1 | 2.00E-06 | — | — |
| 050-CTM--CBL0002-WNE-BRK | CTM Hoist Wire Rope Breaks | 1 | 2.00E-06 | — | — |
| 050-CTM--CBL0102-WNE-CCF | CCF CTM Hoist wire ropes | C | 9.40E-08 | — | — |
| 050-CTM--DRTRN-CT--FOD | Controller Failure | 1 | 4.00E-06 | — | — |
| 050-CTM--DRUM001-DM--FOD | CTM Drum Failure on Demand | 1 | 4.00E-08 | — | — |
| 050-CTM--DRUMBRK-BRP-FOD | CTM Drum Brake (Pneumatic) Failure on Demand | 1 | 5.02E-05 | — | — |
| 050-CTM--DRUMBRK-BRP-FOH | CTM Drum Brake (Pneumatic) Failure | 3 | 2.01E-04 | 8.38E-06 | 2.40E+01 |
| 050-CTM--EQL-SHV-BLK-FOD | CTM Sheaves Failure on Demand | 1 | 1.15E-06 | — | — |
| 050-CTM--GRAPPLE-GPL-FOD | CTM Grapple Failure on Demand | 1 | 1.15E-06 | — | — |
| 050-CTM--HOISTMT-MOE-FTR | CTM Hoist Motor (Electric) Fails to Run | 3 | 6.50E-06 | 6.50E-06 | 1.00E+00 |
| 050-CTM--HOLDBRK-BRK-FOD | CTM Holding Brake Failure on Demand | 1 | 1.46E-06 | — | — |
| 050-CTM--HOLDBRK-BRK-FOH | CTM Holding Brake (Electric) Failure | 3 | 3.52E-05 | 4.40E-06 | 8.00E+00 |

Table 6.9-1. Preclosure Nuclear Safety Design Bases for the WHF ITS SSCs (Continued)

| System or Facility (System Code) | Subsystem or Function (as Applicable)[a] | Component | Nuclear Safety Design Bases | | Representative Event Sequence (Sequence Number) | Source |
|---|---|---|---|---|---|---|
| | | | Safety Function | Controlling Parameters and Values | | |
| **Electrical Power System** | ITS Power | ITS Distribution (Feeders Up to and including ITS Loads, ITS Uninterruptible Power Supply Power) | Provide electrical power to ITS Surface Nuclear Confinement HVAC Systems | 24. The mean conditional probability for ITS electrical power distribution failure shall be less than or equal to $9 \times 10^{-3}$ over a period of 720 hours following the breach of a cask-canister system. | WHF-ESD13-TAD (Seq. 2-5) | NSDB-ITS-DISTRIBUTION |
| | | | | 25. ~~The mean conditional probability for ITS electrical power distribution failure shall be less than or equal to $5 \times 10^{-4}$ over a period of 24 hours following a cask overpressure or a cooling system line break.~~ | ~~WHF-ESD16-CSNF (Seq. 4-3)~~ | ~~NSDB-ITS-DISTRIBUTION-24~~ |
| | | ITS diesel generators (including ITS diesel generator fuel oil system, ITS diesel generator air start system, ITS diesel generator jacket water cooling system, ITS diesel generator lubricating oil system, ITS diesel generator air intake and exhaust system) | Provide electrical power to ITS Surface Nuclear Confinement HVAC Systems | The mean conditional probability for ITS electrical power failure, given the loss of offsite power, shall be less than or equal to $6 \times 10^{-2}$ over a period of 720 hours following a radionuclide release. | WHF-ESD13-TAD (Seq. 2-5) | ITS-EP-FAILURE |

Table 6.9-1. Preclosure Nuclear Safety Design Bases for the WHF ITS SSCs (Continued)

| System or Facility (System Code) | Subsystem or Function (as Applicable)[a] | Component | Nuclear Safety Design Bases | | Representative Event Sequence (Sequence Number) | Source |
|---|---|---|---|---|---|---|
| | | | Safety Function | Controlling Parameters and Values | | |
| ~~**Electrical Power System (Continued)**~~ | ~~ITS Power (Continued)~~ | ~~ITS diesel generators (Continued)~~ | ~~Provide electrical power to ITS Surface Nuclear Confinement HVAC Systems~~ | 26. ~~The mean conditional probability for ITS electrical power failure, given the loss of offsite power, shall be less than or equal to $2 \times 10^{-4}$ over a period of 24 hours following a cask overpressure or a cooling system line break.~~ | ~~WHF-ESD16-CSNF (Seq. 4-3)~~ | ~~ITS-EP-FAILURE-24HR~~ |
| **Fire Protection System** | Fire Suppression | Preaction valves, sprinkler heads, and system actuation panels associated with double-interlock preaction suppression systems that protect areas where there is a potential for canister breach | Maintain moderator control | 27. The mean probability of inadvertent introduction of fire suppression water into a canister shall be less than or equal to $6 \times 10^{-7}$ over a 720 hour period following a radionuclide release. | WHF-ESD02-DPC (Seq. 3-5) | 050-WATER-FIRE-SUPPRESS |
| | Fire Detection | Fire detection system for the ITS preaction valves with associated detectors and control box | Maintain moderator control | 28. The mean probability of inadvertent introduction of fire suppression water into a canister shall be less than or equal to $6 \times 10^{-7}$ over a 720 hour period following a radionuclide release. | WHF-ESD02-DPC (Seq. 3-5) | 050-WATER-FIRE-SUPPRESS |

Table 6.9-1. Preclosure Nuclear Safety Design Bases for the WHF ITS SSCs (Continued)

| System or Facility (System Code) | Subsystem or Function (as Applicable)[a] | Component | Nuclear Safety Design Bases | | Representative Event Sequence (Sequence Number) | Source |
|---|---|---|---|---|---|---|
| | | | Safety Function | Controlling Parameters and Values | | |
| ~~**Surface Nuclear Confinement HVAC System (Continued)**~~ | ~~Surface Nuclear Confinement HVAC (Continued)~~ | ~~Portions of the surface nuclear confinement HVAC system that support the cooling of ITS electrical equipment and battery rooms (Continued)~~ | ~~Support ITS electrical function (Continued)~~ | 78. ~~The mean conditional probability of failure of the portions of the surface nuclear confinement HVAC system that support the cooling of ITS electrical equipment and battery rooms in the WHF shall be less than or equal to $5 \times 10^{-4}$ per ITS electrical train over a period of 24 hours following a cask overpressure or a cooling system line break.~~ | ~~WHF-ESD16-CSNF (Seq. 4-3)~~ ? | ~~EP-WHF-COOL-1-24 and EP-WHF-COOL-2-24~~ |
| **Surface Non-Confinement HVAC System** | Surface Non-Confinement HVAC | Portions of the surface non-confinement HVAC system that support the cooling of ITS electrical equipment and battery rooms | Support ITS electrical function | 79. The mean conditional probability of failure of the portions of the surface non-confinement HVAC system that support the cooling of ITS electrical equipment and battery rooms in the EDGF shall be less than or equal to $2 \times 10^{-2}$ per ITS electrical train over a period of 720 hours following a radionuclide release. | WHF-ESD16-CSNF (Seq. 2-5) | EP-WHF-COOL-1 and EP-WHF-COOL-2 |

Table B4.4-1. Basic Event Probability for the CTM Canister Drop from Below Canister Drop Height Limit Fault Tree

| Name | Description | Calculation Type[a] | Calculation Probability | Failure Probability | Lambda | Mission Time[a] |
|---|---|---|---|---|---|---|
| 050-CTM-#ZSH0112-1ZS-FOH | CTM Shield skirt position switch 0112 fails | 3 | 7.230E-07 | — | 7.230E-06 | 1.000E-01 |
| 050-CTM--CBL0001-WNE-BRK | CTM hoist wire rope Breaks | 1 | 2.000E-06 | 2.000E-06 | — | — |
| 050-CTM--CBL0002-WNE-BRK | CTM hoist wire rope Breaks | 1 | 2.000E-06 | 2.000E-06 | — | — |
| 050-CTM--CBL0102-WNE-CCF | CCF CTM Hoist wire ropes | C | 9.400E-08 | — | — | — |
| 050-CTM--DRTRN-CT--FOD | Controller Failure | 1 | 4.000E-06 | 4.000E-06 | — | — |
| 050-CTM--DRUM001-DM--FOD | CTM Drum Failure on Demand | 1 | 4.000E-08 | 4.000E-08 | — | — |
| 050-CTM--DRUMBRK-BRP-FOD | CTM Drum Brake (Pneumatic) Failure on Demand | 1 | 5.020E-05 | 5.020E-05 | — | — |
| 050-CTM--DRUMBRK-BRP-FOH | CTM Drum Brake (Pneumatic) Failure | 3 | 2.011E-04 | — | 8.380E-06 | 2.400E+01 |
| 050-CTM--EQL-SHV-BLK-FOD | CTM Sheaves Failure on Demand | 1 | 1.150E-06 | 1.150E-06 | — | — |
| 050-CTM--GRAPPLE-GPL-FOD | CTM Grapple Failure on Demand | 1 | 1.150E-06 | 1.150E-06 | — | — |
| 050-CTM--HOISTMT-MOE-FTR | CTM Hoist Motor (Electric) Fails to Run | 3 | 6.500E-06 | — | 6.500E-06 | 1.000E+00 |
| 050-CTM--HOLDBRK-BRK-FOD | CTM Holding Brake Failure on Demand | 1 | 1.460E-06 | 1.460E-06 | — | 1.000E+00 |
| 050-CTM--HOLDBRK-BRK-FOH | CTM Holding Brake (Electric) Failure | 3 | 3.520E-05 | — | 4.400E-06 | 8.000E+00 |
| 050-CTM--IMEC125-IEL-FOD | CTM Hoist Motor Control Interlock Failure on Demand | 1 | 2.750E-05 | 2.750E-05 | — | — |
| 050-CTM--LOWERBL-BLK-FOD | CTM Lower Sheaves Failure on Demand | 1 | 1.150E-06 | 1.150E-06 | — | — |
| 050-CTM--OVERSP--ZS--FOD | CTM Hoist motor speed Limit Switch Failure on Demand | 1 | 2.930E-04 | 2.930E-04 | — | — |
| 050-CTM--PORTGT1-MOE-SPO | Port Gate Motor 1 (Electric) Spurious Operation | 3 | 6.740E-07 | — | 6.740E-07 | 1.000E+00 |
| 050-CTM--PORTGT1-PLC-SPO | Port Gage 1 PLC Spurious Operation | 3 | 3.650E-07 | — | 3.650E-07 | 1.000E+00 |
| 050-CTM--PORTGT2-MOE-SPO | Port Gate Motor 2 (Electric) Spurious Operation | 3 | 6.740E-07 | — | 6.740E-07 | 1.000E+00 |
| 050-CTM--PORTGT2-PLC-SPO | Port Gage 2 PLC Spurious Operation | 3 | 3.650E-07 | — | 3.650E-07 | 1.000E+00 |
| 050-CTM--SLIDEGT-MOE-SPO | CTM Slide Gate Motor (Electric) Spurious Operation | 3 | 6.740E-07 | — | 6.740E-07 | 1.000E+00 |
| 050-CTM--SLIDEGT-PLC-SPO | CTM Slide Gate PLC Spurious Operation | 3 | 3.650E-07 | — | 3.650E-07 | 1.000E+00 |
| 050-CTM--SLIDGT2-IEL-FOD | CTM Slide Gate Interlock Failure | 1 | 2.750E-05 | 2.750E-05 | — | — |
| 050-CTM--TROLLY-MOE-SPO | Motor (Electric) Spurious Operation | 3 | 6.740E-07 | — | 6.740E-07 | 1.000E+00 |
| 050-CTM--UPPERBL-BLK-FOD | CTM Upper Sheaves Failure on Demand | 1 | 1.150E-06 | 1.150E-06 | — | — |

Table B4.4-6. Basic Event Probability for the CTM Drop of Objects onto Canister Fault Tree

| Name | Description | Calculation Type[a] | Calculation Probability | Failure Probability | Lambda | Mission Time[a] |
|---|---|---|---|---|---|---|
| 050-CTM-#ZSH0112-1ZS-FOH | CTM Shield skirt position switch 0112 fails | 3 | 7.230E-07 | — | 7.230E-06 | 1.000E-01 |
| 050-CTM--121122-ZS--CCF | CCF CTM upper limit postion switches | C | 1.377E-05 | — | — | — |
| 050-CTM--330121--ZS--FOD | CTM Hoist First Upper Limit Switch 0121 Failure on Demand | 1 | 2.930E-04 | 2.930E-04 | — | — |
| 050-CTM--330122--ZS--FOD | CTM Final Hoist Upper Limit Switch 0122 Failure on Demand | 1 | 2.930E-04 | 2.930E-04 | — | — |
| 050-CTM--CBL0001-WNE-BRK | CTM hoist wire rope Breaks | 1 | 2.000E-06 | 2.000E-06 | — | — |
| 050-CTM--CBL0002-WNE-BRK | CTM hoist wire rope Breaks | 1 | 2.000E-06 | 2.000E-06 | — | — |
| 050-CTM--CBL0102-WNE-CCF | CCF CTM Hoist wire ropes | C | 9.400E-08 | 9.400E-08 | — | — |
| 050-CTM--DRTRN-CT--FOD | Controller Failure | 1 | 4.000E-06 | 4.000E-06 | — | — |
| 050-CTM--DRUM001-DM--FOD | CTM Drum Failure on Demand | 1 | 4.000E-08 | 4.000E-08 | — | — |
| 050-CTM--DRUMBRK-BRP-FOD | CTM Drum Brake (Pneumatic) Failure on Demand | 1 | 5.020E-05 | 5.020E-05 | — | — |
| 050-CTM--DRUMBRK-BRP-FOH | CTM Drum Brake (Pneumatic) Failure | 3 | 2.011E-04 | — | 8.380E-06 | 2.400E+01 |
| 050-CTM--EQL-SHV-BLK-FOD | CTM Sheaves Failure on Demand | 1 | 1.150E-06 | 1.150E-06 | — | — |
| 050-CTM--GRAPPLE-GPL-FOD | CTM Grapple Failure on Demand | 1 | 1.150E-06 | 1.150E-06 | — | — |
| 050-CTM--HOISTMT-MOE-FTR | CTM Hoist Motor (Electric) Fails to Run | 3 | 6.500E-06 | — | 6.500E-06 | 1.000E+00 |
| 050-CTM--HOLDBRK-BRK-FOD | CTM Holding Brake Failure on Demand | 1 | 1.460E-06 | 1.460E-06 | — | — |
| 050-CTM--HOLDBRK-BRK-FOH | CTM Holding Brake (Electric) Failure | 3 | 3.520E-05 | — | 4.400E-06 | 8.000E+00 |
| 050-CTM--IMEC125-IEL-FOD | CTM Hoist Motor Control Interlock Failure on Demand | 1 | 2.750E-05 | 2.750E-05 | — | — |
| 050-CTM--LOWERBL-BLK-FOD | CTM Lower Sheaves Failure on Demand | 1 | 1.150E-06 | 1.150E-06 | — | — |
| 050-CTM--OVERSP--ZS--FOD | CTM Hoist motor speed Limit Switch Failure on Demand | 1 | 2.930E-04 | 2.930E-04 | — | — |

**Uncertainty Results**

| | | | |
|---|---|---|---|
| Name | CTM-DROP-ONTO-CASK | | |
| Random Seed | 1234 | Events | 53 |
| Sample Size | 10000 | Cut Sets | 84 |
| Point estimate | | | 1.415E-005 |
| Mean Value | | | 1.415E-005 |
| 5th Percentile Value | | | 4.809E-006 |
| Median Value | | | 1.166E-005 |
| 95th Percentile Value | | | 3.099E-005 |
| Minimum Sample Value | | | 1.345E-006 |
| Maximum Sample Value | | | 3.387E-004 |
| Standard Deviation | | | 1.070E-005 |
| Skewness | | | 6.321E+000 |
| Kurtosis | | | 1.163E+002 |
| Elapsed Time | | | 00:00:02.660 |

OK

1.484
1.413

Source: Original

Figure B4.4-21. Uncertainty Results of the "CTM Drop onto Canister" Fault Tree

**Cut Set Generation Results**

Name: CTM-DROP-ONTO-CASK
Elapsed Time: 00:00:00.020

| Cut Size | # | minCut |
|---|---|---|
| 1 | 12 | 9.716E-006 |
| 2 | 46 | 4.428E-006 |
| 3 | 26 | 3.547E-009 |
| 4 | 0 | ------E---- |
| 5 | 0 | ------E---- |
| 6 | 0 | ------E---- |
| 7 | 0 | ------E---- |
| 8 | 0 | ------E---- |
| 9 | 0 | ------E---- |
| 10 | 0 | ------E---- |
| >10 | 0 | ------E---- |
| Total | 84 | 1.415E-005 |

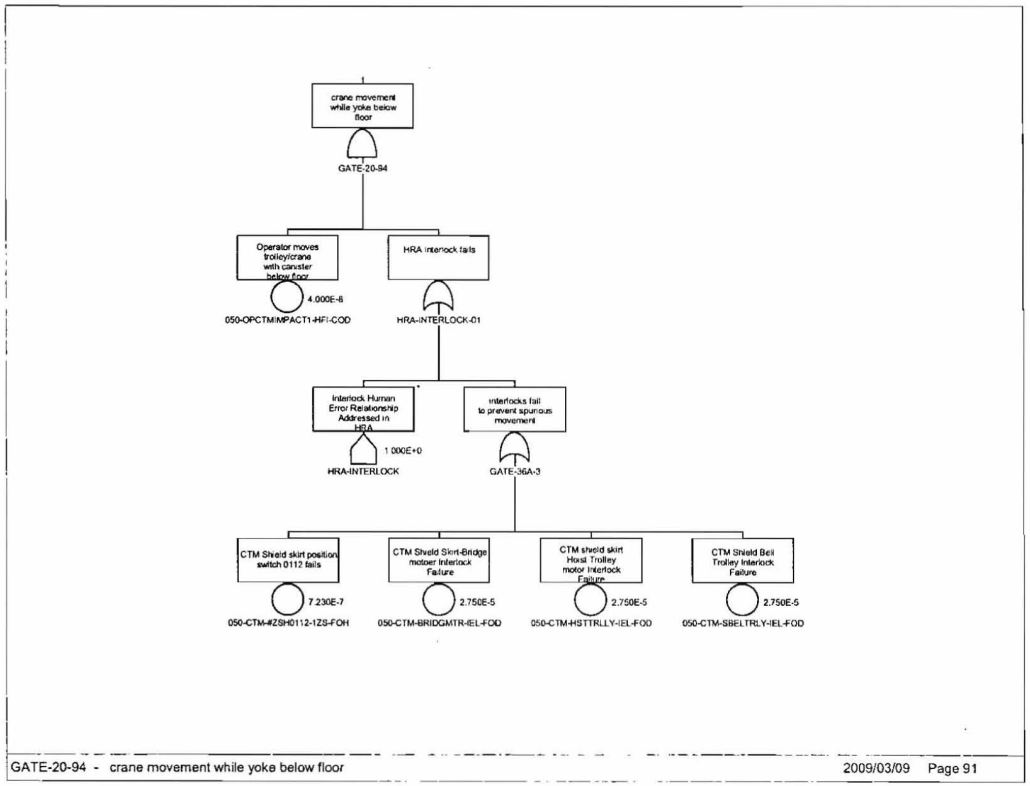
Total Elapsed Time : 00:00:00.030

OK View Results

1.414

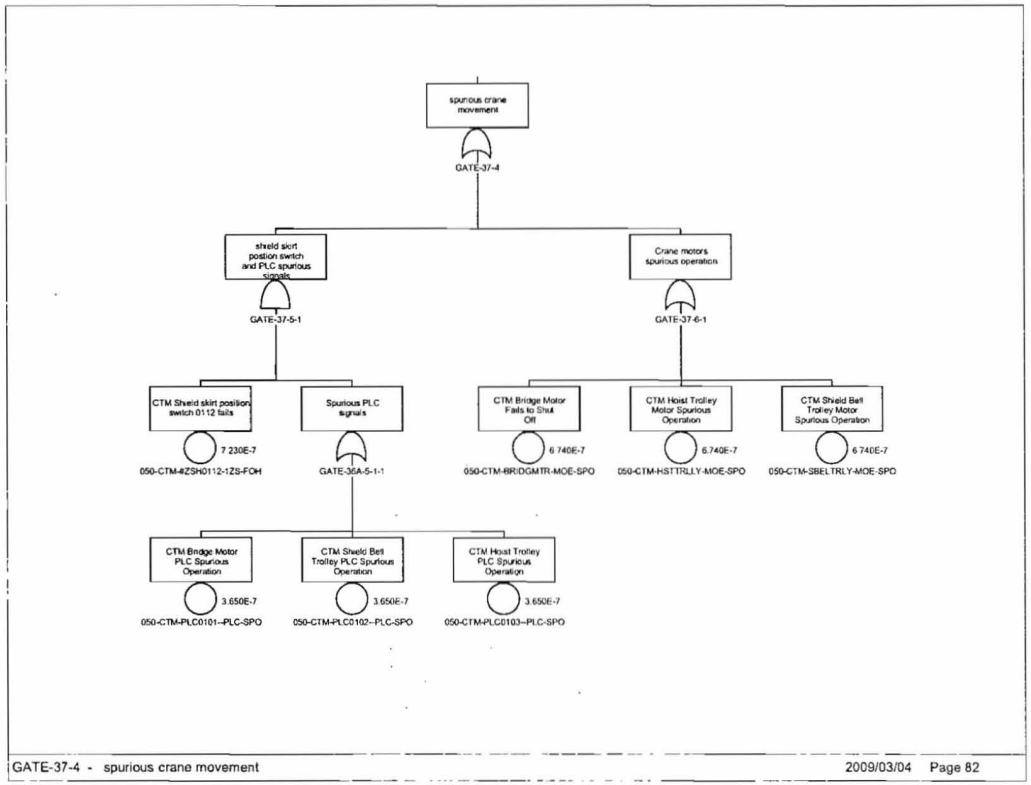
Source: Original

Figure B4.4-22. Cut Set Generation Results for the "CTM Drop onto Canister" Fault Tree




Source: Original

Figure B4.4-26. Drop of Object onto Cask
Sheet 4




Source: Original

Figure B4.4-36. Spurious Crane Movement

Table B4.4-12. Basic Event Probability for the CTM Fault Trees

| Name | Description | Calculation Type[a] | Calculation Probability | Failure Probability | Lambda | Mission Time[a] |
|---|---|---|---|---|---|---|
| 050-CTM-#ZSH0112-1ZS-FOH | CTM Shield skirt position switch 0112 fails | 3 | 7.230E-07 | — | 7.230E-06 | 1.000E-01 |
| 050-CTM-BIDGMTR-#TL-FOH | CTM Bridge motor Torque limiter Failure | 3 | 2.856E-02 | — | 8.050E-05 | 3.600E+02 |
| 050-CTM-BRIDGMTS-MOE-SPO | CTM Bridge Motor (Electric) Spurious Operation -shear | 3 | 6.740E-08 | — | 6.740E-07 | 1.000E-01 |
| 050-CTM-HSTTRLLS-MOE-SPO | CTM Hoist Trolley Motor (Electric) Spurious Operation m- shear | 3 | 6.740E-08 | — | 6.740E-07 | 1.000E-01 |
| 050-CTM-HSTTRLLY-#TL-FOH | CTM Hoist motorTorque limiter Failure | 3 | 2.856E-02 | — | 8.050E-05 | 3.600E+02 |
| 050-CTM-PLC0101S-PLC-SPO | CTM Bridge Motor PLC Spurious Operation - shear | 3 | 3.650E-08 | — | 3.650E-07 | 1.000E-01 |
| 050-CTM-PLC0102S-PLC-SPO | CTM Shield Bell Trolley PLC Spurious Operation -shear | 3 | 3.650E-08 | — | 3.650E-07 | 1.000E-01 |
| 050-CTM-PLC0103S-PLC-SPO | CTM Hoist Trolley PLC Spurious Operation - shear | 3 | 3.650E-08 | — | 3.650E-07 | 1.000E-01 |
| 050-CTM-SBELTRLS-MOE-SPO | CTM shield Bell trolley Motor (Electric) spurious operation-shear | 3 | 6.740E-08 | — | 6.740E-07 | 1.000E-01 |
| 050-CTM-SBELTRLY-#TL-FOH | CTM Shield Bell MotorTorque limiter Failure | 3 | 2.856E-02 | — | 8.050E-05 | 3.600E+02 |
| 050-OPCTMIMPACT1-HFI-COD | Operator moves trolley/crane with canister below floor | 1 | 4.000E-08 | 4.000E-08 | — | — |

NOTE: [a]For Calc. Type 3 with a mission time of 0, SAPHIRE performs the quantification using the system mission time.

CTM = canister transfer machine; PLC = programmable logic controller.

Source: Original

#### B4.4.5.5.1 Human Failure Events

One basic event is associated with human error: 050-OPCTMIMPACT1-HFI-COD (operator moves trolley/crane with canister below floor). This event addresses the possible operator initiated movement of the bridge or trolleys while a canister is being lifted and is between WHF floors. This event was quantified using a detailed HRA that includes the human actions and the operation of interlocks intended to prevent erroneous actions.

#### B4.4.5.5.2 Common-Cause Failures

No CCFs apply to this fault tree.

### B4.4.5.6 Uncertainty and Cut Set Generation

Figure B4.4-44 contains the uncertainty results obtained from running the fault trees for the CTM-SHEAR using a cutoff at 1E-15. Figure B4.4-45 provides the cut set generation results for the CTM-SHEAR fault tree.

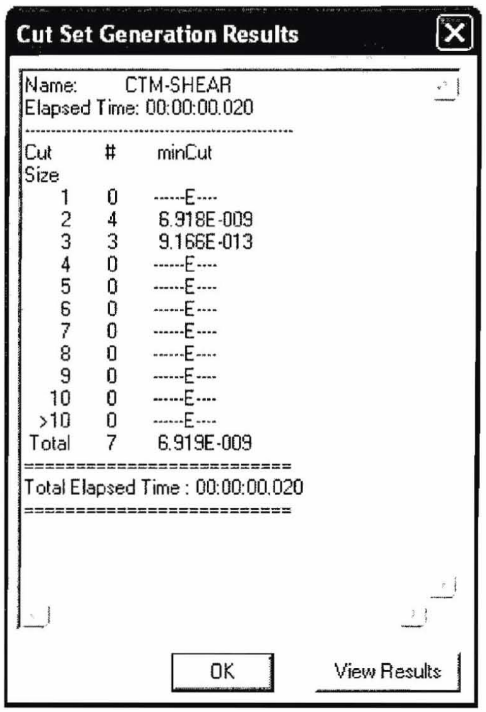
**Uncertainty Results**

| | | | |
|---|---|---|---|
| Name | CTM-SHEAR | | |
| Random Seed | 1234 | Events | 11 |
| Sample Size | 10000 | Cut Sets | 7 |
| Point estimate | | | 6.918E-009 |
| Mean Value | | | 6.739E-009 |
| 5th Percentile Value | | | 5.109E-010 |
| Median Value | | | 3.120E-009 |
| 95th Percentile Value | | | 2.257E-008 |
| Minimum Sample Value | | | 3.093E-011 |
| Maximum Sample Value | | | 4.229E-007 |
| Standard Deviation | | | 1.409E-008 |
| Skewness | | | 1.118E+001 |
| Kurtosis | | | 2.212E+002 |
| Elapsed Time | | | 00:00:00.950 |

OK

Source: Original

Figure B4.4-44. Uncertainty Results of the "CTM Shear" Fault Tree



Cut Set Generation Results

```
Name:        CTM-SHEAR
Elapsed Time: 00:00:00.020
-----------------------------------------
Cut      #      minCut
Size
   1     0      ------E----
   2     4       6.918E-009
   3     3       9.166E-013
   4     0      ------E----
   5     0      ------E----
   6     0      ------E----
   7     0      ------E----
   8     0      ------E----
   9     0      ------E----
  10     0      ------E----
 >10     0      ------E----
Total    7       6.919E-009
==========================
Total Elapsed Time : 00:00:00.020
==========================
```

OK  View Results

Source: Original

Figure B4.4-45. Cut Set Generation Results for the "CTM Shear" Fault Tree

### B4.4.4.7 Cut Sets

Table B4.4-13 contains the cut sets for the "CTM Shear" fault tree.

Table B4.4-13. Dominant Cut Sets for the CTM Shear Fault Tree

| % Total | % Cut Set | Probability/ Frequency | Basic Event | Description | Event Probability |
|---|---|---|---|---|---|
| 27.832 | 27.832 | 1.925E-09 | 050-CTM-SBELTRLS-MOE-SPO | CTM shield Bell trolley Motor (Electric) spurious operation-shear | 6.740E-08 |
| | | | 050-CTM-SBELTRLY-#TL-FOH | CTM Shield Bell MotorTorque limiter Failure | 2.856E-02 |
| 55.664 | 27.832 | 1.925E-09 | 050-CTM-HSTTRLLS-MOE-SPO | CTM Hoist Trolley Motor (Electric) Spurious Operation m- shear | 6.740E-08 |
| | | | 050-CTM-HSTTRLLY-#TL-FOH | CTM Hoist motorTorque limiter Failure | 2.856E-02 |
| 83.496 | 27.82 | 1.925E-09 | 050-CTM-BIDGMTR-#TL-FOH | CTM Bridge motor Torque limiter Failure | 2.856E-02 |
| | | | 050-CTM-BRIDGMTS-MOE-SPO | CTM Bridge Motor (Electric) Spurious Operation -shear | 6.740E-08 |
| 100.00 | 16.51 | 1.143E-09 | 050-CTM-HSTTRLLY-#TL-FOH | CTM Hoist motorTorque limiter Failure | 2.856E-02 |
| | | | 050-OPCTMIMPACT1-HFI-COD | Operator moves trolley/crane with canister below floor | 4.000E-08 |

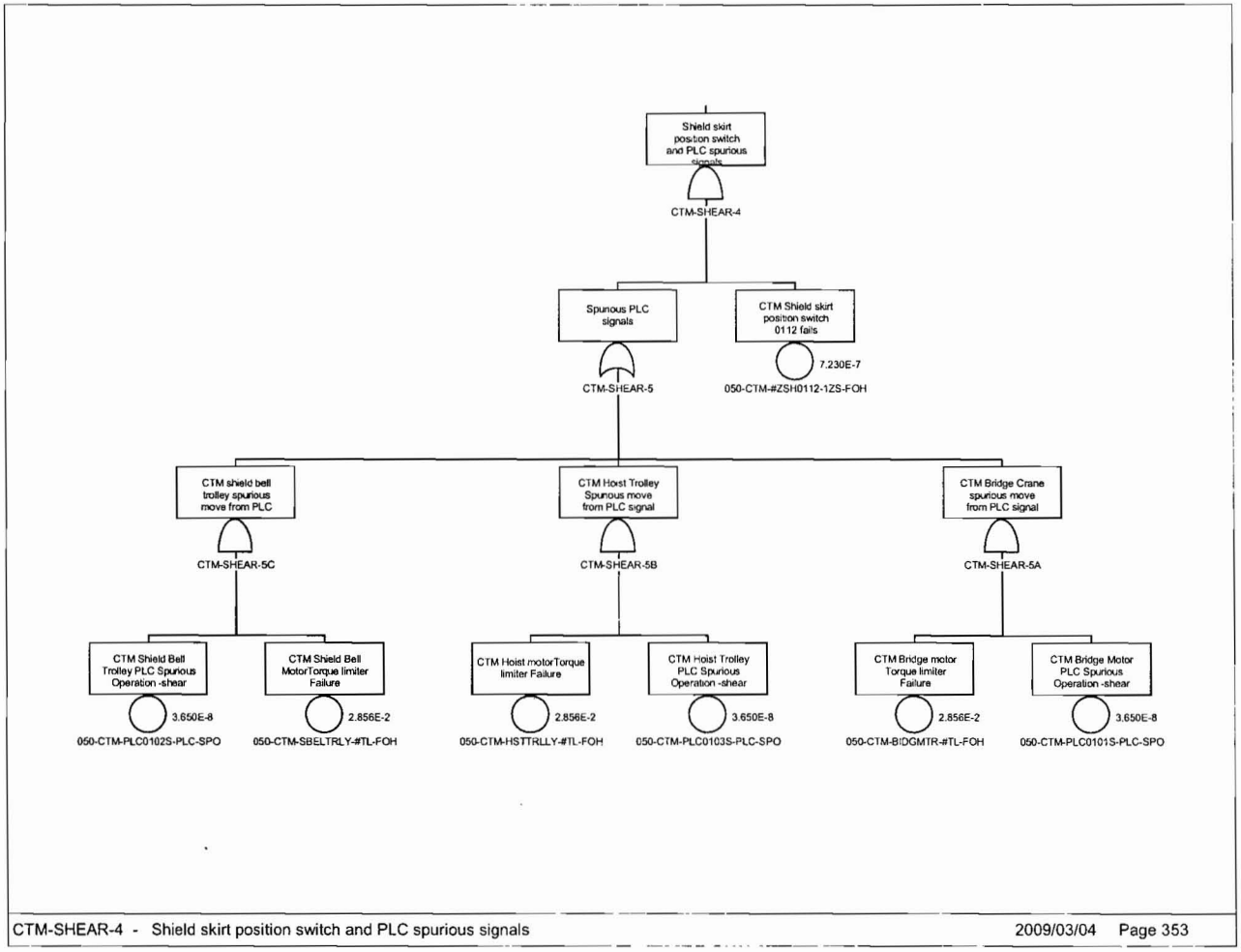
Table B4.4-13. Dominant Cut Sets for the CTM Shear Fault Tree (Continued)

| % Total | % Cut Set | Probability/ Frequency | Basic Event | Description | Event Probability |
|---|---|---|---|---|---|
| 100.00 | 0.00 | 7.538E-016 | 050-CTM-#ZSH0112-1ZS-FOH | CTM Shield skirt position switch 0112 fails | 2.930E-04 |
| | | | 050-CTM-BIDGMTR-#TL-FOH | CTM Bridge motor Torque limiter Failure | 2.856E-02 |
| | | | 050-CTM-PLC0101S-PLC-SPO | CTM Bridge Motor PLC Spurious Operation -shear | 3.650E-08 |
| 100.00 | 0.00 | 7.538E-016 | 050-CTM-#ZSH0112-1ZS-FOH | CTM Shield skirt position switch 0112 fails | 2.930E-04 |
| | | | 050-CTM-HSTTRLLY-#TL-FOH | CTM Hoist motorTorque limiter Failure | 2.856E-02 |
| | | | 050-CTM-PLC0103S-PLC-SPO | CTM Hoist Trolley PLC Spurious Operation -shear | 3.650E-08 |
| 100.00 | 0.00 | 7.538E-016 | 050-CTM-#ZSH0112-1ZS-FOH | CTM Shield skirt position switch 0112 fails | 2.930E-04 |
| | | | 050-CTM-PLC0102S-PLC-SPO | CTM Shield Bell Trolley PLC Spurious Operation -shear | 3.650E-08 |
| | | | 050-CTM-SBELTRLY-#TL-FOH | CTM Shield Bell MotorTorque limiter Failure | 2.856E-02 |

NOTE: CTM = canister transfer machine; PLC = programmable logic controller.

Source: Original

### B4.4.5.8 Fault Tree




Source: Original

Figure B4.4-47. CTM Shear Sheet 2