APPENDIX D
Determination of Frequencies for Selected Accidents

Table D-1, Documentation of Basic Event Variables Used in the Quantification of CH Waste Accident Frequencies

ID	Description	Value	Units	Source/Comments
f_crane_drop	WHB 6 Ton crane drop accident rate per lift.	3.4E-06	/lift	WIPP/WID-96-2196, October 1996, Waste Isolation Pilot Plant, TRUDOCK Crane System Analysis. Dominant failure modes are hook/cable failure and human error. Drop due to loss of power to crane at 4.3E-01/yr and brake failure is a very small contributor.
f_forklift_coll_site	Frequency of forklift equipment failures producing waste container punctures, considering all the forklift operations accomplished during a typical operational year at a typical operational DOE site.	1.3E-02	/site-year	INEL-94/0228, Table B-1, p. B-10. Estimate based on very broad arguments on a site wide basis. This value forms the basis for frequency of forklift collisions per operating hour, f_forklift_op
f_forklift_coll	Frequency of forklift hardware failures (brake failure, accelerator stuck) resulting in collisions with waste drum packages during waste handling operations.	2.6E-06	/op hr	Scoping estimate based on estimate of a typical site year. = f_forklift_coll_site/ (10 forklifts * 2000 operational hours/year * 25% usage factor for each forklift). At WIPP pre-operational checks are accomplished before each shift.
f_forklift_drop_site	Frequency of forklift equipment failures producing waste container drops, considering all the forklift operations accomplished during a typical operational year at a typical operational DOE site.	4.3E-03	/site-year	INEL-94/0228, Table B-1, p. B-10. Estimate based on very broad arguments on a site wide basis.
f_forklift_drop	Frequency of forklift hardware failures (lifting mechanism, suspension, structure) resulting in drops of waste drum packages during waste handling operations.	8.6E-07	/op hr	Scoping estimate based on estimate of a typical site year. = f_forklift_drop_site/ (10 forklifts * 2000 operational hours/year * 25% usage factor for each forklift). At WIPP pre-operational checks are accomplished before each shift.
f_hoist_brake	Failure of hoist braking system, given loss of power to hoist lifting equipment.	1.3E-07	/demand	WIPP/WID-96-2178, Rev 0, WIPP Waste Hoist Brake System Analysis, Average unavailability of brake system based on anticipated annual usage, (see p. A3-18 of report for top event unavailability definition)
f_ign_est	Spontaneous ignition rate for non-WAC verified and non-process specific waste, based on WIPP interpretation of DOE experience	5.3E-05	$/m^3$-yr	Based on applicable experience since 1970. Refer to Tables D-2 and D-3 for evidence used to estimate this frequency.
f_LOSP	Frequency of loss of off-site power to the WIPP site	2.2E-01	/year	Based on 3 events at the WIPP site during the past 13 years. Refer to Table D-12 for evidence used to estimate this frequency.
f_Loss_pwr_hoist	Frequency of loss of on-site power distribution to critical lifting equipment, e.g. the hoist and 6-ton crane.	4.3E-01	/year	Based on 3 LOSP and 3 onsite losses during past 13 years. Refer to Table D-12 for evidence used to estimate this frequency.

Table D-1, Documentation of Basic Event Variables Used in the Quantification of CH Waste Accident Frequencies

ID	Description	Value	Units	Source/Comments
f_roof_hardware	Mechanical failure of either the bolts or resin. As the hardware is straightforward and represents mature technology the likelihood of failure is judged to be dominated by the delivery of flawed materials that are not detected.	1.0E-03	/room	Estimate based on errors during both manufacturing and acceptance of materials. Use product of NUREG/CR-1278, error of omission, Table 20-6, (1) for manufacture and H_check for acceptance to estimate an upper bound.
f_roof_unk	Roof Fall Due to Unanticipated / Unobservable Failure Mechanisms This models the estimated frequency of a roof fall without any prior indications in monitored drifts.	2.6E-05	/year	Refer to the discussion in SAR Section 5.2, CH11 Underground Roof Fall, Roof Fall Initiating Event, Unanticipated/Unobservable Mechanisms. (Estimate shown is the mean value of lognormal distribution with median = 1E-05 and RF = 10)
Factor_events_cor	Correction factor to account for the less than complete detectability of spontaneous ignition events within drums in interim storage..	10		See Section 5.2.3.1 and Table D-2 for a discussion of the evidence and reasoning for the selection of this correction factor.
H_check	HEP for Checker Fail to Detect Operator Error, given not completely independent in time, no immediate safety concerns	1.0E-01	/demand	NUREG/CR-1278, Table 20-22, Item (1), median value
H_com	HEP for commission of error in accomplishing clear and unambiguous tasks	1.0E-03	/demand	NUREG/CR-1278, Inferred from median values HEPs of errors of commission normally associated with clear and unambiguous tasks: Table 20-10, Items (2)&(6); Table 20-11, Items (1)&(2); Table 20-12, Items (3)&(9), Table 20-13 Item (1)
H_filter_UG1	HEP for failure to transfer to underground filtration mode, given a release of TRU waste in the underground during active emplacement of waste. Approximately 2 minutes available to act before material transits from U/G to the surface.	1.0E-01	/demand	WSRC-TR-93-5816, Action 2. Estimate for failure take immediate action. A potential release is considered a compelling signal to act. High mean value selected, because of the potential for injuries compete for attention and limited time.
H_filter_UG2	HEP for failure to transfer to underground filtration mode, given a release of TRU waste in the underground following sustained combustion in a drum. Approximately 2 minutes available to act before material transits from U/G to the surface.	1.0E+00	/demand	Due to the difficulty in detecting and recognizing this event when it occurs within the drum stack, no credit is taken for manual shift to filtration before a significant portion of the release occurs.
H_forklift_drop	HEP for failure to control a forklift during a waste handling operations, resulting in a drop	1.0E-05	/operation	WSRC-TR-93-5816. Action 25. Low value used because the forklift is used in a consistent and repetitious manner for waste transfers, and favorable working conditions must exist for waste handling operations to proceed.

Table D-1, Documentation of Basic Event Variables Used in the Quantification of CH Waste Accident Frequencies

ID	Description	Value	Units	Source/Comments
H_forklift_punct	HEP for failure to control a forklift during a waste handling operations, resulting in a puncture	5.0E-06	/operation	WSRC-TR-93-5816. Action 26. Low value used because the forklift is used in a consistent and repetitious manner for waste transfers, and favorable working conditions must exist for waste handling operations to proceed.
H_High_dep	Conditional failure likelihood to accomplish a subsequent action, given high dependence with failure of a previous task.	5.0E-01	/demand	NUREG/CR-1278, Table 20-18
H_WAC_generic	HEP for failure to verify that drum conforms to WAC - unrepackaged stored waste, generic process	1.0E-01	/demand	Estimate derived from consideration of that failure requires a combination of administrative errors, or errors of omission and/or commission during routine actions.
H_WAC_new	HEP for failure to verify that drum conforms to WAC - wastes that will generated in the future	1.0E-04	/demand	Estimate based on judgement that future generation processes will be subject to close control and checking. See discussion of likelihood for accident CH1 in Section 5.2.3.1 of the SAR for full justification.
H_WAC_repack	HEP multiplier for failure to verify that drum conforms to WAC - wastes that will repackaged prior to shipment to WIPP	1.0E-01	None	Estimate based on reasoning similar to NUREG-1278, Table 20-22, Item (1). Repackaging reduces fraction of unverified drums by a factor associated with checking routine tasks with written materials.
L_combust_gen	Likelihood that sufficient combustibles will be available within a waste drum to support a sustained	1.0E+00	/event	It is assumed that if a drum ignites there will be sufficient combustibles to generate enough energy breach the drum.
L_drum_15	Likelihood that at least one drum is breached, given 7-pack fall from 15 feet	1.0E+00	/event	Ref.: Deremer, K. PLG-1121. Drum is part of stacked seven packs and may be crushed by weight of other drums. All mechanisms considered, including lid dislodgment. No credit for shrink wrap.
L_drum_10	Likelihood that at least one drum is breached, given dual 7-pack fall from 10 feet.	6.2E-01	/event	Ref.: Deremer, K. PLG-1121. Drum is part of stacked seven packs and may be crushed by weight of other drums. All mechanisms considered, including lid dislodgment. No credit for shrink wrap.
L_drum_07	Likelihood that at least one drum is breached, given 7-pack fall from 7 feet.	3.0E-01	/event	Ref.: Deremer, K. PLG-1121. Drum is part of a seven pack and may be crushed by weight of other drums. All mechanisms considered, including lid dislodgment. No credit for shrink wrap.
L_drum_05	Likelihood that at least one drum is breached, given 7-pack fall from 5 feet.	8.5E-02	/event	Ref.: Deremer, K. PLG-1121. Drum is part of a seven pack and may be crushed by weight of other drums. All mechanisms considered, including lid dislodgment. No credit for shrink wrap.
L_drum_punct	Likelihood that a drum is punctured, given that forklift tines collides with it at one of a spectrum of operational speeds.	1.0E+00	/collision	Worst case assumption based on use of WSRC-TR-93-5816, Action 26, for human error for puncture. That variable assumes that puncture is achieved.

Table D-1, Documentation of Basic Event Variables Used in the Quantification of CH Waste Accident Frequencies

ID	Description	Value	Units	Source/Comments
L_filter_UG1	Likelihood of failure to auto-transfer to underground filtration mode, given a puff release of TRU waste in the underground	1.0E+00	/demand	Worst Case Assumption. No credit taken for the ability of the time integrated control logic to prevent a puff release.
L_filter_UG2	Likelihood of failure to auto-transfer to underground filtration mode, given a gradual release of TRU waste in the underground	1.0E+00	/demand	Worst Case Assumption. No credit taken for autoshift, because approximately 13 minutes required between time of first detection at station A and actual shift to filtration.
L_filter_WHB	Likelihood the on-line HEPA filter is open or bypassed, given a release of TRU waste in the WHB, and is therefore unavailable to accomplish its function. (Primary cause is human error that leaves the HEPA filter in an undetected bypassed condition.)	1.0E-04	/event	This condition requires alignment error at the filter and lack of monitoring by the CMRO. Given the HEPA filter is required to be online and the delta-p across the HEPA filter is monitored in the CMR, the estimate is judged to be conservative.
L_oxidant	Likelihood that sufficient oxidant will be available within a waste drum to support a sustained fire	4.2E-03	/event	DOE/WIPP 87-005, p. 39. See SAR Section 5.2.
N_7pack_wk	Throughput for CH waste per week (4ea 7packs/ facility pallet * 7 facility pallets per day * 4 days/ week.)	112	/week	Ref.: SAR Section 4.3.1, which references statement by the RCRA permit. **This basic event controls all the CH waste handling rates quantified in the accident analysis.**
N_7pack_yr	Number of equivalent 7-packs placed per year (= N_7pack_wk * 52 weeks)	5,824	/year	Ref.: SAR Section 4.3.1. The waste handling rate used for accident analysis is based on the maximum planned throughput. The 25% contingency estimated for maintenance and transition time from one room to another is not used here.
N_drum_panel	Number of equivalent 55 gallon drums that can be stored in one panel	81,000	/panel	Ref.: SAR Section 4.3.1, which references statement by the RCRA permit.
N_drum_room	Number of equivalent 55 gallon drums that can be stored in one room (= N_drum_panel/7)	11,571	/room	Drums equally divided among 7 rooms
N_events	Number of events used to estimate the spontaneous ignition frequency for TRU waste drums that have been improperly certified as conforming to the WIPP WAC.	40	events	=N_obs_events * Factor_events_cor. See Section 5.2.3.1 for a discussion of the reasoning using this correction factor in the estimate of the spontaneous ignition frequency in improperly certified TRU waste.
N_obs_events	Number of events associated with the long term storage of TRU waste at the generator sites that can be considered indications of the potential for spontaneous ignition in drums at the WIPP.	4	events	Refer to Table D-3 for a discussion of fire that have been included and excluded from qualifying events.
N_room_yr	Average number of rooms that will be filled per year based on expected throughput = (7 * N_7pack_yr) / (N_drum_room)	3.5	/year	Derived from the estimated throughput of waste per year.

Table D-1, Documentation of Basic Event Variables Used in the Quantification of CH Waste Accident Frequencies

ID	Description	Value	Units	Source/Comments
N_TRUPACT_yr	Number of TRUPACT II shipments to the WIPP per year (= N_7pack_yr/2)	2,912	/year	Calculated based on 2 ea. 7-packs per TRUPACT
T_crane_op	Average time that a TRUPACT load will be suspended on the TRUPACT crane.	0.2	hours	Based on current training activities, operations personnel estimate that time to transfer waste is about 10-15 minutes.
T_forklift_UG	Average time that a forklift requires to transfer one seven-pack from the transporter to the stack in the U/G.	0.1	hours	Based on current training activities, operations personnel estimate that time that BRUDI load will be off the ground is about 5 minutes.
T_forklift_WHB	Average time that a forklift requires to transfer one facility pallet to the hoist transfer room.	0.2	hours	Based on current training activities, operations personnel estimate that time to transfer waste is about 10-15 minutes.
T_hoist_op	Average time that the hoist supports waste during one transfer operation to the underground horizon.	0.2	hours	Ref.: WIPP/WID-96-2178, p.3-3 estimates 8.6 min. cycle time per lift at 500 ft/min. Time rounded to 0.2 hours to account for any additional brake release time that might be required.
Tot_storage_exp	Total time integrated exposure of TRU waste to spontaneous ignition.	7.6E+05	m^3-years	Accounts for the accumulated storage experience of the TRU waste volume at all generator sites since 1970. See Table D-2 for the derivation of this variable.
Vol_CH_UG_room	Maximum volume of CH waste that can be stored in one actively ventilated U shaped panel room with its associated access drifts in which drums are stored.	3,007	m^3	Maximum volume of CH waste currently permitted for storage at WIPP apportioned to 8 panels containing 7 rooms each.
Vol_CH_WHB	Maximum stored volume of CH waste in the Waste Handling Building (= 7 facility pallets * 28 drums/pallet * 0.208 m^3/drum)	40.8	m^3	WIPP RCRA Part B Application, p. D-7 states that a maximum of 7 facility pallets may be left in the storage area.
Vol_CH_WIPP	Total volume of CH TRU waste authorized for disposal at the WIPP	1.7E+05	m^3	= Vol_TOT_WIPP - Vol_CH_WIPP
Vol_drum	Maximum volume for waste inside a 55 gallon drum	0.208	m^3	WIPP SEIS-II App B , p. B-12
Vol_RH_WIPP	Total volume of RH waste anticipated for disposal at the WIPP	7,080	m^3	WIPP RCRA Part B Application, p. D-16
Vol_TOT_WIPP	Total volume of combined RH and CH TRU waste authorized for disposal at the WIPP (=6.2E06 ft^3 * 0.0283 m^3/ft^3)	1.75E+05	m^3	Limit established by Public Law102-579
X_CH_active	Drift length of one actively ventilated U shaped opening in which CH waste is placed, consisting of a panel room with its associated access drifts.	566	feet	Room length is 300 feet. Pillars are 100 feet thick. Therefore, entry ways are 133 feet on each end.
X_UG_active	Total drift length of all active openings in the UG horizon. (4.5 miles)	25,380	feet	WID/WIPP Engineering Memo HA:96:3555, dated June 28, 1996, Subject: LINEAR FOOTAGE OF OPENINGS IN THE UNDERGROUND BEFORE AND AFTER NORTHEND

Table D-2, Estimate of Generic Spontaneous Ignition Frequency Based on DOE Waste Storage Experience

Variable Name	Description	Formula	Resulting Value	Comments
f_ign_est	Spontaneous ignition rate for non-WAC verified and non-process specific waste, based on WIPP interpretation of DOE experience	=N_events/Tot_storage_exp	5.3E-05 /m^3-yr	Based on interpretation of applicability of incidents and the assumed total exposure of TRU waste that could generate those incidents.
N_events	Number of events used to estimate the spontaneous ignition frequency for TRU waste drums that have been improperly certified as conforming to the WIPP WAC.	=N-obs_events * Factor_events_cor	40	Section 5.2.3.1 for a discussion of the reasoning using this correction factor in the estimate of the spontaneous ignition frequency in improperly certified TRU waste.
Factor_events_cor	Correction factor to account for the less than complete detectability of spontaneous ignition events within drums in interim storage..		10	See Section 5.2.3.1 for a discussion of the evidence and reasoning for the selection of this correction factor.
N_obs_events	Number of events associated with the long term storage of TRU waste at the generator sites that can be considered indications of the potential for spontaneous ignition in drums at the WIPP.		4	Refer to Table D-3 for a discussion of fire that have been included and excluded from qualifying events.
Tot_storage_exp	Total time integrated exposure of TRU waste to spontaneous ignition.	=Vol_CH_stored* (Yr_Current -Yr_0) /2	7.6E+05 m^3-yr	Waste can be exposed to spontaneous ignition only for the period for which it is stored, and not all of it is generated at the same time. Waste is assumed to have been generated at a constant rate between 1970 and the present year.
Vol_CH_stored	Total Volume of TRU CH Waste Currently in Storage at all sites		5.85E+04 m^3	See Appendix A for a listing of all final waste forms and the documentation of this cumulative total volume. Appendix A is based on a TWBIR Query, June 1996.
Yr_0	Begin time for generation of TRU waste		1970	Assumed first year in which TRU waste was generated. This is the first year used for the search of fire incidents.
Yr_Current	Current time		1996	

Table D-3, Applicability of DOE Unusual Occurrences Involving Fires, Explosions and Overpressure

NOTES:

The table on the following sheets summarizes the evidence and reasoning used to include or exclude unusual occurrences involving fires, explosions, and overpressure in waste containers for the quantification of the spontaneous ignition frequency of drums that may have been improperly certified to conform to the WIPP WAC when delivered to the WIPP. Evaluation of Incidents that produced fires at other DOE facilities. For the operational safety of WIPP, it is important to have confidence that DOE wide procedures for certifying waste to the WIPP WAC have profited from the lessons learned from all these incidents. However, for the purpose of quantifying the susceptibility of the population of improperly certified drums that will be delivered to the WIPP, the following questions and evaluation criteria are used to evaluate unusual occurrences:

- What was the intended function of the container at the time of the incident?

- To what extent are the composition of materials and TRU inventory of the populations of containers in which the fires occurred similar to a population of drums that would be considered for shipment to the WIPP?

- What were the circumstances under which the containers were stored compared to conditions that would be associated with the handling and interim storage of TRU waste forms that would be considered for shipment to the WIPP?

To qualify as direct evidence of problems in the population of drums to be emplaced at the WIPP, the answers to the above questions should lead one to identify some association with a drum population in long term interim storage awaiting ultimate disposal. For example, temporary storage of turnings and fines that are byproducts of fabrication steps and are awaiting recycling back into feed material will most likely involve pyrophoric plutonium or uranium metal. Moreover, the storage configuration will be designed to maintain the metal in an unoxidized form, thus making it susceptible to spontaneous ignition. Material would normally have to be declared uneconomically recoverable to be designated for ultimate disposal. Therefore, an incident with material stored under these conditions is not indicative of the susceptibility of waste that would be delivered to the WIPP.

Table D-3, Applicability of DOE Unusual Occurrences Involving Fires, Explosions and Overpressure to the Susceptibility of Stored TRU Waste to Spontaneous Ignition at the WIPP

Event	Physical and Environmental Conditions at Time of Event	Consequence	Probable Cause	Applicability for Waste Delivered to WIPP Without Processing/ Repackaging	Applicable to the Population of TRU Waste Susceptible to Spontaneous Combustion at the WIPP?
6/1/70, INEL, Burial ground fire in 55-gal drum. Smoldering fire found during evening patrol.	Outside storage in sun, black drum, top of stack near center of array. Drum had been shipped from RFP. Contained a pyrophoric object that burst into flames during examination following fire, broken glass, dirt, rocks, paper, plastic, glass jars, etc.	Drum breached. Direct monitoring of air showed contamination spread was very low. Fire extinguished by lifting from stack and burying with bulldozer. No spread of contamination detected.	Probable origin of drum traced to an old natural uranium laboratory at RFP. No conclusions drawn other than the spontaneous ignition of uranium.	Drums filled in laboratories during periods of lesser control may still exist in long term interim storage at generator sites.	Yes. Judged to be part of the waste in interim long-term storage at generator sites that will be processed for shipment to the WIPP.
12/3/76, ANL-E, Explosion of 55-gal drum containing solid radioactive waste inside parked truck over night. Damage discovered in morning.	Drum had been placed inside the truck as a standard procedure to await pickup. It contained cardboard, shredded plastic bags, bagged-out plastic pouches, hot plates, rubber hose, etc. Beta-gamma activity was detected in the plastic pouches.	Drum breached, and the lid was blasted through the aluminum roof of the truck. Approximately half of the contents dispersed, being scattered within the truck. Radiation surveys of the truck and premises revealed no contamination.	Flammable organic solvent vapors accumulating in the void space of the sealed drum, ignited by static electricity discharge.	Drum would not qualify for shipment to the WIPP, as it was sealed and most likely contained a high concentration of organic vapors. Drum history and contents were unique.	Yes. Judged to be part of the waste in interim long-term storage at generator sites that will be processed for shipment to the WIPP.
8/17/78, Hanford, Distortion of 55-gal drums due to internal pressure buildup	Drums were sealed tight and awaiting burial. One drum contained 60 grams of Pu and 62 liters of solution, while the other contained 54 grams of Pu and 70 liters of solution. The solutions were contained in Speedy	No ignition occurred. Drums were enclosed in plastic bags and vented under controlled conditions.	Pressurization due to a reaction between nitric acid and organic compounds.	Drum would not qualify for shipment to the WIPP. Drums contained liquids now not permitted for shipment to WIPP. Drums did not contain vents.	No. Spontaneous ignition did not occur. Buildup of VOCs within a drum to the extent indicated here will be eliminated because all drums shipped to WIPP must have vents.
3/13/82, Hanford, Uranium-concrete billet fire.	Wooden pallet of concrete billet cans (did not involve waste containers to be used at WIPP). Pyrophoric uranium in the concrete.	Radiation surveys taken in general area indicated no contamination, but two fire fighters were contaminated on their face, hands, and clothes.	Inadequate process specifications, operating procedures, and training.	This incident does not involve waste in a configuration that would be shipped to the WIPP. It would have to be packaged in a suitable container after being certified to the WIPP WAC.	Yes. It is unknown if the containers cited in the report could have been packaged in 55 gallon drums for long term interim storage.
10/26/89, LANL, Uranium fire in a 30-gallon drum	Workers were opening the drum during the process of combining depleted pyrophoric uranium scrap for disposal.	Fire was smothered by placing the lid back on the drum. No radioactive contamination due to the fire.	The 30-gallon drum had been sent to processing without a protective fluid to isolate the uranium turnings from oxygen.	Not applicable. The material was not TRU waste. It was a known pyrophoric material that was being actively processed.	No. The fire occurred during active processing of known pyrophoric materials. It does not resemble the long term storage configurations that will be processed for WIPP.

Table D-3, Applicability of DOE Unusual Occurrences Involving Fires, Explosions and Overpressure to the Susceptibility of Stored TRU Waste to Spontaneous Ignition at the WIPP

Event	Physical and Environmental Conditions at Time of Event	Consequence	Probable Cause	Applicability for Waste Delivered to WIPP Without Processing/ Repackaging	Applicable to the Population of TRU Waste Susceptible to Spontaneous Combustion at the WIPP?
6/30/83, 1 PM, LLNL, Fire in bags of dry waste temporary piled in a toxic waste holdup area exposed directly to the summer sun awaiting packaging in drums.	Refuse bags piled in the toxic waste holdup area. The bags were not in drums and were exposed to the summer sun for approximately 3 hours prior to the fire.	Although the report did not specify whether the waste was low level or TRU, no radioactivity was detected runoff water used to fight the fire or the immediate vicinity.	Empty drums had not been delivered in time, and bags were piled to await them and was exposed directly to the sun.	Waste was not packaged. The lack of detection of radioactivity after the fact and mode of temporary storage indicate that it is highly unlikely to be TRU waste.	Yes. Because it was awaiting waste drums, the dry waste had the potential to be placed into drums that might contain TRU waste.
4/20/84, INEL, Fumes coming from a radioactive waste container. Material in the container ignited when the fumes were investigated.	Fuming nitric acid absorbed in a paper towel and discarded into a compactible radioactive waste container.	No mention whether radioactive materials were in the container. No contamination was released	Spontaneous ignition of a paper towel that had been used to absorb undiluted fuming nitric acid.	Not applicable. The fire was within a laboratory rather than a disposal area and involved materials prohibited by the WAC.	No. The fire occurred in a container in operational area that was reopened soon after waste was discarded into it. No correlation with long term storage conditions.
7/20/85, ORNL at Y-12, Fire involving thorium in a scrapped glove box.	A one gallon pail of thorium was left in a glove box that had been discarded in a salvage yard. During sorting operations, a forklift lifted the glove	Thorium fire.	Poor control of pyrophoric material. The reason for the presence of thorium in the glove box is not known.	Not applicable. The thorium was not packaged for long term disposal. The glovebox was still intact.	No. The material was not in containers designated for long term storage. The material involved was not TRU waste.
9/19/85, RFP, Pressurization of containers and release of plutonium.	Sealed container containing floor sweepings from the button breakout line. Sweepings contained plutonium fines.	Contamination of personnel and the facility.	Exothermic reaction was initiated between calcium metal and moisture present in the container.	Not applicable. This incident does not involve waste in a configuration applicable to TRU waste to be shipped to the WIPP.	No. Incident occurred with materials awaiting assay rather than containers designated for long term storage
Total of 8 Various Events Reported in DOE Safety Notice DOE/NS-0013, Issue No. 93-1, February 1993.	All recent incidents involved flammable chemical and organic materials being stored in conditions not associated with TRU waste storage.	Various	Normal hazards associated with storing flammable liquids.	The processes and storage configurations are not applicable to TRU waste that could be delivered to the WIPP.	No. The processes and storage configurations are not applicable to TRU waste that could be delivered to the WIPP.

Table D-4, Extract of Baseline Inventory Report for Use in Accident Frequency Quantification

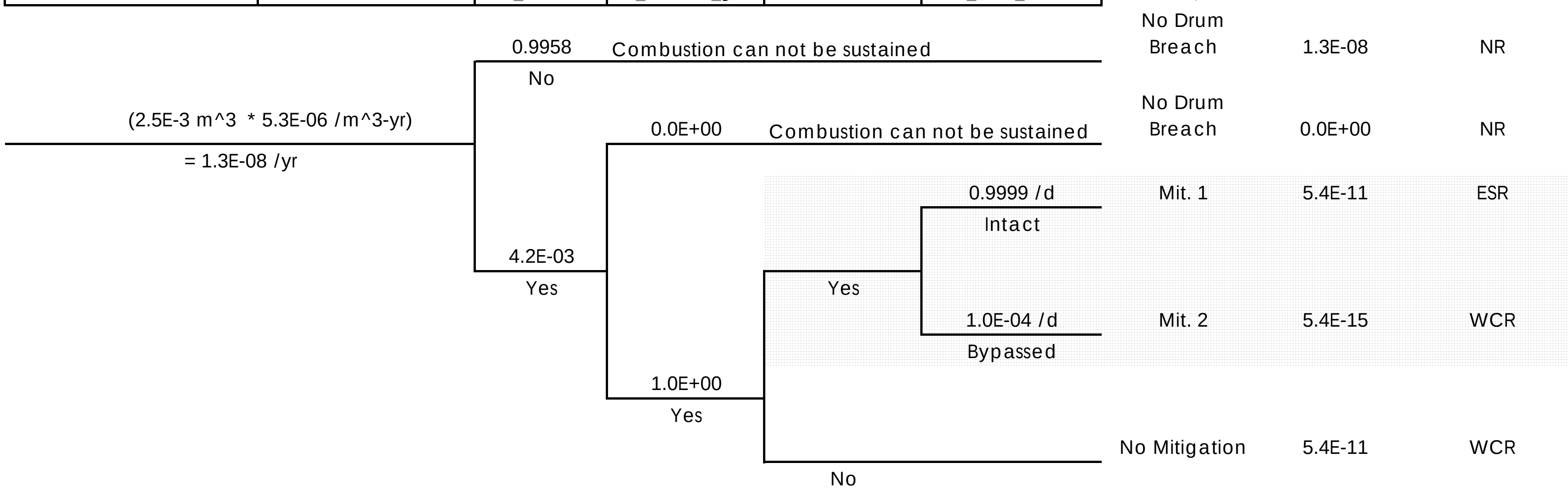
	Currently Stored TRU Waste Summarized by Final Waste Form See Table A-2 for Individual Waste Stream Data					Distribution of Radionuclide Concentrations of Stored TRU Waste *PE-Ci concentrations are waste stream averaged						
						Overall Average PE-Ci /Drum	Not to be Processed/Repackaged Before WIPP Disposal			To be Processed/Repackaged Before WIPP Disposal		
Final Waste Form Consolidated by Generator Site	Stored Volume, m^3	Equivalent Number 55 Gal Drums	Percent of Total Stored Volume	Total PE-Ci	Percent of Total PE-CI		PE-Ci* < 8	8 < PE-Ci* < 20	20 < PE-Ci*	PE-Ci* < 8	8 < PE-Ci* < 20	20 < PE-Ci*
Combustible	5,775	27,763	9.9%	52,857	4.3%	1.9	14.6%	0.5%	0.1%	83.0%	1.9%	0.0%
Filter	218	1,048	0.4%	7,217	0.6%	6.9	60.5%	31.4%	1.2%	6.6%	0.0%	0.3%
Graphite	512	2,461	0.9%	3,668	0.3%	1.5	22.3%	2.7%	0.0%	75.0%	0.0%	0.0%
Heterogeneous	23,016	110,655	39.3%	440,870	36.2%	4.0	5.7%	0.0%	0.0%	82.8%	5.7%	5.8%
Inorganic non-metal	2,928	14,079	5.0%	49,762	4.1%	3.5	7.9%	0.3%	0.0%	80.6%	8.8%	2.3%
Lead/cadmium metal	24	114	0.0%	85	0.0%	0.7	72.7%	0.0%	0.0%	27.3%	0.0%	0.0%
Salt waste	21	102	0.0%	1,712	0.1%	16.8	16.5%	8.4%	8.1%	23.6%	17.7%	25.6%
Soils	407	1,958	0.7%	5,192	0.4%	2.7	4.9%	0.0%	0.0%	70.7%	24.5%	0.0%
Solidified Inorganics	9,635	46,321	16.5%	183,911	15.1%	4.0	33.7%	0.1%	0.0%	64.1%	1.7%	0.4%
Solidified Organics	913	4,388	1.6%	3,131	0.3%	0.7	24.4%	0.1%	0.0%	75.5%	0.0%	0.0%
Uncategorized metal	10,836	52,098	18.5%	100,776	8.3%	1.9	6.2%	0.2%	0.1%	90.1%	2.7%	0.7%
Unknown	66	317	0.1%	3,567	0.3%	11.3	38.3%	0.0%	2.5%	34.9%	0.0%	24.3%
Various RF Residues	4,182	20,105	7.1%	366,439	30.1%	18.2	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
ALL WASTE FORMS	**58,533**	**281,410**	**100.0%**	**1,219,187**	**100.0%**	**4.3**	**11.7%**	**0.3%**	**0.0%**	**74.4%**	**11.0%**	**2.6%**

Table D-5, Assessment of Likelihoods that Waste Forms Now Designated for Disposal at the WIPP May be Susceptible to Spontaneous Ignition Due to Failure of Generator Site Controls

Final Waste Form	L(Failure Generator Sites to Control Pyrophorics)	Justification
Combustible	1.0E-01	Baseline Rate. A wide variety of materials can be classified combustible. It is assigned the baseline error rate for pyrophoric materials
Filter	1.0E-02	Approximately 95% filter material. Loaded filters judged to have had the opportunity to ignite either in place or upon initial exposure to air.
Graphite	1.0E-02	Approximately 95% graphite based solid materials, such as crucibles, graphite components, and pure graphite. Although potentially combustible, these items are judged to be easily separated from potentially pyrophoric materials.
Heterogeneous	1.0E-01	Baseline Rate. A wide variety of materials can be classified heterogeneous. It is assigned the baseline error rate for pyrophoric materials
Inorganic non-metal	1.0E-02	Approximately 95% inorganic nonmetals, such as glass and ceramics. These items are judged to be easily separated from potentially pyrophoric materials.
Lead/cadmium metal	1.0E-02	Approximately 95% by volume metal that contains bulk lead or cadmium, such as glove box parts. These items are judged to be easily separated from potentially pyrophoric materials.
Salt waste	1.0E-01	Baseline rate. Only 50% by volume required to be salts.
Soils	1.0E-02	Approximately 95% by volume soil material. This material would most likely consolidate to the extent that it would preclude the spontaneous ignition of any contaminate within it.
Solidified Inorganics	1.0E-01	Baseline rate. Only 50% by volume required to be inorganic process residues.
Solidified Organics	1.0E-01	Baseline Rate. Only 50% of contents by volume required to be solidified.
Uncategorized metal	1.0E-02	Approximately 95% or more, by volume, metal. This material judged to be easily separated from potentially pyrophoric materials.
Unknown	1.0E-01	Baseline rate. Must be processed and categorized before shipment.
Various Rocky Flats Residues	1.0E-04	This estimate is based on current plans to package Rocky Flats residues in pipe containers in 55-gallon drums. Therefore, this waste form is a special case for which there is high confidence that the generator site will maintain adequate control.

Figure D-1 CH1 - Spontaneous Ignition (Drum) in the Waste Handling Building. (Example Event Tree showing frequency at which containers of combustible waste not to be processed with concentrations of >20 PE-Ci are involved. See Tables D-7and D-8 for overall frequency calculation)

Time Av. Vol. of Not to be Processed Combustible >20PE-Ci in WHB	Spontaneous Ignition Rate for Not to be Processed Combustible	Sufficient Oxidant?	Sufficient Combustibles?	Mitigation Considered?	HEPA Filtration?	Scenario ID	Frequency/ Year	Offsite Release Category
Table D-6	Table D-6	L_oxidant	L_combust_gen		L_filter_WHB	← Source of Event Quantification		



LEGEND:

NR: No Release
ESR: Extremely Small
SR: Small Release
WCR: IE Worst Case Release

Release Category	Summary of Radiological Risk			
	Consequence (Rem)		Frequency (per year)	
	Maximum Exposed Onsite Individual	Maximum Exposed Offsite Individual	Credit for Mitigation Systems	No Credit for Mitigation Systems
NR	-	-	1.3E-08	1.3E-08
ESR	3.30E-05	3.90E-06	5.4E-11	-
SR	-	-	-	-
WCR	3.30E+01	3.80E+00	5.4E-15	5.4E-11
		Total Frequency	1.3E-08	1.3E-08

Table D-6, Initiating Event Logic for CH1 - Spontaneous Ignition (Drum) in the Waste Handling Building (Example for one specific Final Waste Form)

Variable Name	Description	Formula	Resulting Value	Comments
CH1_IE (Example)	Spontaneous ignition frequency of drums containing the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	= Vol_WHB_comb_not_p * f_ign_comb_not_p	1.3E-08 /yr	Illustrates the product of the two contributors to the initiating event frequency.
Vol_WHB_comb_not_p	Total volume weighted Material at Risk for spontaneous ignition of the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	Vol_CH_WHB* Vol%_comb_not_p	2.46E-03	This represents the equivalent volume of material present at all times. The small quantity of waste associated with this waste form will actually be susceptible in container size volumes for short periods of time over the life of the facility.
Vol_CH_WHB	Maximum Stored Waste Volume in the WHB (assumed stored all the time)	=Vol_CH_WHB (=7*28*vol_drum)	41 m^3	Maximum of 7 facility pallets anticipated to be present in the WHB at any one time.
Vol%_comb_not_p	Percent of Total Stored Volume of TRU Waste that consists of the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	= 9.9%* 0.06% from Table D-4, BIR Matrix	0.006%	Product of "Combustible" final waste form % of total volume with the % of "Combustible" waste that is greater than 20 PE-Ci
f_ign_comb_not_p	Spontaneous ignition rate for the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	= f_ign_est * WAC_comb_not_p	5.3E-06 /m^3-yr	Product of the variables listed below
f_ign_est	Spontaneous ignition rate for non-WAC verified and non-process specific waste	= f_ign_est	5.3E-05 /m^3-yr	Refer to Tables D-2 and D-3 for evidence used to estimate this frequency
WAC_comb_not_p	Likelihood that a waste container of the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification, will not conform to the WAC	Table D-7, Entry in subtable, Likelihood of Failure to Verify WAC	0.1	Only waste drums that may not conform to the WAC are susceptible to spontaneous ignition

Table D-7, Frequency of Sustained Combustion Event for Final Waste Forms Planned for Disposal at the WIPP

Frequency of Spontaneous Ignition per Cubic Meter of Waste Stored

Waste Categories	Likelihood of Failure to Verify WAC				Frequency of Spontaneous Ignition, Given WAC not Verified (per m^3-year)				Frequency of Spontaneous Ignition for TRU Waste Stored in the WIPP (per m^3-year)		
Final Waste Form Identification Code	Stored not to be Processed	Stored to be Processed	Projected to be Generated		Stored not to be Processed	Stored to be Processed	Projected to be Generated		Stored not to be Processed	Stored to be Processed	Projected to be Generated
Combustible	1.0E-01	1.0E-02	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-06	5.3E-07	5.3E-09
Filter	1.0E-02	1.0E-03	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-07	5.3E-08	5.3E-09
Graphite	1.0E-02	1.0E-03	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-07	5.3E-08	5.3E-09
Heterogeneous	1.0E-01	1.0E-02	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-06	5.3E-07	5.3E-09
Inorganic non-metal	1.0E-02	1.0E-03	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-07	5.3E-08	5.3E-09
Lead/cadmium metal	1.0E-02	1.0E-03	1.0E-04	●	5.3E-05	5.3E-05	5.3E-05	=	5.3E-07	5.3E-08	5.3E-09
Salt waste	1.0E-01	1.0E-02	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-06	5.3E-07	5.3E-09
Soils	1.0E-02	1.0E-03	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-07	5.3E-08	5.3E-09
Solidified Inorganics	1.0E-01	1.0E-02	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-06	5.3E-07	5.3E-09
Solidified Organics	1.0E-01	1.0E-02	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-06	5.3E-07	5.3E-09
Uncategorized metal	1.0E-02	1.0E-03	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-07	5.3E-08	5.3E-09
Unknown	1.0E-01	1.0E-02	1.0E-04		5.3E-05	5.3E-05	5.3E-05		5.3E-06	5.3E-07	5.3E-09
Various RF Residues	N/A	1.0E-04	N/A		5.3E-05	5.3E-05	5.3E-05		N/A	5.3E-09	N/A

Likelihood of Sustained Combustion per Cubic Meter of Waste Stored

Release due to Spontaneous Ignition

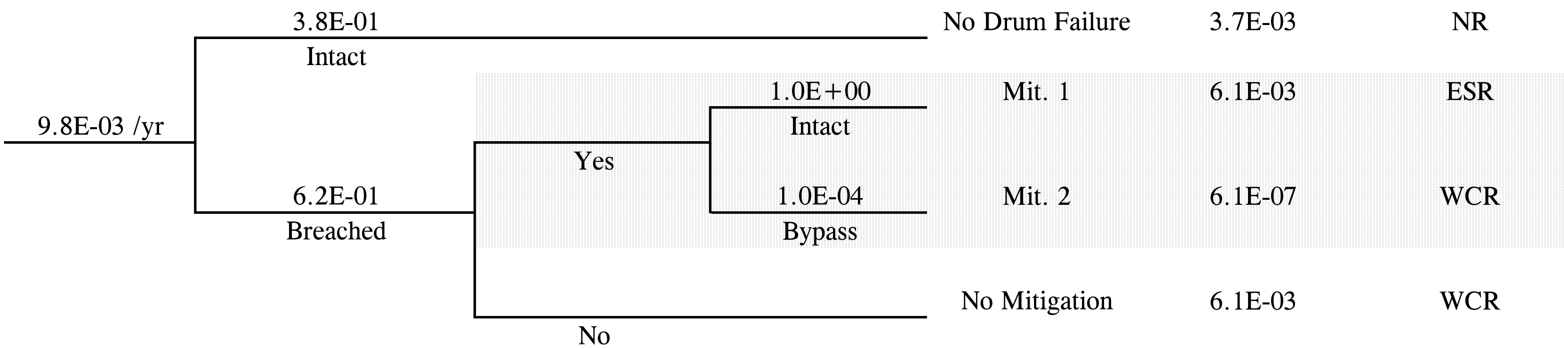
Waste Categories		Likelihood of Sufficient Oxidant				Likelihood of Sufficient Heat of Combustion (Combustibles), Given Spontaneous Ignition				Frequency of Internal Fire Caused Drum Breach per m^3-year of Waste Storage		
Final Waste Form Identification Code		Stored not to be Processed	Stored to be Processed	Projected to be Generated		Stored not to be Processed	Stored to be Processed	Projected to be Generated		Stored not to be Processed	Stored to be Processed	Projected to be Generated
Combustible		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-08	2.2E-09	2.2E-11
Filter		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-09	2.2E-10	2.2E-11
Graphite		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-09	2.2E-10	2.2E-11
Heterogeneous		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-08	2.2E-09	2.2E-11
Inorganic non-metal		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-09	2.2E-10	2.2E-11
Lead/cadmium metal	●	4.2E-03	4.2E-03	4.2E-03	●	1.0E+00	1.0E+00	1.0E+00	=	2.2E-09	2.2E-10	2.2E-11
Salt waste		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-08	2.2E-09	2.2E-11
Soils		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-09	2.2E-10	2.2E-11
Solidified Inorganics		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-08	2.2E-09	2.2E-11
Solidified Organics		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-08	2.2E-09	2.2E-11
Uncategorized metal		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-09	2.2E-10	2.2E-11
Unknown		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		2.2E-08	2.2E-09	2.2E-11
Various RF Residues		4.2E-03	4.2E-03	4.2E-03		1.0E+00	1.0E+00	1.0E+00		N/A	2.2E-11	N/A

Table D-8, Frequency of a Sustained Combustion Event Within the Waste Handling Building (per year of waste handling operation)

	Frequency of Drum Breach Due to Sustained Combustion		Waste Volume in WHB		Distribution of Radionuclide Concentrations of Stored TRU Waste *PE-Ci concentrations are waste stream averaged						Frequency of Sustained Combustion of stored waste (Events/year)			
Waste Categories	Per m^3-year of Storage		Apportioned to Each Final Waste Form		Not to be Processed/Repackaged Before WIPP Disposal			To be Processed/Repackaged Before WIPP Disposal			Combined Contribution of Processed and Non-Processed TRU Waste			
Final Waste Form Identification Code	Stored not to be Processed	Stored to be Processed	Vol. % of All Stored Waste	Material at Risk, m^3	PE-Ci* < 8	8 < PE-Ci* < 20	20 < PE-Ci*	PE-Ci* < 8	8 < PE-Ci* < 20	20 < PE-Ci*	PE-Ci* < 8	8 < PE-Ci* < 20	20 < PE-Ci*	Overall Frequency
Combustible	2.2E-08	2.2E-09	9.9%	4.0	14.6%	0.5%	0.06%	83.0%	1.9%		2.03E-08	5.7E-10	5.4E-11	2.1E-08
Filter	2.2E-09	2.2E-10	0.4%	0.2	60.5%	31.4%	1.2%	6.6%		0.3%	2.1E-10	1.1E-10	4.1E-12	3.1E-10
Graphite	2.2E-09	2.2E-10	0.9%	0.4	22.3%	2.7%		75.0%			2.3E-10	2.2E-11		2.6E-10
Heterogeneous	2.2E-08	2.2E-09	39.3%	16.0	5.7%	0.03%	0.01%	82.8%	5.7%	5.8%	4.9E-08	2.1E-09	2.1E-09	5.4E-08
Inorganic non-metal	2.2E-09	2.2E-10	5.0%	2.0	7.9%	0.3%	0.04%	80.6%	8.8%	2.3%	7.2E-10	5.4E-11	1.2E-11	7.9E-10
Lead/cadmium metal	2.2E-09	2.2E-10	0.04%	0.02	72.7%			27.3%			2.8E-11			2.8E-11
Salt waste	2.2E-08	2.2E-09	0.04%	0.01	16.5%	8.4%	8.1%	23.6%	17.7%	25.6%	6.1E-11	3.3E-11	3.5E-11	1.3E-10
Soils	2.2E-09	2.2E-10	0.7%	0.3	4.9%			70.7%	24.5%		7.5E-11	1.5E-11		9.0E-11
Solidified Inorganics	2.2E-08	2.2E-09	16.5%	6.7	33.7%	0.1%	0.01%	64.1%	1.7%	0.4%	5.9E-08	4.4E-10	7.2E-11	6.0E-08
Solidified Organics	2.2E-08	2.2E-09	1.6%	0.6	24.4%	0.1%		75.5%			4.5E-09	2.0E-11		4.5E-09
Uncategorized metal	2.2E-09	2.2E-10	18.5%	7.5	6.2%	0.2%	0.1%	90.1%	2.7%	0.7%	2.5E-09	7.2E-11	3.0E-11	2.6E-09
Unknown	2.2E-08	2.2E-09	0.1%	0.0	38.3%		2.5%	34.9%		24.3%	4.2E-10		5.0E-11	4.7E-10
Various RF Residues	N/A	2.2E-11	7.1%	2.9					100.0%			6.4E-11		6.4E-11
Maximum Waste Volume in Waste Handling Building =				41	(= Vol_CH_WHB)					Totals of All Final Waste Forms	1.4E-07	3.5E-09	2.3E-09	1.4E-07
										Percent of Overall Frequency	95.9%	2.4%	1.6%	100%

Figure D-2, Event Tree for CH2 - Crane Drop of Waste Containers in Waste Handling Building

Crane drop of waste containers in WHB	Drums Breached?	Mitigation Considered?	HEPA Filtration?	Scenario ID	Frequency per Year	Offsite Release Category
Table D-9	L_drum_10		L_filter_WHB	← Source of Event Quantification		



Release Category	Summary of Radiological Risk			
	Consequence (Rem)		Frequency (per year)	
	Maximum Exposed Onsite Individual	Maximum Exposed Offsite Individual	With Mitigation	No Mitigation
NR	-	-	3.7E-03	3.7E-03
ESR	2.70E-06	3.10E-07	6.1E-03	-
SR	-	-	-	-
WCR	2.70E+00	3.10E-01	6.1E-07	6.1E-03
		Total Frequency	9.8E-03	9.8E-03

LEGEND:

NR: No Release
ESR: Extremely Small Release
SR: Small Release
WCR: IE Worst Case Release

Table D-9, Initiating Event Logic for CH2 - Crane Drop of Waste Containers in Waste Handling Building

Variable Name	Description	Formula	Resulting Value	Comments
CH2_IE	Frequency of 6-Ton crane drop accidents in the WHB per year involving waste containers.	= f_crane_drop * N_TRUPACT_yr	9.8E-03 /yr	Agrees with the overall results of DOE/WIPP-96-2196, September, 1996, Waste Isolation Pilot Plant, TRUPACT Crane System Analysis.
f_crane_drop	Crane drop rate per lift due to all mechanisms	= f_crane_drop	3.4E-06 /op	DOE/WIPP-96-2196, September, 1996, Waste Isolation Pilot Plant, TRUPACT Crane System Analysis. (Uses loss of power to the crane = 4.3E-01/yr)
N_TRUPACT_yr	Average number of CH Waste hoist transfers per year	= N_TRUPACT_yr	2912 op/yr	Based on current estimated throughput.

Figure D-3, CH3 - Puncture of Waste Containers by Forklift in Waste Handling Building

Puncture of Waste Containers by Forklift	Mitigation Considered?	Forklift Disengaged?	HEPA Filtration?	Scenario ID	Frequency per Year	Offsite Release Category
Table D-10		H_high_dep	L_filter_WHB	← Source of Event Quantification		
8.0E-03 /yr	Yes	5.0E-01 /d No	1.0E+00 Intact	Mit. 1	4.0E-03	ESR
			1.0E-04 Bypass	Mit. 2	4.0E-07	SR
		5.0E-01 /d Yes	1.0E+00 Intact	Mit. 3	4.0E-03	ESR
			1.0E-04 Bypass	Mit. 4	4.0E-07	WCR
	No			No Mitigation	8.0E-03	WCR

Summary of Radiological Risk

Release Category	Consequence (Rem)		Frequency (per year)	
	Maximum Exposed Onsite Individual	Maximum Exposed Offsite Individual	With Mitigation	No Mitigation
NR	-	-	-	-
ESR	2.00E-06	2.30E-07	8.0E-03	-
SR	-	-	4.0E-07	-
WCR	3.80E+00	4.40E-01	4.0E-07	8.0E-03
		Total Frequency	8.0E-03	8.0E-03

LEGEND:

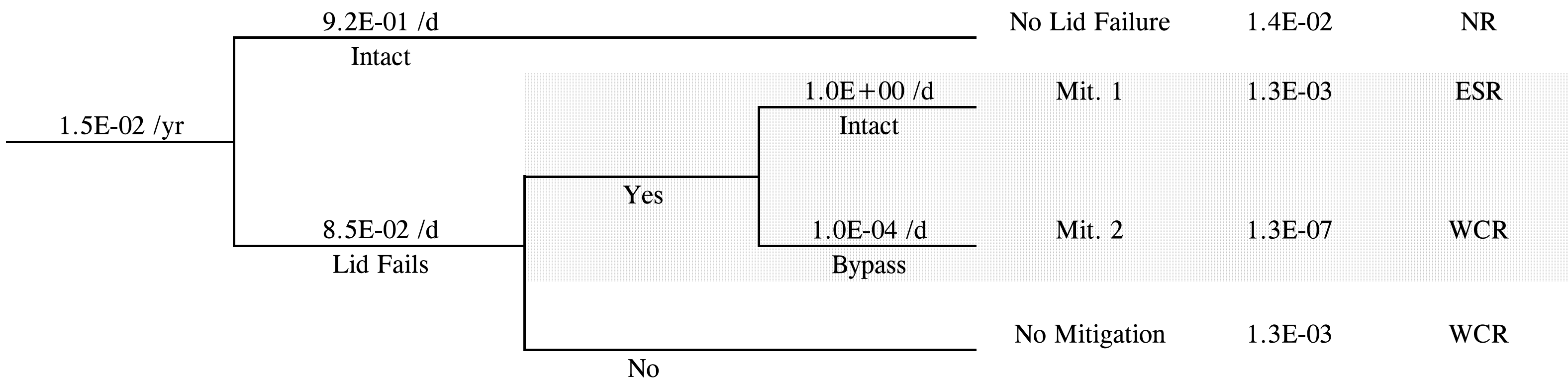
NR: No Release
ESR: Extremely Small Release
SR: Small Release
WCR: IE Worst Case Release

Table D-10, Initiating Event Logic for CH3 - Puncture of Waste Containers by Forklift in Waste Handling Building

Variable Name	Description	Formula	Resulting Value	Comments
CH3_IE	Puncture of Waste Containers by Forklift	=N_forklift_WHB* f_coll/op_WHB	8.0E-03 /yr	Product of number of forklift operations times the accident rate per operation.
N_forklift_WHB	Number of forklift operations in the WHB per year	= N_7pack_yr/4	1456 op/yr	In the WHB a forklift is used to transport a facility pallet containing 4 TRUPACT 7-packs
f_coll/op_WHB	Frequency of seven pack puncture from forklift during a waste handling operation in the WHB	= H_forklift + f_hardware	5.5E-06 /op	A puncture can occur due to either hardware failure or human error during the operation
H_forklift_punct	Puncturing collision of forklift with waste drums due to human error	=H_forklift_punct	5.0E-06 /op	The forklift transfer in the WHB is a standard operation done under excellent working conditions.
f_hardware	Puncturing collision with waste drums due to forklift hardware failure	= f_forklift_coll * T_forklift_WHB	5.2E-07 /op	Forklift hardware failures result from time-related mechanisms during operation, but only produce collisons during the time period when the forklift is handling waste.

Figure D-4, CH4 - Drop of Waste Containers by Forklift in Waste Handling Building

Initiating Event - Drum Drop	Drum Breached?	Mitigation Considered?	HEPA Filtration?	Scenario ID	Frequency per Year	Offsite Release Category
Table D-11	L_drum _05		L_filter_WHB	← Source of Event Quantification		



LEGEND:

NR: No Release
ESR: Extremely Small Release
SR: Small Release
WCR: IE Worst Case Release

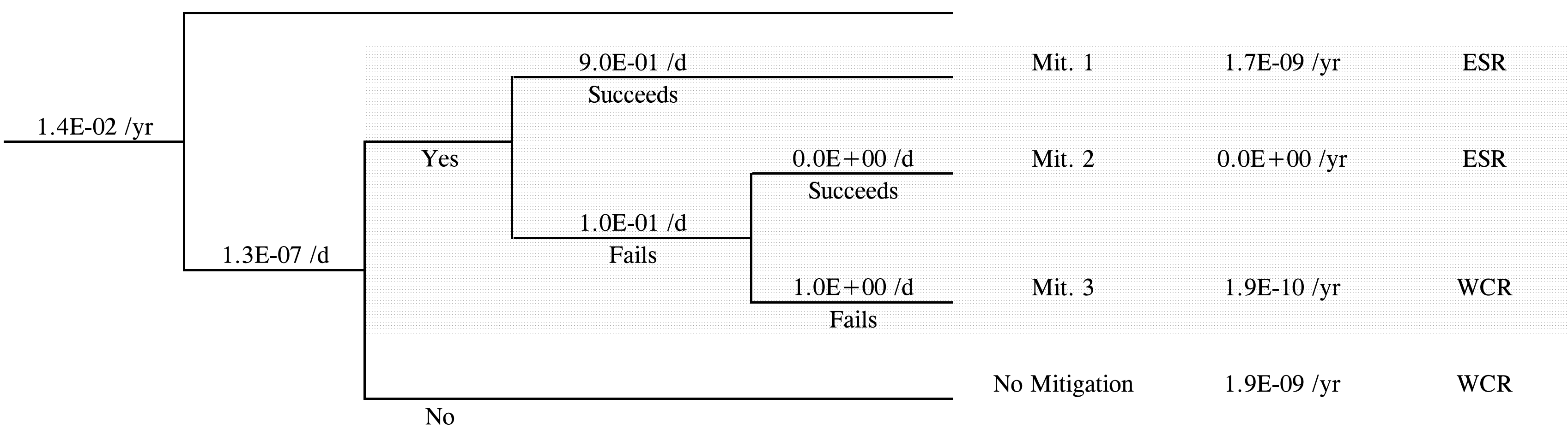
Release Category	Summary of Radiological Risk			
	Consequence (Rem)		Frequency (per year)	
	Maximum Exposed Onsite Individual	Maximum Exposed Offsite Individual	With Mitigation	No Mitigation
NR	-	-	1.4E-02	1.4E-02
ESR	8.60E-07	1.00E-07	1.3E-03	-
SR	-	-	-	-
WCR	8.60E-01	1.00E-01	1.3E-07	1.3E-03
		Total Frequency	1.5E-02	1.5E-02

Table D-11 Initiating Event Logic for CH4 - Drop of Waste Containers by Forklift in Waste Handling Building

Variable Name	Description	Formula	Resulting Value	Comments
CH4_IE	Drop of a drum seven-pack in the WHB	= N_forklift_WHB * f_7pack_WHB	1.5E-02 /yr	Product of number of forklift operations times the accident rate per operation.
N_forklift_WHB	Number of forklift operations in the WHB per year	= N_7pack_yr/4	1456 op/yr	In the WHB a forklift is used to transport a facility pallet containing 4 TRUPACT 7-packs
f_7pack_WHB	Frequency of seven pack drops from forklift during waste handling operations in the WHB	= H_forklift_drop + f_hardware	1.0E-05 /op	A drop can occur due to either hardware failure or human error during the operation.
H_forklift_drop	Drop of waste drums from the forklift due to human error	=H_forklift_drop	1.0E-05 /op	The forklift transfer in the WHB is a standard operation done under excellent working conditions. See Table D-1 for variable documentation.
f_hardware	Drop due to forklift hardware failure	= f_forklift_drop * T_forklift_WHB	1.7E-07 /op	Forklift hardware failures result from time-related mechanisms during operation, but only produce drops during the time period when the forklift is handling waste.

Figure D-5, Event Tree for CH5 - Waste Hoist Failure

Loss of Power to Hoist While Transporting Waste	Hoist Brake System Functions?	Mitigation Considered?	Manual Shift to Filtration?	Auto-Shift to Filtration?	Scenario ID	Frequency per Year	Offsite Release Category
Table D-12	f_hoist_brake		H_filter_UG1	L_filter_UG1	← Source of Event Quantification		



LEGEND:

NR: No Release
ESR: Extremely Small Release
SR: Small Release
WCR: IE Worst Case Release

Summary of Radiological Risk

Release Category	Consequence (Rem)		Frequency (per year)	
	Maximum Exposed Onsite Individual	Maximum Exposed Offsite Individual	With Mitigation	No Mitigation
NR	-	-		
ESR	3.10E-05	5.00E-05	1.7E-09	-
SR	-	-		-
WCR	6.10E+01	1.00E+01	1.9E-10	1.9E-09
		Total Frequency	1.9E-09	1.9E-09

Table D-12, Initiating Event Logic for CH5 - Loss of Power to Hoist While Waste is being Transferred to the Underground Horizon (Sheet 1 of 2)

Variable Name	Description	Formula	Resulting Value	Comments
CH5_IE	Frequency of loss of Power to Hoist While Transferring Waste to the Underground	= f_Loss_pwr_hoist * T_hoist_yr/8760	1.4E-02 /yr	Constitutes dominant demand for brake system to function without backup. See DOE/WID-96-2178, Rev 0, Ref 39.
f_Loss_pwr_hoist	Frequency of loss power to the waste hoist(events/year)	= f_LOSP + f_Loss_onsite_pwr	4.3E-01 /yr	Power lost due to either the loss of the source or the loss of distribution. Onsite power sources will not come on line quickly enough to prevent a requirement for the hoist brake system to function upon loss of power.
f_Loss_onsite_pwr	Frequency of loss of distribution of power onsite to critical lifting equipment	= 3/T_pwr_exp	2.2E-01 /yr	Based on 3 offsite events in 13.8 years (See Sheet 2 of this table)
f_LOSP	Frequency of loss of offsite power from the STS	= 3/T_pwr_exp	2.2E-01 /yr	Based on 3 onsite events in 13.8 years (See Sheet 2 of this table)
T_hoist_yr	Time that hoist supports waste over a year of operation.	= N_hoist_ops * T_hoist_op	291 hr	Total exposure time of the hoist to events that could require the brakes to function to prevent a waste drop.
N_hoist_ops	Average number of CH Waste hoist transfers per year	=N_7pack_yr/4	1456 op/yr	Based on current estimated throughput.
T_hoist_op	Duration of time that the hoist supports waste during one transfer operation to the underground. (hours)	=T_hoist_op	0.20 hr	Based on current estimate by operations personnel

Table D-12, Initiating Event Logic for CH5 - Loss of Power to Hoist While Waste is being Transferred to the Underground Horizon (Sheet 2 of 2)

Loss of Power Events at the WIPP Site

Description	SPS (utility/offsite)	WIPP (onsite)	Comments
Event on12/8/1982	X		Probably preventable with additional transmission line (under construction)
Event on 10/23/1983		X	
Event on 5/16/1984		X	
Event on 1/31/1985		X	
Event during 1995	X		Post-'85 data per Lahey discussion
Event during 04/96	X		Post-'85 dats per Lahey discussion
Events through 05/96	3	3	

Sources: 1) Facilities Engineering letter to R.M. Coleman, HA:85:0549
2) Discussion with Dave Lahey, Electrical Engineering Department

Experience Baseline for Loss of Power Events

Description	Variable Name		Comments
Begin date for power loss experience	D_pwr_exp_begin	8/1/82	
End Date for power loss experience	D_pwr_exp_end	5/31/96	Date of Analysis
Elapsed time in years	T_pwr_exp	13.83 yr	

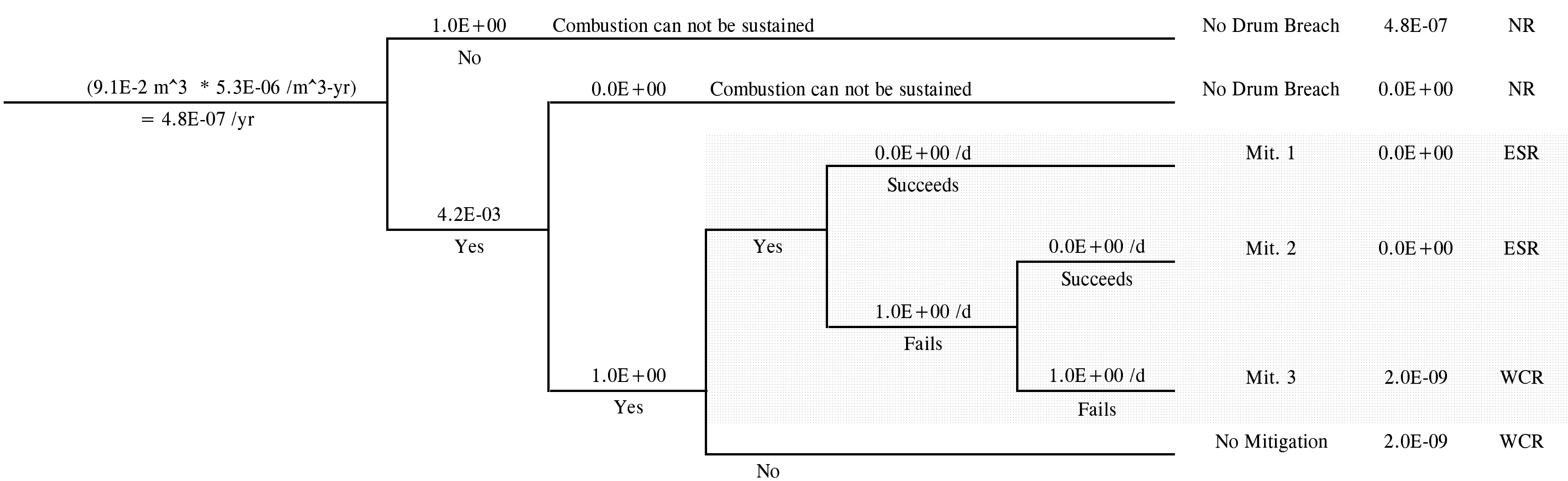
Table D-13, CH6 Seismicm Event

This section develops the scenario initiating event probability assuming that the preventative and mitigative measures function as designed during the accident scenario.

As discussed in (1) Chapters 2 and 3 of the existing WIPP FSAR WP 02-9 and the FY-95 Annual Update DOE/WIPP-Draft-2065, (2) the Draft Project Technical Baseline for Regulatory Compliance WP 02-RC1 and (3) Final Environmental Impact Statement DOE/EIS-0026, UC-70, the Design Basis Earthquake (DBE) is the most severe credible earthquake that could occur at the WIPP site. The DBE is based on a 1000-yr return interval established through a site specific study. The maximum ground acceleration for the DBE is 0.1 g in both the horizontal and vertical directions, with 10 maximum stress cycles.

Figure D-6 CH7 - Spontaneous Ignition (drum) in the Actively Ventilated Underground. (Example Event Tree showing frequency at which containers of combustible waste not to be processed with concentrations of >20 PE-Ci are involved. See Tables D-7 and D-15 for overall frequency calculation)

Time Av. Vol. of Not to be Processed Combustible >20PE-Ci in ventilated U/G	Spontaneous Ignition Rate for Not to be Processed Combustible	Sufficient Oxidant?	Sufficient Combustibles?	Mitigation Considered?	Manual U/G Shift to Filtration?	Auto-Shift to Filtration?	Scenario ID	Frequency/ Year	Offsite Release Category
Table D-14	Table D-14	L_oxidant	L_combust_gen		H_filter_UG2	L_filter_UG2	← Source of Event Quantification		



LEGEND:

NR: No Release
ESR: Extremely Small Release
SR: Small Release
WCR: IE Worst Case Release

Release Category	Summary of Radiological Risk			
	Consequence (Rem)		Frequency (per year)	
	Maximum Exposed Onsite Individual	Maximum Exposed Offsite Individual	With Mitigation	No Mitigation
NR	-	-	4.8E-07	4.8E-07
ESR	1.70E-05	2.75E-06	0.0E+00	-
SR	-	-	-	-
WCR	3.30E+01	5.50E+00	2.0E-09	2.0E-09
		Total Frequency	4.8E-07	4.8E-07

Table D-14, Initiating Event Logic for CH7 - Spontaneous Ignition (Drum) Within the Actively Ventilated Underground Horizon (Example for on specific Final Waste Form)

Variable Name	Description	Formula	Resulting Value	Comments
CH7_IE (Example)	Spontaneous ignition frequency of drums containing the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	= Vol_UG_vent_comb_not_p* f_ign_comb_not_p	4.8E-07 /yr	Illustrates the product of the two contributors to the initiating event frequency.
Vol_UG_vent_comb_not_p	Volume averaged Material at Risk for spontaneous ignition of the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	'= Vol_UG_vent* Vol%_comb_not_p	0.091 m^3	Product of the volume of non-WAC verified waste drums present and the spontaneous combustion rate for the final waste form category.
Vol_UG_vent	Time Averaged Stored Waste Volume in a ventilated panel room	=Vol_CH_UG_room/2	1503 m^3	It is assumed that a panel room is filled at a constant rate.
Vol%_comb_not_p	Percent of Total Stored Volume of TRU Waste that consists of the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	= 9.9%* 0.06% from Table D-4, BIR Matrix	0.006%	Product of %-Volume and % waste > 20 PE-Ci not to be processed
f_ign_comb_not_p	Spontaneous ignition rate for the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	= f_ign_est* WAC_comb_not_p	5.3E-06 /m^3-yr	
f_ign_est	Spontaneous ignition rate for non-WAC verified and non-process specific waste	=f_ign_est	5.3E-05 /m^3-yr	Refer to Sheet f(Spontaneous Ignition) for evidence used to estimate this frequency
WAC_comb_not_p	HEP for failure to verify that drum conforms to WAC for the "Combustible" final waste form with a TRU concentration > 20 PE-Ci/drum, not to be processed before certification.	Table D-7, Entry in subtable, Likelihood of Failure to Verify WAC	0.1	Only waste drums that may not conform to the WAC are susceptible to spontaneous ignition

Table D-15, Frequency of CH7, Sustained Combustion Event Within the Actively Ventilated Underground Horizon

	Frequency of Drum Breach Due to Sustained Combustion		Waste Volume in WHB		Distribution of Radionuclide Concentrations of Stored TRU Waste *PE-Ci concentrations are waste stream averaged						Frequency of Sustained Combustion of stored waste (Events/year)			
Waste Categories	Per m^3-year of Storage		Apportioned to Each Final Waste Form		Not to be Processed/Repackaged Before WIPP Disposal			To be Processed/Repackaged Before WIPP Disposal			Combined Contribution of Processed and Non-Processed TRU Waste			
Final Waste Form Identification Code	Stored not to be Processed	Stored to be Processed	Vol. % of All Stored Waste	Material at Risk, m^3	PE-Ci* < 8	8 < PE-Ci* < 20	20 < PE-Ci*	PE-Ci* < 8	8 < PE-Ci* < 20	20 < PE-Ci*	PE-Ci* < 8	8 < PE-Ci* < 20	20 < PE-Ci*	Overall Frequency
Combustible	2.2E-08	2.2E-09	9.9%	148.3	14.6%	0.5%	0.06%	83.0%	1.9%		7.50E-07	2.1E-08	2.0E-09	7.7E-07
Filter	2.2E-09	2.2E-10	0.4%	5.6	60.5%	31.4%	1.2%	6.6%		0.3%	7.6E-09	3.9E-09	1.5E-10	1.2E-08
Graphite	2.2E-09	2.2E-10	0.9%	13.1	22.3%	2.7%		75.0%			8.6E-09	7.9E-10		9.4E-09
Heterogeneous	2.2E-08	2.2E-09	39.3%	591.2	5.7%	0.03%	0.01%	82.8%	5.7%	5.8%	1.8E-06	7.8E-08	7.7E-08	2.0E-06
Inorganic non-metal	2.2E-09	2.2E-10	5.0%	75.2	7.9%	0.3%	0.04%	80.6%	8.8%	2.3%	2.7E-08	2.0E-09	4.4E-10	2.9E-08
Lead/cadmium meta	2.2E-09	2.2E-10	0.04%	0.61	72.7%			27.3%			1.0E-09			1.0E-09
Salt waste	2.2E-08	2.2E-09	0.04%	0.54	16.5%	8.4%	8.1%	23.6%	17.7%	25.6%	2.3E-09	1.2E-09	1.3E-09	4.8E-09
Soils	2.2E-09	2.2E-10	0.7%	10.5	4.9%			70.7%	24.5%		2.8E-09	5.6E-10		3.3E-09
Solidified Inorganics	2.2E-08	2.2E-09	16.5%	247.5	33.7%	0.1%	0.01%	64.1%	1.7%	0.4%	2.2E-06	1.6E-08	2.6E-09	2.2E-06
Solidified Organics	2.2E-08	2.2E-09	1.6%	23.4	24.4%	0.1%		75.5%			1.7E-07	7.4E-10		1.7E-07
Uncategorized meta	2.2E-09	2.2E-10	18.5%	278.3	6.2%	0.2%	0.1%	90.1%	2.7%	0.7%	9.3E-08	2.7E-09	1.1E-09	9.7E-08
Unknown	2.2E-08	2.2E-09	0.1%	1.7	38.3%		2.5%	34.9%		24.3%	1.6E-08		1.8E-09	1.7E-08
Various RF Residue	N/A	2.2E-11	7.1%	107.4					100.0%			2.4E-09		2.4E-09
Average Waste Volume in Ventilated Underground Room =				1,503	(=Vol_CH_UG_room/2)			Totals of All Final Waste Forms			5.1E-06	1.3E-07	8.6E-08	5.3E-06
								Percent of Overall Frequency			95.9%	2.4%	1.6%	100%

Table D-16, Frequency of CH8, Aircraft Crash (Sheet 1 of 2)

This section develops the scenario initiating event probability assuming that the preventative and mitigative measures discussed below function as designed during the accident scenario.

- Air space share facility not part of normal flight patterns
- Remote location

Using NUREG-800, the total aircraft hazard probability (combined airway, airport, and military designated airspace operations probability of an aircraft crash) is calculated as follows:

(1) Airport Operations

The Standard Review Plan (SRP) criteria state that if the number of annual operations is less than 1000d^2, where d is the distance from the facility to the airport (d > 10 mi) then the frequency of air crashes is assumed to be 1 x 10^7/yr (considered to be the general frequency of aircraft crashes from airports and federal airways). The closest commercial airport to the WIPP site is in Carlsbad, NM, at a distance of 28 miles. Therefore, applying the SRP criteria, the minimum frequency of operations yields:

1000d^2 = 1000 (28 mi)^2 = 784,000

This is well above the number of operations at the Carlsbad airport. Therefore, a frequency of 1 x 10^7/yr is assigned for aircraft crashes into the WIPP WHB as a result of airport operations.

(2) Airways

The SRP provides a method to estimate the frequency of aircraft crashes due to activity along airways as follows:

Pfa = C x N x A/w   C = in-flight crash rate
N = number of flights per year along airway
A = effective area of plant
w = width of airway (plus twice distance from airway edge to site)

Table D-16, Frequency of CH8, Aircraft Crash (Sheet 2 of 2)

Two airways, J15 and V102 pass within 5 miles of the WIPP:

J15 (4 mi NE of site)

C = in-flight crash rate = 4 x 10^10/flight-mile
N = number of flights per year along airway = (365d/yr)(23 flights/d) = 8,395 fights/yr
A = effective area of plant = (0.25 mi)^2 = 0.063 mi^2 (Property Protection area)
w = width of airway = 10 mi + 2 (4mi) = 18 mi

Pfa = C x N x A/w = (4 x 10^10/flight-mile)(8,395 fights/yr)[(0.063 mi^2)/18mi)] = 1.18 x 10-8/yr

V102 (3 mi NW of site)

C = in-flight crash rate = 4 x 10^10/flight-mile
N = number of flights per year along airway = (365d/yr)(5 flights/d) = 1,825 flights/yr
A = effective area of plant = (0.25 mi)^2 = 0.063 mi^2 (Property Protection area)
w = width of airway = 10 mi + 2 (3mi) = 16 mi

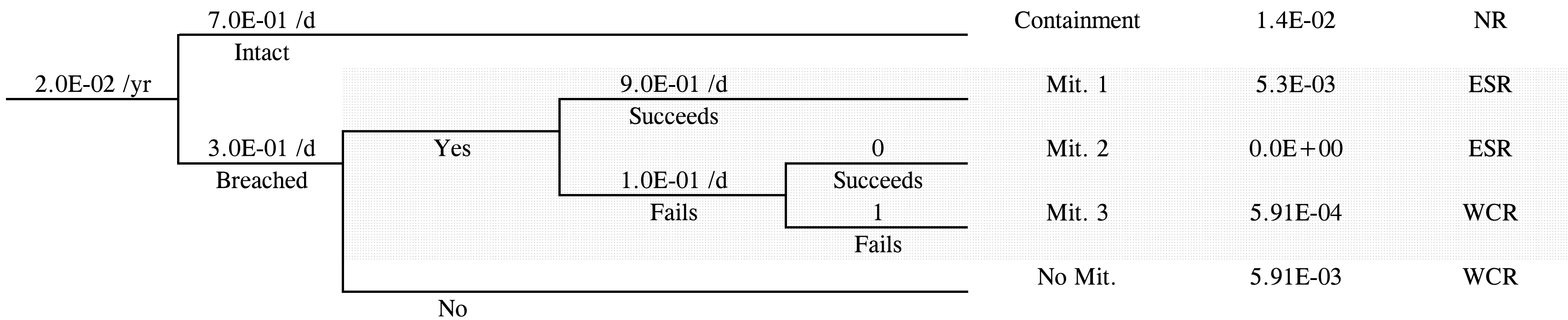
Pfa = C x N x A/w = (4 x 10^10/flight-mile)(1,825 flights/yr)[(0.063 mi^2)/16mi)] = 2.87 x 10^9/yr

Therefore, the total aircraft hazard probability (combined airway and airport probability of an aircraft crash) =

Pfa = (1 x 10^7/yr) + (1.18 x 10^8/yr) + (2.87 x 10^9/yr) = 1.03 x 10^7/yr

Figure D-7 Event Tree for CH9 - Drop of Waste Containers by Forklift in the Underground

Initiating Event - U/G Drop	Drums Breached?	Mitigation Considered?	Manual U/G Shift to Filtration?	Auto-Shift to Filtration?	Scenario ID	Frequency per Year	Offsite Release Category
Table D-17	L_drum_07		H_filter_UG1	L_filter_UG1	← Source of Event Quantification		



LEGEND:

NR: No Release
ESR: Extremely Small Release
SR Small Release
WCR: IE Worst Case Release

Summary of Radiological Risk

Release Category	**Consequence (Rem)** Maximum Exposed Onsite Individual	**Consequence (Rem)** Maximum Exposed Offsite Individual	**Frequency (per year)** With Mitigation	**Frequency (per year)** No Mitigation
NR	-	-	1.4E-02	1.4E-02
ESR	1.30E-06	2.20E-07	5.3E-03	-
SR	-	-	-	-
WCR	2.70E+00	4.40E-01	5.9E-04	5.9E-03
		Total Frequency	2.0E-02	2.0E-02

Table D-17, Initiating Event Logic for CH9 - Drop of Waste Containers by Forklift in the Underground

Variable Name	Description	Formula	Resulting Value	Comments
CH9_IE	Drop of a drum seven-pack in the U/G	= N_forklift_UG * f_7pack_UG* f_top_level	2.0E-02 /yr	Frequency on an annual basis is the product of the number of operations in which a breach could occur and the accident rate per operation.
f_top_level	Fraction of operations that results in placing waste on third level of waste stack.	= 1/3	1/3	This is the only configuration in which the BRUDI clamp is released when the 7-pack is above 4 feet., thus putting the load in hazard for a drop that can produce consequences.
N_forklift_UG	Number of forklift operations in the U/G per year	= N_7pack_yr	5824 op/yr	Set equal to the throughput of 7-packs per year. One forklift operation per 7-pack.
f_7pack_UG	Frequency of seven pack drops from forklift during waste handling operations in the UG horizon	= H_forklift_drop + f_hardware	1.0E-05 /op	Drop may occur due to either human error or hardware failure.
H_forklift_drop	Drop due to human error	=H_forklift_drop	1.0E-05 /op	The forklift transfer in the underground is a standard operation done under excellent working conditions. Foor will be leveled prior to storage operations in a panel room. See Table D-1 for variable documentation.
f_hardware	Drop due to forklift hardware failure	= f_forklift_drop * T_forklift_op	8.6E-08 /op	Forklift hardware failures result from time-related mechanisms during operation, but only produce drops during the time period when the forklift is handling waste.

Table D-18, Frequency of CH10, Tornado Event

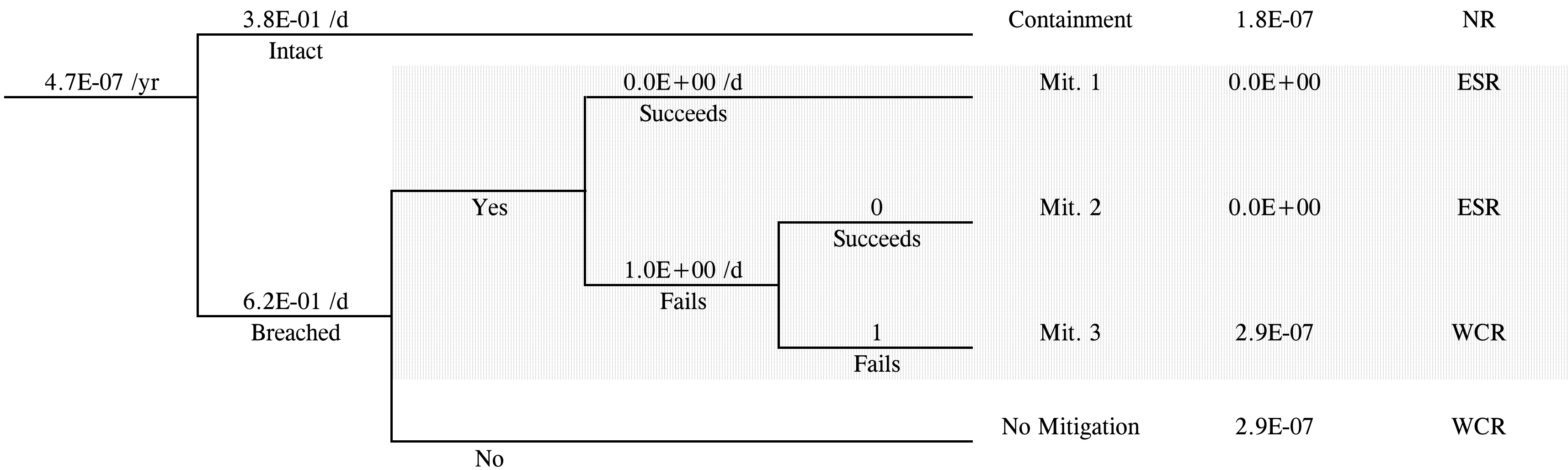
This section develops the scenario initiating event probability assuming that the preventative and mitigative measures discussed in Table 5.1-9 function as designed during the accident scenario.

As discussed in (1) Chapters 2 and 3 of the existing WIPP FSAR WP 02-9 and the FY-95 Annual Update DOE/WIPP-Draft-2065, (2) the Draft Project Technical Baseline for Regulatory Compliance WP 02-RC1, and (3) Final Environmental Impact Statement DOE/EIS-0026, UC-70, the Design Basis Tornado (DBT) is the most severe credible tornado (183 mi/hr) that could occur at the WIPP site, based on a 1,000,000-yr. recurrence period.

The DBT was developed by a site specific study SMRP No. 155, "A Site-Specific Study of Wind and Tornado Probabilities at the WIPP Site in Southeast New Mexico," Department of Geophysical Sciences, T. Fujita, University of Chicago, February 1978 and its Supplement of August 1978.

Figure D-8, Event Tree for CH11 - Unexpected Roof Fall on TRU Waste Stack in Actively Ventilated Underground

Initiating Event - Roof Fall	Waste drums Breached?	Mitigation Considered?	Manual Shift to Filtration?	Auto-Shift to Filtration?	Scenario ID	Frequency per Year	Offsite Release Category
Table D-19	L_drum_10		H_filter_UG2	L_filter_UG1	← Source of Event Quantification		



Summary of Radiological Risk

Release Category	Consequence (Rem): Maximum Exposed Onsite Individual	Consequence (Rem): Maximum Exposed Offsite Individual	Frequency (per year): With Mitigation	Frequency (per year): No Mitigation
NR	-	-	1.8E-07	1.8E-07
ESR	2.60E-06	4.30E-07	0.0E+00	-
SR	-	-	-	-
WCR	5.20E+00	8.60E-01	2.9E-07	2.9E-07
Total Frequency			4.7E-07	4.7E-07

LEGEND:
NR: No Release
ESR: Extremely Small Release
SR: Small Release
WCR: IE Worst Case Release

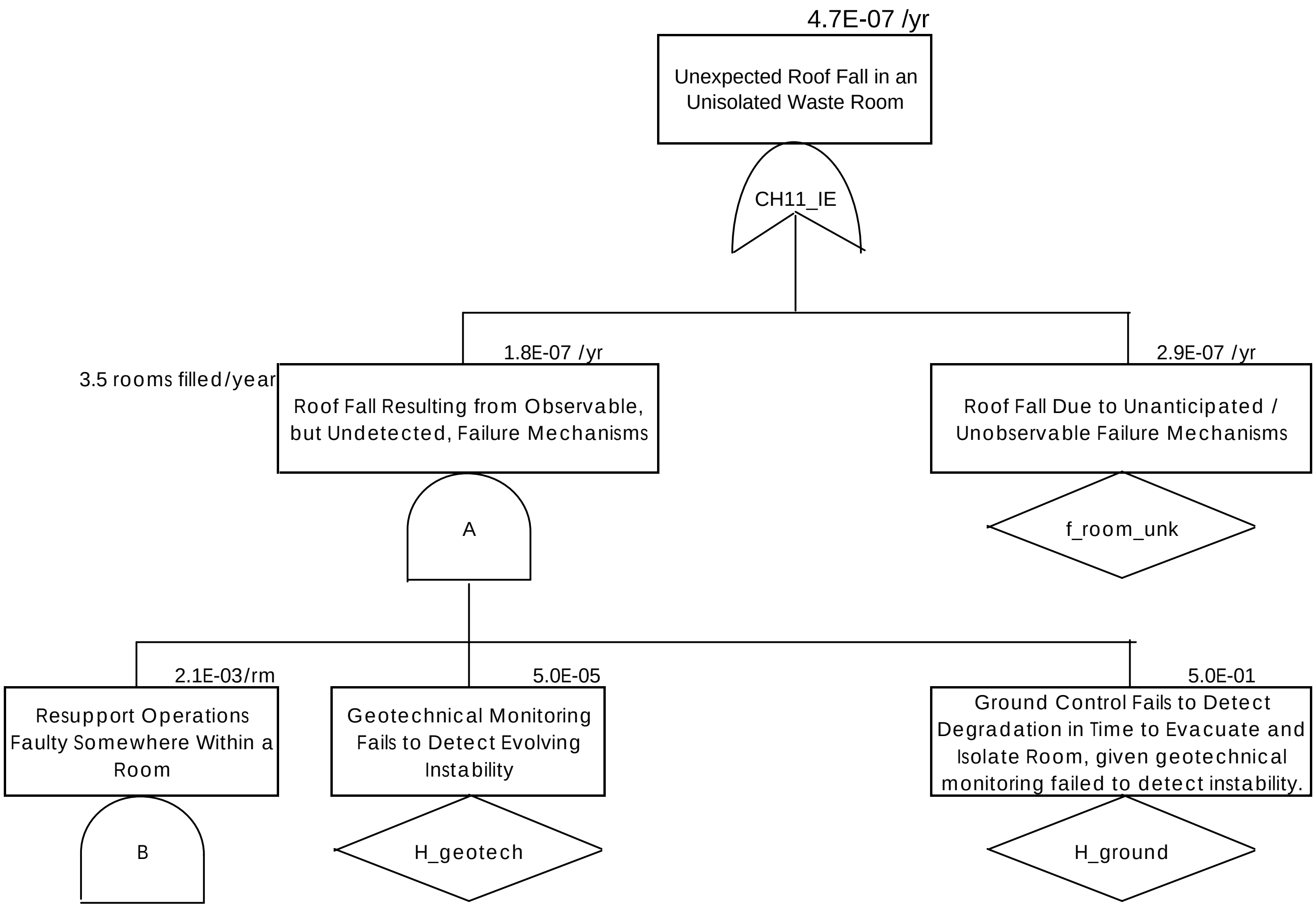
Table D-19, Initiating Event Logic for CH11 - Unexpected Roof Fall on TRU Waste Stack in Actively Ventilated Underground

Variable Name	Description	Formula	Resulting Value	Comments
CH11_IE	Unexpected Roof Fall in an Unisolated Waste Room	= f_room_unk + A	4.7E-07 /yr	
f_room_unk	Roof Fall Due to Unanticipated / Unobservable Failure Mechanisms	= f_roof_unk * (X_CH_active/2) /X_UG_active	2.9E-07 /yr	This event will be sudden and unannounced, but it can occur in any part of the active UG. Only a fall in the fraction of the UG having both CH and active ventilation will produce hazardous materials consequences. On average 1/2 of a room will be filled.
A	Roof Fall Resulting from Observable, but Undetected, Failure Mechanisms	= N_room_yr* H_geotech* H_ground* B	1.8E-07 /yr	Refer to the discussion of roof fall mechanisms in SAR Section 5.2.3.11.
N_room_yr	Average number rooms filled per year	=N_room_yr	3.5 /yr	Based on currently estimated throughput per year.
H_geotech	Geotechnical Monitoring Fails to Detect Evolving Instability	=H_com* H_check* H_High_dep	5.0E-05	At least three successive human errors required for this activity to fail. Refer to the discussion of geotechnical monitoring errors in SAR Section 5.2.3.11.
H_ground	Ground Control Fails to Detect Degradation in Time to Evacuate and Isolate Room, given geotechnical monitoring failed to detect instability.	=H_High_dep	5.0E-01	Ground control ability to detect is limited to that which can be observed in accessible areas. Therefore, there is a high dependence with failure of the geotechnical monitoring program.
B	Resupport Operations Faulty Somewhere Within a Room	= C*H_check	2.1E-03/rm	Estimate is for likelihood that observable unstable conditions could exist anywhere in the room. Instability is then assumed to propagate.
H_check	Torque Test Fails to Detect Bolt Installation Error	=H_check	1.0E-01	Torque testing is modeled as an immediate check of the installation, unless it can be shown as always being done by a crew that is completely independent of the installation crew..
C	Three or More Adjacent Supports Improperly Installed in a Room	= H_bolt_room + f_roof_hardware	2.1E-02/rm	Human error dominates the likelihood. Likelihood is represented for all the operations in the room.

Table D-19, Initiating Event Logic for CH11 - Unexpected Roof Fall on TRU Waste Stack in Actively Ventilated Underground

Variable Name	Description	Formula	Resulting Value	Comments
H_bolt_room	Human Error During Installation of Bolts	=H_com*20	2.0E-02/rm	Error of commission at 3 or more adjacent bolts. One independent opportunity to commit a multiple error of commission per shift. Estimate 20 shifts of teams to complete bolting.
f_roof_hardware	Mechanical failure of bolts or anchor resin	= f_roof_hardware	1.0E-03	Failure rate dominated by resin failure. One in one thousand batches assumed to be bad and not detected.

Figure D-9, Fault Tree for Initiating Event of CH11 - Unexpected Roof Fall on TRU Waste Stack in Actively Ventilated Underground



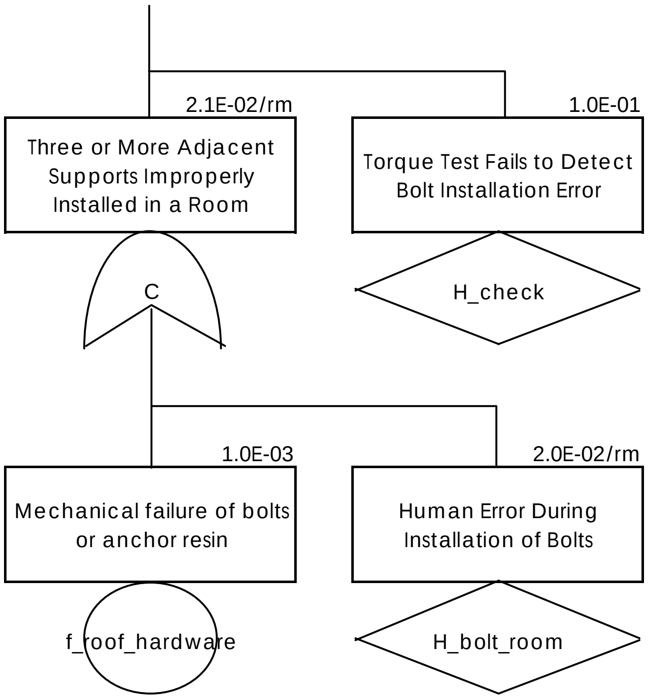

2.1E-02/rm
Three or More Adjacent Supports Improperly Installed in a Room
1.0E-01
Torque Test Fails to Detect Bolt Installation Error
C
H_check
1.0E-03
Mechanical failure of bolts or anchor resin
2.0E-02/rm
Human Error During Installation of Bolts
f_roof_hardware
H_bolt_room

Table D-20, Estimate of Life-Cycle for WHB 6-Ton cranes

Description	Value	Comments
Total scaled volume (m^3) of CH TRU waste authorized for dispersal at the WIPP	168,380	=Vol_CH_WIPP
Volume of one 55-gallon drum (m^3)	0.208 m^3	
Total number of drums that would be disposed at WIPP, if all waste is placed in drums.	809,519	
Total drums/TRUPACT-II	14	
Total TRUPACT-II deliveries	57,823	
Number of crane lifts per TRUPACT-II delivery	5	2 lifts ea for both the inner and outer containment vessel lids, plus the TRUPACT-II payload
Total number of crane lifts	289,114	
Total number of cranes	2	
Total lifts per crane during actual waste handling operations.	144,557	
Design lift cycles per crane	350,000	
Percentage of design lift cycles	41%	Plenty of room for training and partial loads
Number of TRUPACT II shipments to the WIPP per year (= N_7pack_yr/2)	2,912	
Number of years required to deliver TRUPACTS containing the total scaled volume of waste at SAR Section 4.3.1 throughput rate.	19.9	
Crane Design life in years	25	Design life can be extended with good maintenance.
Percentage of Design life to receive scaled volume of waste	79%	Time will be shorter if only stored and projected waste will be shipped to the WIPP, or the throughput is increased.

Table D-21, Comparison of Effective Dose Equivalent to 40CFR191, Subpart A, Paragraph 191.03(b) Standards for the Maximum Exposed Offsite Individual

Accident Scenario ID	Committed Effective Dose Equivalent (Rem)		Release Frequency (per year)		Annual Dose Equivalent (Rem/yr)	
	Unfiltered Release	Filtered Release	Mitigation Systems Fail to Function	Mitigation Systems Function Successfully	Mitigation Systems Fail to Function	Mitigation Systems Function Successfully
CH1	3.80	3.8E-06	5.4E-15	5.4E-11	2.1E-14	2.1E-16
CH2	0.31	3.1E-07	6.1E-07	6.1E-03	1.9E-07	1.9E-09
CH3	0.44	4.4E-07	4.0E-07	8.0E-03	1.8E-07	3.5E-09
CH4	0.10	1.0E-07	1.3E-07	1.3E-03	1.3E-08	1.3E-10
CH5	10.00	1.0E-05	1.9E-10	1.7E-09	1.9E-09	1.7E-14
CH7	5.50	5.5E-06	2.0E-09	Assumed Failed	1.1E-08	
CH9	0.44	4.4E-07	5.9E-04	5.3E-03	2.6E-04	2.3E-09
CH11	0.86	8.6E-07	2.9E-07	Assumed Failed	2.5E-07	
				Total	2.6E-04	7.9E-09

Comparison Requirement	Combined Annual Dose Equivalent	40 CFR 191.03 (b) Standard
Annual Dose Equivalent to the Whole Body	0.26 mrem/yr	< 25 mrem/yr
Annual Dose Equivalent To Most Critical Organ (Surface of Bone)*	4.7 mrem/yr	< 75 mrem/yr

*Ratio of most critical organ dose to whole body CEDE for Pu-239 = 2.11E-03/1.16E-04 = = 18.2

References for Appendix D

1. DOE/WIPP-96-2196, Waste Isolation Pilot Plant TRUDOCK Crane System Analysis, Westinghouse Waste Isolation Division, September, 1996.

2. INEL-94/0226, Safety Analysis Report for the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory.

3. WIPP/WID-96-2178, WIPP Waste Hoist Brake System Analysis. July, 1996.

4. NUREG/CR-1274, Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications, Sandia National Laboratories, Albuquerque, N.M., June, 1983.

5. WSRC-TR-93-581, Savannah River Site Human Error Data Base Development for Nonreactor Nuclear Facilities.

6. PLG-1121, Damage Assessment of Waste Containers Involved in Accidents at the Waste Isolation Pilot Plant, PLG, Inc., August, 1996.

7. DOE/WIPP 87-005, Waste Drum Fire Propagation at the WIPP, April 1987.

8. DOE/WIPP 91-018, Position Paper on Flammability Concerns Associated with TRU Waste Destined for WIPP, Rev. 0, April 1991.

9. DOE/EIS-0026, Final Environmental Impact Statement, Waste Isolation Pilot Plant, 2 Vol., U.S. DOE, Carlsbad, New Mexico, 1980.

10. DOE/CAO-95-1121, U.S. Department of Energy Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report (BIR), Revision 02, December 1995.

11. DOE\WIPP 87-005, Waste Drum Fire Propagation at the WIPP, April 1987.

12. EEG-45, Preliminary Investigation Into the Explosion Potential of Volatile Organic Compounds in WIPP CH-TRU Waste, Environmental Evaluation Group, New Mexico, June, 1990.

13. EEG-48, An Assessment of the Flammability Potential of Transuranic Waste, Environmental Evaluation Group, New Mexico, June, 1991.

14. DOE/WIPP-91-018, Position Paper on Flammability Concerns Associated with TRU Waste Destined for WIPP, April, 1991.

15. DOE/NS-0013, Fire, Explosion, and High-Pressure Hazards Associated with Waste Drums and Containers, DOE Office of Nuclear Safety, Safety Notice Issue No. 93-1, February, 1993.

16. CAO-94-1010, Revision 0, WIPP Quality Assurance Program Plan, U.S. Department of Energy, Carlsbad, N.M., 1995

17. WSTD-TME-063, Probability of a Catastrophic Waste Hoist Accident at the WIPP, July 1985.

18. SMRP No. 155, A Site Specific Study of Wind and Tornado Probabilities at the WIPP Site in Southeast New Mexico, Department of Geophysical Sciences, T. Fujita, February 1978 and Supplement of August 1978.

19. NUREG-800, U.S. Nuclear Regulatory Commission. Standard Review Plan, 3.5.1.6, Aircraft Hazards, Rev. 2, July 1981.

20. DOE/WIPP 93-033, The Current Basis for Roof Fall Prediction at WIPP and the Preliminary Prediction for SPDV Room II, August 1993.

21. DOE/WIPP-91-023, U.S. Department of Energy, Report of the Geotechnical Panel on the Effective Life of Rooms in Panel 1, DOE/WIPP 91-023, Waste Isolation Pilot Plant, Carlsbad, NM, 1991.

22. DOE/WIPP-94-2027, Westinghouse Electric Corporation, Waste Isolation Division, 1994 Panel 1 Utilization Plan, .WIPP/WID-94-2027.

23. DOE/WIPP-96-2180, Westinghouse Geotechnical Engineering, 1996 Long-Term Ground Control Plan for the Waste Isolation Pilot Plant, WIPP/WID-95-2180, June 1996.

24. WIPP-DOE-069, Rev. 4, TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant, December 1991.

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