

APPENDIX E
Source Term/Dose
Calculations

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TABLE E-1 SOURCE TERM ANALYSIS FOR RH 3 LOC IN THE WHB												
CI (PE-Ci)	CD	MAR (PE-Ci)	DR	ARF	CF	CRF	NCF	NCRF	Mit. LPF w/HEPA	Mit. Q (PE-Ci)	Unmit. Q (PE-Ci)	
Direct Load												
80	1	80	1.00E+00	1.00E-03	5.00E-02	1.00E-01	9.50E-01	1.00E+00	1.00E-06	7.64E-08	7.64E-02	
Double Containment												
240	1	240	1.00E-01	1.00E-03	5.00E-02	1.00E-01	9.50E-01	1.00E+00	1.00E-06	2.29E-08	2.29E-02	

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$$

$$Q = (\text{CD} * \text{CI} * \text{DR} * \text{ARF} * ((\text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF}))) * \text{LPF}$$

where:

Q = the source term (Ci)

CD = # of containers damaged

CI = the waste container inventory

$$\text{MAR} = \text{CD} * \text{CI}$$

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

ARF = Airborne Release Fraction = The fraction of radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of the MAR that is combustible

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e. HEPA Filtration, plateout)

TABLE E-2 ON-SITE AND OFF-SITE CONSEQUENCE ANALYSIS FOR RH3 LOC IN THE WHB									
	Q (PE-Ci)	On-Site (100 m) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 m) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
Direct Load	7.64E-08	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	6.58E-05	5.19E-06	3.87E-07
Double Containment	2.29E-08	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	1.97E-05	1.56E-06	1.16E-07
Unmitigated									
Direct Load	7.64E-02	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	6.58E+01	5.19E+00	3.87E-01
Double Containment	2.29E-02	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	1.97E+01	1.56E+00	1.16E-01

Committed Effective Dose Equivalent (CEDE) = D = Q * X/Q * BR * DCF (Ref. Eq. 5-5)

where:

- Q = the source term (Ci)
- X/Q = Site specific air dispersion factor (s/m3)
- BR = Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)
- DCF = Internal Dose Conversion Factor (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.10E+08 rem/Ci)

TABLE E-3 RH3 CHEMICAL SOURCE TERM/ CONSEQUENCE ANALYSIS FOR LOC IN THE WHB										
Compound	MAR (mg/ canister)	CD (canister)	Q (canister) (mg)	RR (sec)	On-site (100 meters) X/Q(s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exclusive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Canister										
methylene chloride*	8.88E+02	1	8.88E+02	1.00E+00	5.07E-03	4.00E-04	2.98E-05	4.50E+00	3.55E-01	2.65E-02
chloroform	8.57E+01	1	8.57E+01	1.00E+00	5.07E-03	4.00E-04	2.98E-05	4.34E-01	3.43E-02	2.55E-03
carbon tetrachloride*	1.64E+03	1	1.64E+03	1.00E+00	5.07E-03	4.00E-04	2.98E-05	8.31E+00	6.56E-01	4.88E-02
1,1,2,2-Tetrachloroethane	4.48E+01	1	4.48E+01	1.00E+00	5.07E-03	4.00E-04	2.98E-05	2.27E-01	1.79E-02	1.34E-03

Limiting On-site Criteria (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
1.25E+04	2.50E+03	0.04%	0.01%	0.00%
2.50E+04	2.50E+02	0.00%	0.01%	0.00%
4.00E+03	6.00E+02	0.21%	0.11%	0.01%
6.00E+02	3.50E+01	0.04%	0.05%	0.00%

$C = (Q \cdot X / Q) / RR$

where:

C = Concentration (mg/m3)

Q = Source Term (mg)

RR = Release rate- the RR is the amount of material suspended in air as a function of time.

X/Q = Site specific air dispersion factor (s/m3)

TABLE E-4 SOURCE TERM ANALYSIS FOR RH4-A LOC IN THE UNDERGROUND (WASTE HOIST DROP)										
Q (PE-Ci)	CD (dropped)	MAR (PE-Ci)	DR	ARF	CF	CRF	NCF	Mit. LPF w/HEPA	Mit. Q (PE-Ci)	Unmit. Q (PE-Ci)
Direct Load										
80	1	80	2.50E-01	1.00E-03	5.00E-02	1.00E-01	9.50E-01	1.00E-06	1.91E-08	1.91E-02
Double Containment										
240	1	240	2.50E-02	1.00E-03	5.00E-02	1.00E-01	9.50E-01	1.00E-06	5.73E-09	5.73E-03

$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$

$Q = (\text{CD} * \text{CI} * \text{DR} * \text{ARF} * ((\text{CF} * \text{CRF}) + \text{NCF})) * \text{LPF}$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (with HEPA filtration)

Unmit. Q = the unmitigated source term (without HEPA filtration)

CD (drop) = # of containers damaged by drop

CI = the waste container inventory

$\text{MAR} = \text{CD} * \text{CI}$

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

ARF = Airborne Release Fraction = The fraction of radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of the MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere (i.e., HEPA filtration; plateout)

TABLE E-5 ON-SITE AND OFF-SITE CONSEQUENCE ANALYSIS FOR RH4-A LOC IN THE UNDERGROUND (WASTE HOIST DROP)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
Direct Load	1.91E-08	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	1.46E-05	1.37E-06	9.44E-08
Double Containment	5.73E-09	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	4.38E-06	4.10E-07	2.83E-08
Unmitigated									
Direct Load	1.91E-02	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	1.46E+01	1.37E+00	9.44E-02
Double Containment	5.73E-03	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	4.38E+00	4.10E-01	2.83E-02

Committed Effective Dose Equivalent (CEDE) = D = Q * X/Q * BR * DCF (Ref. Eq. 5-5)

where:

- Q = the source term (Ci)
- X/Q = Site specific air dispersion factor (s/m3)
- BR = Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)
- DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 re

TABLE E-6 CHEMICAL SOURCE TERM/CONSEQUENCE ANALYSIS FOR RH4-A LOC IN THE UNDERGROUND (WASTE HOIST DROP)

Compound	MAR (mg/ canister)	CD (canisters)	Q (canister) (mg)	RR (1/1 sec)	On-site (100 meters) X/Q(s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exclusive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Canisters										
methylene chloride	8.87E+02	1	8.87E+02	1.00E+00	4.50E-03	4.21E-04	2.91E-05	3.99E+00	3.74E-01	2.58E-02
chloroform	8.57E+01	1	8.57E+01	1.00E+00	4.50E-03	4.21E-04	2.91E-05	3.86E-01	3.61E-02	2.49E-03
carbon tetrachloride	1.64E+03	1	1.64E+03	1.00E+00	4.50E-03	4.21E-04	2.91E-05	7.38E+00	6.90E-01	4.77E-02
1,1,2,2-Tetrachloroethane	4.48E+01	1	4.48E+01	1.00E+00	4.50E-03	4.21E-04	2.91E-05	2.02E-01	1.89E-02	1.30E-03

Limiting On-site Criteria (100meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
1.25E+04	2.50E+03	0.03%	0.01%	0.00%
2.50E+04	2.50E+02	0.00%	0.01%	0.00%
4.00E+03	6.00E+02	0.18%	0.12%	0.01%
6.00E+02	3.50E+01	0.03%	0.05%	0.00%

CONCENTRATION (C)=(Q*X/Q)/RR (Ref. Eq. 5-6)

where:

- Q = the source term (Ci)
- RR =release rate- the RR is the amount of material suspended in air as a function of time.
- X/Q =Site specific air dispersion factor (s/m3)

TABLE E-7 SOURCE TERM ANALYSIS FOR RH4-B LOC IN THE U/G FORKLIFT DROP OF WASTE CANISTER										
CI (PE-Ci)	CD (containers)	MAR (PE-Ci)	DR	ARF	CF	CRF	NCF	Mit. LPF w/HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
Direct Load										
80	1	80	1.00E-02	1.00E-03	5.00E-02	1.00E-01	9.50E-01	1.00E-06	7.64E-10	7.64E-04
Double Containment										
240	1	240	1.00E-03	1.00E-03	5.00E-02	1.00E-01	9.50E-01	1.00E-06	2.29E-10	2.29E-04

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$$

$$Q = (\text{CI} * \text{CD}) * \text{DR} * \text{ARF} * ((\text{CF} * \text{CRF}) + (\text{NCF})) * \text{LPF}$$

where:

Mit.Q = the mitigated source term (*with* HEPA filtration)

Unmit. Q = the unmitigated source term (*without* HEPA filtration)

CD = # of containers involved

CI = the waste container inventory (PE-Ci)

MAR = Material at Risk = CD * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

ARF = Airborne Release Fraction-The fraction of radioactive material that is suspended in air.

CF = Combustible Fraction = Fraction of the waste that is combustible=1 for this analysis.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

Mit.LPF = Leakpath Factor = The cumulative fraction of airborne material that escapes to the atmosphere (i.e.,HEPA filtration; plateout)

Unmit. LPF = Unmitigated Leakpath Factor =(1 for this scenario and, therefore, not represented in the table)=The cumulative fraction of airborne material that escapes to the atmosphere.

TABLE E-8 ON-SITE AND OFF-SITE CONSEQUENCE ANALYSIS FOR RH4-B LOC IN THE U/G FORKLIFT DROP OF WASTE CANISTER									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
Direct Load	7.64E-10	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	5.84E-07	5.46E-08	3.78E-09
Double Containment	2.29E-10	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	1.75E-07	1.64E-08	1.13E-09
Unmitigated									
Direct Load	7.64E-04	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	5.84E-01	5.46E-02	3.78E-03
Double Containment	2.29E-04	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	1.75E-01	1.64E-02	1.13E-03

Committed Effective Dose Equivalent (CEDE) = D = Q*X/Q*BR*DCF

where:

D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)

Q = the source term (Ci)

X/Q = Site specific air dispersion factor (s/m3)

BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)

DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public

(Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.10E+08 rem/Ci)

TABLE E-9 CHEMICAL SOURCE TERM/CONSEQUENCE ANALYSIS FOR RH4-B DROP OF WASTE CANISTER FROM FORKLIFT IN THE UNDERGROUND

Compound	MAR (mg/canister)	CD (canister)	Q (drums) (mg)	RR (1/1 sec)	On-site (100 meters) X/Q(s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exclusive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Canister										
methylene chloride*	8.88E+ 02	1	8.88E+02	1.00E+00	4.50E-03	4.21E-04	2.91E-05	4.00E+00	3.74E-01	2.58E-02
chloroform	8.57E+ 01	1	8.57E+01	1.00E+00	4.50E-03	4.21E-04	2.91E-05	3.86E-01	3.61E-02	2.49E-03
carbon tetrachloride*	1.64E+ 03	1	1.64E+03	1.00E+00	4.50E-03	4.21E-04	2.91E-05	7.38E+00	6.90E-01	4.77E-02
1,1,2,2-Tetrachloroethane	4.48E+ 01	1	4.48E+01	1.00E+00	4.50E-03	4.21E-04	2.91E-05	2.02E-01	1.89E-02	1.30E-03

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
2.50E+03	6.00E+02	0.16%	0.06%	0.00%
2.50E+02	1.00E+01	0.15%	0.36%	0.02%
6.00E+02	1.25E+02	1.23%	0.55%	0.04%
3.50E+01	2.00E+01	0.58%	0.09%	0.01%

$C = (Q * X / Q) / RR$

- C =Concentration (mg/m3)
- Q = Source Term (mg)
- RR = Release Rate=The RR is the amount of material suspended in air as a function of time = 1/1 sec.G24:G25
- X/Q =Dispersion Coefficient (mg)

TABLE E-10 SOURCE TERM ANALYSIS FOR RH5 FIRE FOLLOWED BY EXPLOSION IN THE UNDERGROUND (BDBA)														
	CI (PE-Ci)	CD (damaged)	MAR (PE-Ci)	DR	ARF	CF	CRF	NCF	NCRF	Source Term (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
Direct Load	80	1	80	1.00E-02	1.00E-03	5.00E-02	1.00E-01	9.50E-01	1.00E+00	7.64E-04	1.00E-06	1.00E+00	7.64E-10	7.64E-04
Double Containment	240	1	240	1.00E-03	1.00E-03	5.00E-02	1.00E-01	9.50E-01	1.00E+00	2.29E-04	1.00E-06	1.00E+00	2.29E-10	2.29E-04

$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$

$Q = \text{CD} * \text{CI} * \text{DR} * \text{ARF} * ((\text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF})) * \text{LPF}$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (with HEPA filtration)

Unmit. Q = the unmitigated source term (without HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

ARF = Airborne Release Fraction-The fraction of radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

TABLE E-11 CONSEQUENCE ANALYSIS FOR RH5 FIRE FOLLOWED BY EXPLOSION IN THE UNDERGROUND (BDBA)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
Direct Load	7.64E-10	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	5.84E-07	5.46E-08	3.78E-09
Double Containment	2.29E-10	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	1.75E-07	1.64E-08	1.13E-09
Unmitigated									
Direct Load	7.64E-04	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	5.84E-01	5.46E-02	3.78E-03
Double Containment	2.29E-04	4.50E-03	4.21E-04	2.91E-05	3.33E-04	5.10E+08	1.75E-01	1.64E-02	1.13E-03

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

- D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)
- Q = the source term (Ci)
- X/Q = Site specific air dispersion factor (s/m3)
- BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)
- DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public
(Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-12 CHEMICAL SOURCE TERM/CONSEQUENCE ANALYSIS FOR RH5 FIRE FOLLOWED BY EXPLOSION IN THE UNDERGROUND (BDBA)

Compound	MAR (mg/ canister)	CD (canister)	Q (drums) (mg)	RR (sec)	On-site (100 m) X/Q(s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exclusive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Canister										
methylene chloride*	8.88E+ 02	1	8.88E+02	1.00E+00	4.50E-03	4.21E-04	2.91E-05	4.00E+00	3.74E-01	2.58E-02
chloroform	8.57E+ 01	1	8.57E+01	1.00E+00	4.50E-03	4.21E-04	2.91E-05	3.86E-01	3.61E-02	2.49E-03
carbon tetrachloride*	1.64E+ 03	1	1.64E+03	1.00E+00	4.50E-03	4.21E-04	2.91E-05	7.38E+00	6.90E-01	4.77E-02
1,1,2,2-Tetrachloroethane	4.48E+ 01	1	4.48E+01	1.00E+00	4.50E-03	4.21E-04	2.91E-05	2.02E-01	1.89E-02	1.30E-03

Limiting On-site Criteria (100 m) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 m)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
1.25E+04	2.50E+03	0.03%	0.01%	0.00%
2.50E+04	2.50E+02	0.00%	0.01%	0.00%
4.00E+03	6.00E+02	0.18%	0.12%	0.01%
6.00E+02	3.50E+01	0.03%	0.05%	0.00%

$C = (Q \cdot X / Q) / RR$

- C =Concentration (mg/m3)
- Q = Source Term (mg)
- RR = Release Rate=The RR is the amount of material suspended in air as a function of time
- X/Q =Dispersion Coefficient (mg)

TABLE E-13 IMMEDIATE WORKER CONSEQUENCE ANALYSIS FOR RH4-A LOC IN THE U/G (WASTE HOIST DROP)						
	Q (PE-Ci)	V (m3)	T (sec)	BR (m3/s)	DCF (rem/Ci)	CEDE (rem)
Waste Container						
Direct Load	1.91E-02	2.80E+01	1.00E+00	3.33E-04	5.10E+08	1.16E+02
Double Containment	5.73E-03	2.80E+01	1.00E+00	3.33E-04	5.10E+08	3.48E+01

$$D = (Q * T * BR * DCF) / V \text{ (Ref. Eq. 5-7)}$$

where:

- D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)
- Q = Radiological source term (Ci)
- T = Exposure time in seconds (depends on the scenario)
- BR = Breathing rate (standard man) (m3/s)
- DCF = Dose conversion factor (rem/Ci)
- V = Volume (m3) - Based on area at the Hoist Shaft

TABLE E-14 IMMEDIATE WORKER CONSEQUENCE ANALYSIS FOR RH4-B LOC IN THE U/G FORKLIFT DROP						
	Q (PE-Ci)	V (m3)	T (sec)	BR (m3/s)	DCF (rem/Ci)	CEDE (rem)
Waste Container						
Direct Load	7.64E-04	2.40E+01	1.00E+00	3.33E-04	5.10E+08	5.41E+00
Double Containment	2.29E-04	2.40E+01	1.00E+00	3.33E-04	5.10E+08	1.62E+00

$$D = (Q * T * BR * DCF) / V \text{ (Ref. Eq. 5-7)}$$

where:

- D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)
- Q = Radiological source term (Ci)
- T = Exposure time in seconds (depends on the scenario)
- BR = Breathing rate (standard man) (m3/s)
- DCF = Dose conversion factor (rem/Ci)
- V = Volume (m3) - Based on the area in the drift

TABLE E-15 IMMEDIATE WORKER CONSEQUENCE ANALYSIS FOR RH5 FIRE FOLLOWED BY EXPLOSION IN THE U/G (BDDBA)						
	Q (PE-Ci)	V (m3)	T (sec)	BR (m3/s)	DCF (rem/Ci)	CEDE (rem)
Waste Container						
Direct Load	7.64E-04	2.40E+01	1.00E+00	3.33E-04	5.10E+08	5.41E+00
Double Containment	2.29E-04	2.40E+01	1.00E+00	3.33E-04	5.10E+08	1.62E+00

$$D = (Q * T * BR * DCF) / V \text{ (Ref. Eq. 5-7)}$$

where:

- D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)
- Q = Radiological source term (Ci)
- T = Exposure time in seconds (depends on the scenario)
- BR = Breathing rate (standard man) (m3/s)
- DCF = Dose conversion factor (rem/Ci)
- V = Volume of expanding cloud at time to reach receptor (m3) - Based on the area in the drift

TABLE E-16 IMMEDIATE WORKER CHEMICAL CONSEQUENCE ANALYSIS FOR RH4-A LOC IN THE U/G (WASTE HOIST DROP)								
	MAR canister (mg)	CD (canister)	RR (1/1 sec)	Q (canister) (mg)	V (m3)	Canister C (mg/m3)	Limit (mg/m3)	Canister Ratio (Conc /limit)
methylene chloride	8.88E+02	1	1.00E+00	8.88E+02	2.80E+01	3.17E+01	1.25E+04	0.25%
chloroform	8.57E+01	1	1.00E+00	8.57E+01	2.80E+01	3.06E+00	2.50E+04	0.01%
carbon tetrachloride	1.64E+03	1	1.00E+00	1.64E+03	2.80E+01	5.85E+01	4.00E+03	1.46%
1,1,2,2-Tetrachloroethane	4.48E+01	1	1.00E+00	4.48E+01	2.80E+01	1.60E+00	6.00E+02	0.27%

$$C=(Q*T)/(RR*V) \text{ (Ref. Eq. 5-8)}$$

where:

C = Concentration (mg/m3)

Q = Source Term (mg)

RR = Release Rate = The amount of material suspended in air as a function of time.

T = Time of exposure = 1 second for this scenario.

V = Volume (m3) - Based on the area of the Waste Hoist Shaft

TABLE E-17 IMMEDIATE WORKER CHEMICAL CONSEQUENCE ANALYSIS FOR RH4-B LOC IN THE U/G								
	MAR canister (mg)	CD (canister)	RR (1/1 sec)	Q (canister) (mg)	V (m3)	Canister C (mg/m3)	Limit (mg/m3)	Canister Ratio (Conc /limit)
Chemical								
methylene chloride	8.88E+02	1	1.00E+00	8.88E+02	2.40E+01	3.70E+01	1.25E+04	0.30%
chloroform	8.57E+01	1	1.00E+00	8.57E+01	2.40E+01	3.57E+00	2.50E+04	0.01%
carbon tetrachloride	1.64E+03	1	1.00E+00	1.64E+03	2.40E+01	6.83E+01	4.00E+03	1.71%
1,1,2,2-Tetrachloroethane	4.48E+01	1	1.00E+00	4.48E+01	2.40E+01	1.87E+00	6.00E+02	0.31%

$$C=(Q*T)/(RR*V) \text{ (Ref. Eq. 5-8)}$$

where:

- C = Concentration (mg/m3)
- Q = Source Term (mg)
- RR = Release Rate = The amount of material suspended in air as a function of time.
- T = Time of exposure = 1 second for this scenario.
- V = Volume (m3) - Based on the area in the drift

TABLE E-18 SOURCE TERM ANALYSIS FOR NC1 FIRE IN THE HOT CELL													
CD (damaged)	MAR (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Source Term -Q (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
1	20	1.00E+00	5.00E-04	9.50E-01	1.00E+00	6.00E-03	5.00E-02	1.00E-02	9.56E-03	1.00E-06	1.00E+00	9.56E-09	9.56E-03

$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$

$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (*with* HEPA filtration)

Unmit. Q = the unmitigated source term (*without* HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

TABLE E-19 CONSEQUENCE ANALYSIS FOR NC1 FIRE IN THE HOT CELL									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	9.56E-09	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	8.23E-06	6.49E-07	4.84E-08
Unmitigated									
	9.56E-03	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	8.23E+00	6.49E-01	4.84E-02

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)

Q = the source term (Ci)

X/Q = Site specific air dispersion factor (s/m3)

BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)

DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public

(Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-20 CHEMICAL SOURCE TERM ANALYSIS FOR NC1 FIRE IN THE HOT CELL											
Compound	CD (damaged)	MAR (mg)	DR	CARF	CF	CRF	NCF	NCRF	NCARF	LPF	Q(mg)
Chemical (Solid)											
Asbestos	1	2.98E+05	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	2.32E+01
Beryllium	1	2.31E+04	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	1.80E+00
Cadmium	1	3.31E+02	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	2.58E-02
Lead	1	9.15E+05	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	7.13E+01
Chemical (Liquid)											
Butyl Alcohol	1	3.31E+05	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	2.58E+01
Carbon Tetrachloride	1	6.94E+05	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	5.41E+01
Mercury	1	3.86E+05	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	5.00E-01	1.50E+01
Methyl Alcohol	1	8.82E+02	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	6.87E-02
Methylene Chloride	1	4.41E+04	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	3.44E+00
Polychlorinated Biphenyl (PCB)	1	9.37E+05	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	7.30E+01
Trichloroethylene	1	4.30E+05	1.63E-01	5.00E-04	9.50E-01	1.00E+00	5.00E-02	1.00E-02	6.00E-03	1.00E+00	3.35E+01

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$$

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR =(CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF =Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-21 CHEMICAL CONSEQUENCE ANALYSIS FOR NC1 FIRE IN THE HOT CELL

Compound	Q (mg)	LPF	RR (1/1 sec)	On-site C (mg/m3) (100 meters)	Exclusive Use Area C (mg/m3)	Site Boundary C (mg/m3)	Ratio conc/limit 100 meters	Ratio conc/limit Exclusive Use Area	Ratio conc/limit Site Boundary
Chemical (Solid)									
Asbestos	2.32E+01	1.00E+00	9.00E+02	1.01E-03	7.94E-05	5.91E-06	0.00%	0.01%	0.00%
Beryllium	1.80E+00	1.00E+00	9.00E+02	1.01E-05	8.00E-07	5.96E-08	0.01%	0.00%	0.00%
Cadmium	2.58E-02	1.00E+00	9.00E+02	1.45E-07	1.15E-08	8.54E-10	0.00%	0.00%	0.00%
Lead	7.13E+01	1.00E+00	9.00E+02	4.02E-04	3.17E-05	2.36E-06	0.00%	0.01%	0.00%
Chemical (Liquid)									
Butyl Alcohol	2.58E+01	1.00E+00	9.00E+02	1.45E-04	1.15E-05	8.54E-07	0.00%	0.00%	0.00%
Carbon Tetrachloride	5.41E+01	1.00E+00	9.00E+02	3.05E-04	2.40E-05	1.79E-06	0.00%	0.00%	0.00%
Mercury	1.50E+01	5.00E-01	9.00E+02	4.24E-05	3.34E-06	2.49E-07	0.00%	0.00%	0.00%
Methyl Alcohol	6.87E-02	1.00E+00	9.00E+02	3.87E-07	3.05E-08	2.28E-09	0.00%	0.00%	0.00%
Methylene Chloride	3.44E+00	1.00E+00	9.00E+02	1.94E-05	1.53E-06	1.14E-07	0.00%	0.00%	0.00%
Polychlorinated Biphenyl (PCB)	7.30E+01	1.00E+00	9.00E+02	4.11E-04	3.24E-05	2.42E-06	0.01%	0.00%	0.00%
Trichloroethylene	3.35E+01	1.00E+00	9.00E+02	1.89E-04	1.49E-05	1.11E-06	0.00%	0.00%	0.00%

$C = (Q * LPF * X / Q) / RR$ (Ref. Eq. 5-6)

where:

Q = Source Term

RR = Release Rate - the amount of material suspended in air as a function of time

LPF = Leak Path Factor

X/Q = Site specific air dispersion factor (s/m3)

100 meter X/Q = 5.07E-03

Exclusive Use Area X/Q = 4.00E-04

Site Boundary X/Q = 2.98E-05

Chemical	On Site Limit	Off Site Limit
Asbestos	5.00E+02	1.00E+00
Beryllium	1.00E-01	2.50E-02
Cadium	9.00E+00	4.00E+00
Lead	1.00E+02	2.50E-01
Butyl Alcohol	4.00E+03	1.50E+02
Carbon Tet	4.00E+03	6.00E+02
Mercury	4.10E+00	2.50E+00
Methyl Alcohol	6.00E+03	1.25E+03
Methylene Chloride	1.25E+04	2.50E+03
PCBs	5.00E+00	2.50E+00
Trichloroethylene	2.50E+04	2.50E+03

TABLE E-22 SOURCE TERM ANALYSIS FOR NC3-A LOC IN THE RH BAY AND HOT CELL (DROPPED OBJECT ON WASTE IN HOT CELL)

CI (PE-Ci)	CD (damaged)	MAR (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Source Term (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
20	1	20	1.00E-01	1.00E-03	5.00E-02	1.00E-01	1.00E-03	9.50E-01	1.00E+00	1.91E-03	1.00E-06	1.00E+00	1.91E-09	1.91E-03

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (*with* HEPA filtration)

Unmit. Q = the unmitigated source term (*without* HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-23 CONSEQUENCE ANALYSIS FOR NC3-A LOC IN THE WHB (DROPPED OBJECT ON WASTE IN HOT CELL)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	1.91E-09	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	1.64E-06	1.30E-07	9.67E-09
Unmitigated									
	1.91E-03	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	1.64E+00	1.30E-01	9.67E-03

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)

Q = the source term (Ci)

X/Q = Site specific air dispersion factor (s/m3)

BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)

DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-24 VOC CHEMICAL SOURCE TERM ANALYSIS FOR NC3-A LOC IN THE WHB (DROPPED OBJECT ON WASTE IN HOT CELL)

Compound	CI (mg)	CD	MAR (mg)	DR	CF	CRF	CARF	NCF	NCRF	NCARF	Q (mg)
Chemical											
Methylene Chloride	2.03E+02	10	2.03E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	2.03E+03
Chloroform	1.96E+01	10	1.96E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.96E+02
1,1,2,2- Tetrachloroethane	1.03E+01	10	1.03E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.03E+02
Carbon Tetrachloride	3.75E+02	10	3.75E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	3.75E+03

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF} * \text{NCARF}))$$

where:

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e., HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-25 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-A LOC IN THE WHB (DROPPED OBJECT ON WASTE IN HOT CELL)

Compound	Q (mg)	LPF	RR (sec)	On-site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exculsive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Chemical									
Methylene Chloride	2.03E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.03E+01	8.14E-01	6.06E-02
Chloroform	1.96E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	9.96E-01	7.86E-02	5.85E-03
1,1,2,2- Tetrachloroethane	1.03E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	5.20E-01	4.10E-02	3.06E-03
Carbon Tetrachloride	3.75E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.90E+01	1.50E+00	1.12E-01

CONCENTRATION (C)=(Q*LPF*X/Q)/RR (Ref. Eq. 5-6)

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
2.50E+03	6.00E+02	0.41%	0.14%	0.01%
2.50E+02	1.00E+01	0.40%	0.79%	0.06%
3.50E+01	2.00E+01	1.49%	0.21%	0.02%
6.00E+02	1.25E+02	3.17%	1.20%	0.09%

where:

- Q = Source Term
- RR =Release rate- the RR is the amount of material suspended in air as a function of time.
- X/Q =Site specific air dispersion factor (s/m3)
- LPF =Leak Path Factor

TABLE E-26 SOURCE TERM ANALYSIS FOR NC3-B LOC IN THE WHB (DROPPED OBJECT ON WASTE OUTSIDE HOT CELL)													
CD (damaged)	CI (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Q (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
1	20	1.00E-01	1.00E-03	5.00E-02	1.00E-01	1.00E-03	9.50E-01	1.00E+00	1.91E-03	1.00E-06	1.00E+00	1.91E-09	1.91E-03

$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$

$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (*with* HEPA filtration)

Unmit. Q = the unmitigated source term (*without* HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF =Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-27 CONSEQUENCE ANALYSIS FOR NC3-B LOC IN THE WHB (DROPPED OBJECT ON WASTE OUTSIDE HOT CELL)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	1.91E-09	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	1.64E-06	1.30E-07	9.67E-09
Unmitigated									
	1.91E-03	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	1.64E+00	1.30E-01	9.67E-03

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)

Q = the source term (Ci)

X/Q = Site specific air dispersion factor (s/m3)

BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)

DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public
(Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-28 VOC CHEMICAL SOURCE TERM ANALYSIS FOR NC3-B LOC IN THE WHB (DROPPED OBJECT ON WASTE OUTSIDE HOT CELL)

Compound	CI (mg)	CD	MAR (mg)	DR	CF	CRF	CARF	NCF	NCRF	NCARF	Q (mg)
Chemical											
Methylene Chloride	2.03E+02	5	1.02E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.02E+03
Chloroform	1.96E+01	5	9.82E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	9.82E+01
1,1,2,2- Tetrachloroethane	1.03E+01	5	5.13E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	5.13E+01
Carbon Tetrachloride	3.75E+02	5	1.88E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.88E+03

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF} * \text{NCARF}))$$

where:

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e., HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-29 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-B LOC IN THE WHB (DROPPED OBJECT ON WASTE OUTSIDE HOT CELL)

Compound	Q (mg)	LPF	RR (sec)	On-site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exculsive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Chemical									
Methylene Chloride	1.02E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	5.16E+00	4.07E-01	3.03E-02
Chloroform	9.82E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	4.98E-01	3.93E-02	2.93E-03
1,1,2,2- Tetrachlorothane	5.13E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	2.60E-01	2.05E-02	1.53E-03
Carbon Tetracholride	1.88E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	9.52E+00	7.51E-01	5.59E-02

CONCENTRATION (C)=(Q*LPF*X/Q)/RR (Ref. Eq. 5-6)

where:

- Q = Source Term
- RR =Release rate- the RR is the amount of material suspended in air as a function of time
- X/Q =Site specific air dispersion factor (s/m3)
- LPF =Leak Path Factor

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
2.50E+03	6.00E+02	0.21%	0.07%	0.01%
2.50E+02	1.00E+01	0.20%	0.39%	0.03%
3.50E+01	2.00E+01	0.74%	0.10%	0.01%
6.00E+02	1.25E+02	1.59%	0.60%	0.04%

TABLE E-30 RADIOLOGICAL SOURCE TERM FOR NC3-C LOC IN THE WHB (DROPPED DRUM OR CANISTER IN HOT CELL)

CD (damaged)	CI (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Q (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
2	20	2.50E-02	1.00E-03	5.00E-02	1.00E-01	1.00E-03	9.50E-01	1.00E+00	9.55E-04	1.00E-06	1.00E+00	9.55E-10	9.55E-04

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (*with* HEPA filtration)

Unmit. Q = the unmitigated source term (*without* HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF =Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-31 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR NC3-C LOC IN THE WHB (DROPPED DRUM OR CANISTER IN HOT CELL)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	9.55E-10	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	8.22E-07	6.49E-08	4.83E-09
Unmitigated									
	9.55E-04	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	8.22E-01	6.49E-02	4.83E-03

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

- D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)
- Q = the source term (Ci)
- X/Q = Site specific air dispersion factor (s/m3)
- BR = C31Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)
- DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-32 VOC CHEMICAL SOURCE TERM ANALYSIS FOR NC3-C LOC IN THE WHB (DROPPED DRUM OR CANISTER IN HOT CELL)											
Compound	CI (mg)	CD	MAR (mg)	DR	CF	CRF	CARF	NCF	NCRF	NCARF	Q (mg)
Chemical											
Methylene Chloride	2.03E+02	2	4.07E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	4.07E+02
Chloroform	1.96E+01	2	3.93E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	3.93E+01
1,1,2,2- Tetrachloroethane	1.03E+01	2	2.05E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	2.05E+01
Carbon Tetrachloride	3.75E+02	2	7.51E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	7.51E+02

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF} * \text{NCARF}))$$

where:

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF =Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-33 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-C LOC IN THE WHB (DROPPED DRUM OR CANISTER IN HOT CELL)									
Compound	Q (mg)	LPF	RR (sec)	On-site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exculsive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Chemical									
Methylene Chloride	4.07E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	2.06E+00	1.63E-01	1.21E-02
Chloroform	3.93E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.99E-01	1.57E-02	1.17E-03
1,1,2,2- Tetrachlorothane	2.05E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.04E-01	8.21E-03	6.12E-04
Carbon Tetracholride	7.51E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	3.81E+00	3.00E-01	2.24E-02

CONCENTRATION (C)=(Q*LPF*X/Q)/RR (Ref. Eq. 5-6)

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
2.50E+03	6.00E+02	0.08%	0.03%	0.00%
2.50E+02	1.00E+01	0.08%	0.16%	0.01%
3.50E+01	2.00E+01	0.30%	0.04%	0.00%
6.00E+02	1.25E+02	0.63%	0.24%	0.02%

where:

- Q = Source Term
- RR =release rate- the RR is the amount of material suspended in air as a function of time.
- X/Q =Site specific air dispersion factor (s/m3)
- LPF =Leak Path Factor

TABLE E-34 RADIOLOGICAL SOURCE TERM FOR NC3-D LOC IN THE WHB (DROPPED DRUM OR CANISTER OUTSIDE HOT CELL)													
CD (damaged)	CI (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Q (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
1	20	2.50E-02	1.00E-03	5.00E-02	1.00E-01	1.00E-03	9.50E-01	1.00E+00	4.78E-04	1.00E-06	1.00E+00	4.78E-10	4.78E-04

$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$

$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (with HEPA filtration)

Unmit. Q = the unmitigated source term (without HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-35 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR NC3-D LOC IN THE WHB (DROPPED DRUM OR CANISTER OUTSIDE HOT CELL)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	4.78E-10	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	4.11E-07	3.24E-08	2.42E-09
Unmitigated									
	4.78E-04	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	4.11E-01	3.24E-02	2.42E-03

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)

Q = the source term (Ci)

X/Q = Site specific air dispersion factor (s/m3)

BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)

DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-37 VOC CHEMICAL SOURCE TERM ANALYSIS FOR NC3-D LOC IN THE WHB (DROPPED DRUM OR CANISTER OUTSIDE HOT CELL)											
Compound	CI (mg)	CD	MAR (mg)	DR	CF	CRF	CARF	NCF	NCRF	NCARF	Q (mg)
Chemical											
Methylene Chloride	2.03E+02	10	2.03E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	2.03E+03
Chloroform	1.96E+01	10	1.96E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.96E+02
1,1,2,2- Tetrachloroethane	1.03E+01	10	1.03E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.03E+02
Carbon Tetrachloride	3.75E+02	10	3.75E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	3.75E+03

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF} * \text{NCARF}))$$

where:

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e., HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-37 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-D LOC IN THE WHB (DROPPED DRUM OR CANISTER OUTSIDE HOT CELL)

Compound	Q (mg)	LPF	RR (sec)	On-site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exculsive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Chemical									
Methylene Chloride	2.03E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.03E+01	8.14E-01	6.06E-02
Chloroform	1.96E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	9.96E-01	7.86E-02	5.85E-03
1,1,2,2- Tetrachlorothane	1.03E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	5.20E-01	4.10E-02	3.06E-03
Carbon Tetracholride	3.75E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.90E+01	1.50E+00	1.12E-01

CONCENTRATION (C)=(Q*LPF*X/Q)/RR (Ref. Eq. 5-6)

where:

- Q = Source Term
- RR =Release rate- the RR is the amount of material suspended in air as a function of time.
- X/Q =Site specific air dispersion factor (s/m3)
- LPF =Leak Path Factor

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters) Exclusive Use Area	Ratio (conc/limit) Site Boundary
2.50E+03	6.00E+02	0.41%	0.14%
2.50E+02	1.00E+01	0.40%	0.79%
3.50E+01	2.00E+01	1.49%	0.21%
6.00E+02	1.25E+02	3.17%	1.20%

TABLE E-38 RADIOLOGICAL SOURCE TERM FOR NC3-E LOC IN THE WHB (PUNCURE DRUM IN HOT CELL)													
CD (damaged)	CI (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Q (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
1	20	5.00E-02	1.00E-03	5.00E-02	1.00E-01	1.00E-03	9.50E-01	1.00E+00	9.55E-04	1.00E-06	1.00E+00	9.55E-10	9.55E-04

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (*with* HEPA filtration)

Unmit. Q = the unmitigated source term (*without* HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF =Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-39 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR NC3-E LOC IN THE WHB (PUNCURE DRUM IN HOT CELL)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	9.55E-10	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	8.22E-07	6.49E-08	4.83E-09
Unmitigated									
	9.55E-04	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	8.22E-01	6.49E-02	4.83E-03

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)

Q = the source term (Ci)

X/Q = Site specific air dispersion factor (s/m3)

BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)

DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-40 VOC CHEMICAL SOURCE TERM ANALYSIS FOR NC3-E LOC IN THE WHB (PUNCURE DRUM IN HOT CELL)											
Compound	CI (mg)	CD	MAR (mg)	DR	CF	CRF	CARF	NCF	NCRF	NCARF	Q (mg)
Chemical											
Methylene Chloride	2.03E+02	1	2.03E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	2.03E+02
Chloroform	1.96E+01	1	1.96E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.96E+01
1,1,2,2- Tetrachloroethane	1.03E+01	1	1.03E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.03E+01
Carbon Tetrachloride	3.75E+02	1	3.75E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	3.75E+02

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF} * \text{NCARF}))$$

where:

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e., HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-41 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-E LOC IN THE WHB (PUNCURE DRUM IN HOT CELL)									
Compound	Q (mg)	LPF	RR (sec)	On-site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exculsive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Chemical									
Methylene Chloride	2.03E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.03E+00	8.14E-02	6.06E-03
Chloroform	1.96E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	9.96E-02	7.86E-03	5.85E-04
1,1,2,2- Tetrachlorothane	1.03E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	5.20E-02	4.10E-03	3.06E-04
Carbon Tetracholride	3.75E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.90E+00	1.50E-01	1.12E-02

CONCENTRATION (C)=(Q*LPF*X/Q)/RR (Ref. Eq. 5-6)

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
2.50E+03	6.00E+02	0.04%	0.01%	0.00%
2.50E+02	1.00E+01	0.04%	0.08%	0.01%
3.50E+01	2.00E+01	0.15%	0.02%	0.00%
6.00E+02	1.25E+02	0.32%	0.12%	0.01%

where:

- Q = Source Term
- RR =release rate- the RR is the amount of material suspended in air as a function of time.
- X/Q =Site specific air dispersion factor (s/m3)
- LPF =Leak Path Factor

TABLE E-42 RADIOLOGICAL SOURCE TERM FOR NC3-F LOC IN THE WHB (PUNCURE DRUM OR CANISTER OUTSIDE HOT CELL)													
CD (damaged)	CI (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Q (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
3	20	5.00E-02	1.00E-03	5.00E-02	1.00E-01	1.00E-03	9.50E-01	1.00E+00	2.87E-03	1.00E-06	1.00E+00	2.87E-09	2.87E-03

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (with HEPA filtration)

Unmit. Q = the unmitigated source term (without HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-43 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR NC3-F LOC IN THE WHB (PUNCURE DRUM OR CANISTER OUTSIDE HOT CELL)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	2.87E-09	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	2.47E-06	1.95E-07	1.45E-08
Unmitigated									
	2.87E-03	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	2.47E+00	1.95E-01	1.45E-02

Committed Effective Dose Equivalent (CEDE) = D = Q*X/Q*BR*DCF (Ref. Eq. 5-5)

where:

D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)

Q = the source term (Ci)

X/Q = Site specific air dispersion factor (s/m3)

BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)

DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-44 VOC CHEMICAL SOURCE TERM ANALYSIS FOR NC3-F LOC IN THE WHB (PUNCTURE DRUM OR CANISTER OUTSIDE HOT CELL)

Compound	CI (mg)	CD	MAR (mg)	DR	CF	CRF	CARF	NCF	NCRF	NCARF	Q (mg)
Chemical											
Methylene Chloride	2.03E+02	3	6.10E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	6.10E+02
Chloroform	1.96E+01	3	5.89E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	5.89E+01
1,1,2,2- Tetrachloroethane	1.03E+01	3	3.08E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	3.08E+01
Carbon Tetrachloride	3.75E+02	3	1.13E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.13E+03

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF} * \text{NCARF}))$$

where:

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF =Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-45 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-F LOC IN THE WHB (PUNCURE DRUM OR CANISTER OUTSIDE HOT CELL)

Compound	Q (mg)	LPF	RR (sec)	On-site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exclusive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Chemical									
Methylene Chloride	6.10E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	3.09E+00	2.44E-01	1.82E-02
Chloroform	5.89E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	2.99E-01	2.36E-02	1.76E-03
1,1,2,2- Tetrachloroethane	3.08E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.56E-01	1.23E-02	9.17E-04
Carbon Tetrachloride	1.13E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	5.71E+00	4.51E-01	3.36E-02

CONCENTRATION (C)=(Q*LPF*X/Q)/RR (Ref. Eq. 5-6)

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
2.50E+03	6.00E+02	0.12%	0.04%	0.00%
2.50E+02	1.00E+01	0.12%	0.24%	0.02%
3.50E+01	2.00E+01	0.45%	0.06%	0.00%
6.00E+02	1.25E+02	0.95%	0.36%	0.03%

where:

- Q = Source Term
- RR =Release rate- the RR is the amount of material suspended in air as a function of time.
- X/Q =Site specific air dispersion factor (s/m3)
- LPF =Leak Path Factor

TABLE E-46 RADIOLOGICAL SOURCE TERM FOR NC3-G LOC IN THE WHB (PUNCURE OF 10-160B CASK IN RH BAY)													
CD (damaged)	CI (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Q (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
1	20	2.50E-02	1.00E-03	5.00E-02	1.00E-01	1.00E-03	9.50E-01	1.00E+00	4.78E-04	1.00E-06	1.00E+00	4.78E-10	4.78E-04

$Q = MAR * DR * ARF * RF * LPF$

$Q = CD * CI * DR * ((CARF * CF * CRF) + (NCARF * NCF * NCRF)) * LPF$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (*with* HEPA filtration)

Unmit. Q = the unmitigated source term (*without* HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-47 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR NC3-G LOC IN THE WHB (PUNCURE OF 10-160B CASK IN RH BAY)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	4.78E-10	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	4.11E-07	3.24E-08	2.42E-09
Unmitigated									
	4.78E-04	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	4.11E-01	3.24E-02	2.42E-03

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

- D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)
- Q = the source term (Ci)
- X/Q = Site specific air dispersion factor (s/m3)
- BR = C31 Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)
- DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-48 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR IMMEDIATE WORKER FOR NC3-G LOC IN THE WHB (PUNCURE OF 10-160B CASK IN RH BAY)							
Type	Q (PE-Ci)	BR (m³/s)	DCF (rem/Ci)	Air Movement Rate (m/s)	Time Exposure Begins (sec)	Time Exposure Ends (sec)	Immediate Worker CEDE (rem)
Unmitigated	4.78E-04	3.33E-04	5.10E+08	2.50E-01	1.50E+01	3.00E+01	4.13E+00

$$D=(Q*T_0*BR*DCF)*[3/(4\pi a^3)]*(T_1^{-2} - T_2^{-2}) \text{ (Ref. Eq. 5-10)}$$

where:

- D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)
- Q = Radiological source term (Ci)
- T₀ = Exposure time in seconds (T₀=1sec)
- BR = Breathing rate (standard man) (m³/s) International Commission on Radiological Protection (ICRP) No.23 (Light activity 5.3 gallons/min [20.0 liters/min or 3.33 E-04 m³/s])
- DCF = Dose conversion factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.10E+08 rem/Ci)
- V = Volume of hemisphere of air (m³) = 2/3(PI)r³
- r = Radius of hemisphere = a * t
- a = cloud expansion rate, 0.82 ft/s (0.25 m/s) = Air Movement Rate
- t = time after accident (seconds)

TABLE E-49 VOC CHEMICAL SOURCE TERM ANALYSIS FOR NC3-G LOC IN THE WHB (PUNCURE OF 10-160B CASK IN RH BAY)											
Compound	CI (mg)	CD	MAR (mg)	DR	CF	CRF	CARF	NCF	NCRF	NCARF	Q (mg)
Chemical											
Methylene Chloride	2.03E+02	3	6.10E+02	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	6.10E+02
Chloroform	1.96E+01	3	5.89E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	5.89E+01
1,1,2,2- Tetrachloroethane	1.03E+01	3	3.08E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	3.08E+01
Carbon Tetrachloride	3.75E+02	3	1.13E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.13E+03

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF} * \text{NCARF}))$$

where:

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e., HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-50 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-G LOC IN THE WHB (PUNCURE OF 10-160B CASK IN RH BAY)

Compound	Q (mg)	LPF	RR (sec)	On-site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exculsive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Chemical									
Methylene Chloride	6.10E+02	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	3.09E+00	2.44E-01	1.82E-02
Chloroform	5.89E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	2.99E-01	2.36E-02	1.76E-03
1,1,2,2- Tetrachlorothane	3.08E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	1.56E-01	1.23E-02	9.17E-04
Carbon Tetracholride	1.13E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	5.71E+00	4.51E-01	3.36E-02

CONCENTRATION (C)=(Q*LPF*X/Q)/RR (Ref. Eq. 5-6)

where:

- Q = Source Term
- RR =release rate- the RR is the amount of material suspended in air as a function of time.
- X/Q =Site specific air dispersion factor (s/m3)
- LPF =Leak Path Factor

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) Exclusive Use Area	Ratio (conc/limit) Site Boundary
1.25E+04	2.50E+03	0.02%	0.01%	0.00%
2.50E+04	2.50E+02	0.00%	0.01%	0.00%
6.00E+02	3.50E+01	0.03%	0.04%	0.00%
4.00E+03	6.00E+02	0.14%	0.08%	0.01%

TABLE E-51 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-G LOC IN THE WHB (PUNCURE OF 10-160B CASK IN RH BAY) FOR IMMEDIATE WORKER					
Compound	Q (mg)	Exposure Time (sec)	RR (1/1 sec)	Expanding Cloud Volume (m ³)	Immediate Worker C(mg/m ³ or f/cc)*
Chemical					
Methylene Chloride	6.10E+02	1.50E+01	1.00E+00	1.14E+02	8.03E+01
Chloroform	5.89E+01	1.50E+01	1.00E+00	1.14E+02	7.75E+00
1,1,2,2- Tetrachlorothane	3.08E+01	1.50E+01	1.00E+00	1.14E+02	4.05E+00
Carbon Tetrachloride	1.13E+03	1.50E+01	1.00E+00	1.14E+02	1.48E+02

$C = (Q*T)/(RR*V)$

where:

- C = Concentration (mg/m³)
- Q = Chemical Source Term (mg)
- T =Length of exposure (seconds)
- RR =Release Rate (VOCs are assumed to be instantaneously released, RR = 1 Second)
- V =Volume of expanding cloud (m³)

Limiting Criteria	% of Guidelines (Conc/Limit)
1.25E+04	0.64%
2.50E+04	0.03%
6.00E+02	0.68%
4.00E+03	3.71%

TABLE E-52 RADIOLOGICAL SOURCE TERM FOR NC3-H LOC IN THE WHB (DROPPED 10-160B CASK IN RH BAY)													
CD (damaged)	CI (PE-Ci)	DR	CARF	CF	CRF	NCARF	NCF	NCRF	Q (PE-Ci)	Mit. LPF w/HEPA	Unmit. LPF w/o HEPA	Mit. Q w/HEPA (PE-Ci)	Unmit. Q w/o HEPA (PE-Ci)
1	20	2.50E-02	1.00E-03	5.00E-02	1.00E-01	1.00E-03	9.50E-01	1.00E+00	4.78E-04	1.00E-06	1.00E+00	4.78E-10	4.78E-04

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCARF} * \text{NCF} * \text{NCRF})) * \text{LPF}$$

where:

Q = the source term (Ci)

Mit.Q = the mitigated source term (*with* HEPA filtration)

Unmit. Q = the unmitigated source term (*without* HEPA filtration)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF =Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e.,HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-53 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR NC3-H LOC IN THE WHB (DROPPED 10-160B CASK IN RH BAY)									
	Q (PE-Ci)	On-Site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	BR (m3/s)	DCF (rem/Ci)	On-Site (100 meters) CEDE (rem)	Exclusive Use Area CEDE (rem)	Site Boundary CEDE (rem)
Mitigated									
	4.78E-10	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	4.11E-07	3.24E-08	2.42E-09
Unmitigated									
	4.78E-04	5.07E-03	4.00E-04	2.98E-05	3.33E-04	5.10E+08	4.11E-01	3.24E-02	2.42E-03

Committed Effective Dose Equivalent (CEDE) = $D = Q \cdot X/Q \cdot BR \cdot DCF$ (Ref. Eq. 5-5)

where:

D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)

Q = the source term (Ci)

X/Q = Site specific air dispersion factor (s/m3)

BR = C31Breathing rate (standard man) (m3/s) International Commission on Radiological Protection (ICRP) No. 23 (Light activity 20.0 liters/min or 3.33 E-04 m3/s)

DCF = Dose Conversion Factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+02 rem/uCi or 5.1E+08 rem/Ci)

TABLE E-54 RADIOLOGICAL CONSEQUENCE ANALYSIS FOR IMMEDIATE WORKER FOR NC3-H LOC IN THE WHB (DROPPED 10-160B CASK IN RH BAY)

Type	Q (PE-Ci)	BR (m ³ /s)	DCF (rem/Ci)	Air Movement Rate (m/s)	Time Exposure Begins (sec)	Time Exposure Ends (sec)	Immediate Worker CEDE (rem)
Unmitigated	4.78E-04	3.33E-04	5.10E+08	2.50E-01	1.50E+01	3.00E+01	4.13E+00

$D = (Q * T * BR * DCF) / V$ (Ref. Eq. 5-7)

where:

- D = Radiological dose (Committed Effective Dose Equivalent (CEDE)) (rem)
- Q = Radiological source term (Ci)
- T = Exposure time in seconds (depends on the scenario)
- BR = Breathing rate (standard man) (m³/s) International Commission on Radiological Protection (ICRP) No.23 (Light activity 5.3 gallons/min [20.0 liters/min or 3.33 E-04 m³/s])
- DCF = Dose conversion factor (rem/Ci) Internal Dose Conversion Factors for Calculation of Dose to the Public (Pu-239 Class W CEDE Inhalation 5.1E+ 02 rem/uCi or 5.10E+ 08 rem/Ci)
- V = Volume of hemisphere of air (m³) = 2/3(PI)r³
- r = Radius of hemisphere = a * t
- a = cloud expansion rate, 0.82 ft/s (0.25 m/s) = Air Movement Rate
- t = time after accident (seconds)

TABLE E-55 VOC CHEMICAL SOURCE TERM ANALYSIS FOR NC3-H LOC IN THE WHB (DROPPED 10-160B CASK IN RH BAY)											
Compound	CI (mg)	CD	MAR (mg)	DR	CF	CRF	CARF	NCF	NCRF	NCARF	Q (mg)
Chemical											
Methylene Chloride	2.03E+02	5	1.02E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.02E+03
Chloroform	1.96E+01	5	9.82E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	9.82E+01
1,1,2,2- Tetrachloroethane	1.03E+01	5	5.13E+01	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	5.13E+01
Carbon Tetrachloride	3.75E+02	5	1.88E+03	1.00E+00	5.00E-02	1.00E+00	1.00E+00	9.50E-01	1.00E+00	1.00E+00	1.88E+03

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF}$$

$$Q = \text{CD} * \text{CI} * \text{DR} * ((\text{CARF} * \text{CF} * \text{CRF}) + (\text{NCF} * \text{NCRF} * \text{NCARF}))$$

where:

Q = the source term (Ci)

CD = # of containers damaged by drop or puncture

CI = the waste container inventory

MAR = (CD puncture + CD drop) * CI

DR = Damage Ratio = The DR is that fraction of the MAR actually impacted by the accident condition.

CARF = Combustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

CF = Combustible Fraction = Percentage of MAR that is combustible.

CRF = Combustible Respirable Fraction = The percentage of combustible material that is in the respirable size range

NCF = Noncombustible Fraction = Percentage of the MAR that is noncombustible.

NCRF = Noncombustible Respirable Fraction = The percentage of noncombustible material that is in the respirable size range.

LPF = Leakpath Factor = the cumulative fraction of airborne material that escapes to the atmosphere from the postulated accident (i.e., HEPA filtration; plateout)

NCARF = Noncombustible Airborne Release Fraction-The fraction of combustible radioactive material that is suspended in air.

TABLE E-56 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-H LOC IN THE WHB (DROPPED 10-160B CASK IN RH BAY)									
Compound	Q (mg)	LPF	RR (sec)	On-site (100 meters) X/Q (s/m3)	Exclusive Use Area X/Q (s/m3)	Site Boundary X/Q (s/m3)	On-site (100 meters) C (mg/m3)	Exculsive Use Area C (mg/m3)	Site Boundary C (mg/m3)
Chemical									
Methylene Chloride	1.02E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	5.16E+00	4.07E-01	3.03E-02
Chloroform	9.82E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	4.98E-01	3.93E-02	2.93E-03
1,1,2,2- Tetrachloroethane	5.13E+01	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	2.60E-01	2.05E-02	1.53E-03
Carbon Tetrachloride	1.88E+03	1.00E+00	1.00E+00	5.07E-03	4.00E-04	2.98E-05	9.52E+00	7.51E-01	5.59E-02

CONCENTRATION (C)=(Q*LPF*X/Q)/RR (Ref. Eq. 5-6)

Limiting On-site Criteria (100 meter) (mg/m3)	Limiting Off-site Criteria (mg/m3)	Ratio (conc/limit) (100 meters)	Ratio (conc/limit) (mg/m3) Exclusive Use Area	Ratio (conc/limit) Site Boundary
1.25E+04	2.50E+03	0.04%	0.02%	0.00%
2.50E+04	2.50E+02	0.00%	0.02%	0.00%
6.00E+02	3.50E+01	0.04%	0.06%	0.00%
4.00E+03	6.00E+02	0.24%	0.13%	0.01%

where:

Q = Source Term

RR =Release rate - the RR is the amount of material suspended in air as a function of time

X/Q =Site specific air dispersion factor (s/m3)

LPF =Leak Path Factor

TABLE E-57 VOC CHEMICAL CONSEQUENCE ANALYSIS FOR NC3-H LOC IN THE WHB (DROPPED 10-160B CASK IN RH BAY) FOR IMMEDIATE WORKER					
Compound	Q (mg)	Exposure Time (sec)	RR (1/1 sec)	Expanding Cloud Volume (m ³)	Immediate Worker C(mg/m ³)
Chemical					
Methylene Chloride	1.02E+03	1.50E+01	1.00E+00	1.14E+02	1.34E+02
Chloroform	9.82E+01	1.50E+01	1.00E+00	1.14E+02	1.29E+01
1,1,2,2- Tetrachloroethane	5.13E+01	1.50E+01	1.00E+00	1.14E+02	6.75E+00
Carbon Tetrachloride	1.88E+03	1.50E+01	1.00E+00	1.14E+02	2.47E+02

$$C = (Q*T)/(RR*V)$$

where:

- C = Concentration (mg/m³)
- Q = Chemical Source Term (mg)
- T =Length of exposure (seconds)
- RR =Release Rate (VOCs are assumed to be instantaneously released, RR = 1 Second)
- V =Volume of expanding cloud (m³) - Based on area of the RH Bay

Limiting Criteria	% of Guidelines (Conc/limit)
1.25E+04	1.07%
2.50E+04	0.05%
6.00E+02	1.13%
4.00E+03	6.18%

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