

10 CONSEQUENCE ANALYSIS

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10 CONSEQUENCE ANALYSIS

10.1 INTRODUCTION

This section describes the offsite consequence evaluation (Level 3 analysis). Key inputs and assumptions are described. The calculated results are compared to consequence related goals to determine if the goals are satisfied.

The MACCS2 Version 1.13.1 computer code (Ref. 10-1) is used to determine the consequences of potential reactor accidents. The MACCS2 code evaluates offsite dose and consequences such as early fatality risk and latent cancer fatality risk for each source term (i.e., radionuclide release category) over a range of possible weather conditions and evacuation assumptions. The MACCS2 code model is described in Ref. 10-1. The rationale for site related input selection is presented in Section 10.2. Other more generic input parameters for the MACCS2 analysis are based on "Sample Problem A" of Ref. 10-1. ESBWR specific reference data from the plant performance analysis in Section 8 and Section 9 are used as MACCS2 inputs as presented in Subsection 10.3. The calculated consequence results are compared to the goals in Subsection 10.5-7b. In Section 10.5, a sensitivity study is summarized. Table 10.2-1 through 10.5-7b present the MACCS2 base case and sensitivity study results. Figure 10.4-1 presents the exceedance probability as a function of population dose.

10.2 ASSUMPTIONS

The evaluation of the offsite consequences of a reactor accident uses generic site parameters (e.g., weather, population, land use).

The subsections below describe the rationale for the selection of site meteorology, population, and evacuation parameters. The following tables present these inputs:

<u>Table</u>	<u>Inputs</u>
10.2-1	Population Density
10.2-2	Shielding and Exposure Parameters

10.2.1 Meteorology

For this study, a meteorological condition comparable with ALWR URD (Ref. 10-2) meteorological reference data set is used. For base case study, weather category bin sampling approach of the meteorological data is used as was done in the URD. An hourly sampling approach of the meteorological data is presented in the sensitivity study.

10.2.2 Population

For the ESBWR consequence evaluation, the SANDIA Siting Study population density data (Table 3-2 of Ref. 10-3) is used to develop a uniform population density corresponding to each spatial interval. The population distribution is developed for distances to 0.5, 1, 2, 3, 4, 5, 10, 20, 30, 40 and 50 miles from the site.

The three offsite consequence goals defined for the ESBWR are concerned with consequences within 10 miles of the site; a limited 0-10 mile population density is used. The maximum 0-10 mile population distribution value from the “all” sites column of Table 3-2 of Ref. 10-3 is used for the ESBWR consequence evaluation and is provided in Table 10.2-1. As can be seen from Table 10.2-1, the 0-5 mile population density is larger than the 5-10 mile population density and is used in this bounding analysis as a constant uniform density. This approach provides a more limiting 0-10 mile population density than that provided in the ALWR URD (Ref. 10-2). The limiting population density applied is intended for future emergency planning evaluation.

10.2.3 Evacuation

Many evacuation related characteristics (local roads, population demographics, emergency services) are site specific. The evacuation parameters used in this study are assumptions in that no evacuation, relocation, and sheltering are assumed. The public is assumed to continue normal activity during the reactor accident in this limiting analysis. Shielding and exposure values used for normal activity are the standard MACCS2 assumptions and are provided in Table 10.2-2.

Table 10.2-2 provides the following information for people engaged in normal activity:

- Cloudshine Shielding Factor – Fraction of cloudshine dose received from direct external exposure to the plume
- Inhalation Protection Factor – Fraction of inhalation dose received from cloud inhalation
- Breathing Rate – Breathing rate for people in normal activity
- Skin Protection Factor – Fraction of skin dose received from material deposited on skin
- Groundshine Shielding Factor – Fraction of groundshine dose received from material deposited on the ground

**Table 10.2-1
Population Distribution**

Radial Interval	Maximum Population
	All Sites People per sq. km.(per sq. mi.)
0-8.1 km (0-5 mi)	305 (790)
8.1-16.1 km (5-10 mi)	270 (700)
16.1-32.2 km (10-20 mi)	282 (730)
32.2-48.3 km (20-30 mi)	772 (2000)
48.3-80.5 km (30-50 mi)	965 (2500)

Data taken from Ref. 10-3, Table 3-2.

The 0-5 mile population density (790 people per square mile) is used in the ESBWR analysis as a uniform density for all radial intervals in the 0-50 mile region.

Table 10.2-2
Shielding and Exposure Data

MACCS2 Parameter	Normal Activity Value
Cloudshine Shielding Factor	7.50E-01
Inhalation Protection Factor	4.10E-01
Breathing Rate (m ³ /sec)	2.66E-04
Skin Protection Factor	4.10E-01
Groundshine Shielding Factor	3.30E-01

All values are based on Ref. 10-1

10.2.4 Risk Goals

The radiological consequences are measured by comparing risk goals to the quantified consequence results.

The information used to derive the risk goals is assumed and based on generic US society information on accident rates and human vulnerability to diseases.

Site specific and plant specific information, when available, can be used to update the goal measures.

10.2.5 Radiological Sources

The radiological release sources, presented in Section 9 of NEDO-33201, are used as the inputs to the consequence evaluation in this section. The isotopic distributions are derived from thermal-hydraulic analysis, presented in Section 9 of NEDO-33201, based on assumptions made on accident sequences propagations. The release frequencies of various categories of radiological sources (groups) are derived from Section 8 of NEDO-33201 and are based on assumptions made in level 2 PRA study.

10.2.6 Sensitivity Study

Section 10.4.2 presents consequence results based on typical and generic input parameter assumptions. Section 10.5 further assumed various variations of Section 10.4.2 input parameters and presents the comparison of these sensitivity study results and their comparison to the risk goals.

10.3 MACCS2 RADIONUCLIDE RELEASE INPUT DATA

10.3.1 MACCS2 Radionuclide Release Input Data

ESBWR specific radionuclide release data is used in this analysis to model the dispersion of a plume of material released to the environment during a reactor accident.

The following tables present these inputs:

<u>Table</u>	<u>Inputs</u>
10.3-1	Building Data for Meteorological Modeling of Wake Effects
10.3-2	Core Inventory Parameters
10.3-3a	Reactor Accident Release Parameters 24 Hours After the Onset of Core Damage
10.3-3b	Reactor Accident Release Parameters 72 Hours After the Onset of Core Damage
10.3-4	Nuclide Release Categories

10.3.2 ESBWR Release Parameters

ESBWR specific parameters are used for wake effect data, core inventory, and reactor thermal power. The width and height of the building wake are used by MACCS2 to model the initial plume dimensions. These parameters for the ESBWR are provided in Table 10.3-1.

The equilibrium core inventory and reactor thermal power used in this analysis are ESBWR specific and are provided in Table 10.3-2. These parameters are used to determine the inventory of each nuclide in the core at accident initiation.

10.3.3 Input to MACCS2 from MAAP

The severe accident sequence analysis results provide input parameters to the MACCS2 code and are described here and are shown in Table 10.3-3a and Table 10.3-3b. Table 10.3-3a provides the release parameters 24 hours after the onset of core damage, and Table 10.3-3b provides the release parameters 72 hours after the onset of core damage. The severe accident sequence analysis performed using the MAAP code is further described in Section 8. The representative MAAP cases used as MACCS2 inputs are summarized in Section 9. Important input release characteristics include the nuclide release time, duration, and release fraction. The MAAP cases are used to develop source terms for each release category for the consequence analysis. Tables 10.3-3a and 10.3-3b describe the source terms and corresponding radionuclide release categories used for the MACCS2 analysis.

For each source term, which represents a release category from Section 8, the following data are used (Table 10.3-3a and Table 10.3-3b):

- Source Term – Source term developed from the severe accident analysis that characterizes the release category. The source terms are summarized in Section 9.
- Release Category – Release category represented by the source term.
- MAAP Case – Severe accident sequence analysis results which are used to develop each source term. Section 8 and Section 9 provide a summary of the MAAP cases.
- Release Frequency – The frequency per year associated with the radionuclide release category. The release frequencies are calculated in Section 8.
- Time of Plume Release – Time from reactor trip (time of accident initiation) until the time of the modeled plume release to the atmosphere. This parameter is based on the severe accident analysis results discussed in Section 9 and is approximately the time when the CsI release from containment begins.
- Duration of Release - Duration of release of radionuclides from the plant is used to determine the dispersion of the release cloud. Each MAAP case for the ESBWR was performed for 72 hours after the onset of core damage. MACCS2 limits the duration of an individual plume to a maximum of 10 hours. Source terms in which the release flattens out after a short time (i.e., less than 10 hours) are characterized by a release duration corresponding to the time the release starts to the time the release flattens out. Each release fraction is reviewed in determining the release duration, with special attention given to the nuclides with the greatest offsite consequence impacts (i.e., iodine and cesium).
- NG – Release fraction of Noble gases from containment to the environment.
- CsI – Release fraction of Iodine from containment to the environment.

For this assessment no warning time is assumed due to no evacuation being credited. This would be the time between official notification of the public and the release of radioactivity from the plant.

For each source term, the release is assumed to occur at ground level. The thermal content of the plume is assumed to be the same as ambient.

A sensitivity study is presented in Section 10.5 addressing elevated release, with and without buoyant plume rise, and different meteorological conditions.

MAAP provides results for twelve (12) nuclide release fractions from containment to the atmosphere. These nuclide release fractions are related to the MACCS2 release groups as shown in Table 10.3-4.

**Table 10.3-1
Site and Reactor Data for Meteorological Modeling**

Parameter	Measurement, m (ft)
Reactor Building Length	49.0 (160)
Reactor Building Width	49.0 (160)
Reactor Building Height	48.0 (157)
Fuel Building Length	49.0 (160)
Fuel Building Height	24.0 (78)
Fuel Building Width	21.0 (69)

Table 10.3-2
ESBWR Core Inventory

ESBWR Core Power is 4500 MWt			
Nuclide	Bq/MWt	Nuclide	Bq/MWt
Co-58	5.10E+12	Te-131m	1.42E+14
Co-60	4.92E+12	Te-132	1.41E+15
Kr-85	1.23E+13	I-131	9.90E+14
Kr-85m	2.73E+14	I-132	1.44E+15
Kr-87	5.27E+14	I-133	2.04E+15
Kr-88	7.42E+14	I-134	2.25E+15
Rb-86	2.35E+12	I-135	1.91E+15
Sr-89	9.93E+14	Xe-133	2.03E+15
Sr-90	9.76E+13	Xe-135	6.72E+14
Sr-91	1.25E+15	Cs-134	1.98E+14
Sr-92	1.34E+15	Cs-136	6.89E+13
Y-90	1.04E+14	Cs-137	1.28E+14
Y-91	1.27E+15	Ba-139	1.84E+15
Y-92	1.35E+15	Ba-140	1.77E+15
Y-93	1.55E+15	La-140	1.82E+15
Zr-95	1.79E+15	La-141	1.68E+15
Zr-97	1.85E+15	La-142	1.62E+15
Nb-95	1.80E+15	Ce-141	1.68E+15
Mo-99	1.90E+15	Ce-143	1.56E+15
Tc-99m	1.68E+15	Ce-144	1.36E+15
Ru-103	1.50E+15	Pr-143	1.53E+15
Ru-105	1.00E+15	Nd-147	6.69E+14
Ru-106	5.21E+14	Np-239	1.93E+16
Rh-105	9.10E+14	Pu-238	3.34E+12

Table 10.3-2
ESBWR Core Inventory

ESBWR Core Power is 4500 MWt			
Nuclide	Bq/MWt	Nuclide	Bq/MWt
Sb-127	1.03E+14	Pu-239	4.02E+11
Sb-129	3.15E+14	Pu-240	5.21E+11
Te-127	1.05E+14	Pu-241	1.51E+14
Te-127m	1.37E+13	Am-241	1.70E+11
Te-129	3.10E+14	Cm-242	4.01E+13
Te-129m	4.60E+13	Cm-244	1.94E+12

Table 10.3-3a
Event Release Parameter
24 Hours After the Onset of Core Damage

Source Term (1), (2)	Release Category	MAAP CASE	Relative Fraction ⁽⁵⁾	Total Release Frequency (per year)	Time of Plume Release (hr)	Duration of Release (hr) ⁽³⁾	NG ⁽⁴⁾ Release Fraction	CsI ⁽⁴⁾ Release Fraction
1	BOC	BOCs _d _nIN_R1	0.500	1.47E-10	0.7	7.45	9.7E-01	7.0E-01
2		BOC _{dr} _nIN_R1	0.500		0.6	5.5	2.4E-01	1.1E-01
3	BYP	T_nIN_BYP_R1	0.026	5.6E-11	0.7	8	9.5E-01	2.1E-01
4		T_nDP_nIN_BYP_R1	0.974		1.3	7.5	5.3E-01	3.3E-02
5	CCID	T_nIN_nD_CCID_R1	0.717	ε	25.8	10	0.0	0.0
6		T_nDP_nIN_nD_CCID_R1	0.283		16.0	2.6	9.1E-01	6.7E-02
7	CCIW	T_nIN_CCIW_R1	0.538	9.9E-11	25.6	10	0.0	0.0
8		T_nDP_nIN_CCIW_R1	0.462		18.4	10	6.4E-01	1.2E-04
9	EVE	T_nIN_nD_EVE_R1	1.000	6.10E-10	7.4	10	8.3E-01	2.8E-02
10	FR	T-AT_nIN_nCHR_FR_R1	1.000	ε	28.9	10	0.0	0.0
11	OPVB	T_nDP_nIN_VB_R1	0.050	6E-12	13.8	10	4.3E-01	1.33E-04
12		T_nIN_VB_R1	0.950		8.7	3	8.6E-01	5.0E-03
13	OPW1	T_nDP_nIN_nCHR_W1_R1	1.000	ε	34.2	10	0.0	0.0
14	OPW2	T_nDP_nIN_nCHR_W2_R1	1.000	ε	53.1	10	0.0	0.0
15	TSL	T_AT_nIN_TSL2x_R1	1.000	1.12E-08	0.5	7.5	2.7E-03	1.6E-04

Notes to Table 10.3-3a

- (1) See Subsection 10.3.3 for definition of parameters in this table.
 - (2) For this bounding analysis, release height is ground level and release sensible heat is same as ambient.
 - (3) The release parameters are based on the 24 hours after the onset of core damage value. Each MAAP case for the ESBWR was performed for 72 hours after the onset of core damage. MACCS2 limits the duration of an individual plume to a maximum of 10 hours. Source terms in which the release flattens out after a short time (i.e., less than 10 hours) are characterized by a release duration corresponding to the time the release starts to the time the release flattens out. The nuclides with the greatest offsite consequences (i.e., Iodine and Cesium) are conservatively used.
 - (4) Noble Gases (NG) and Cesium Iodine (CsI) release fractions are the cumulative release fractions at 24 hours after the onset of core damage.
 - (5) Relative Fraction is the relative contribution of each of the representative sequences to their release category.
- ε Less than 1E-12

Table 10.3-3b
Event Release Parameter
72 Hours After the Onset of Core Damage

Source Term (1), (2)	Release Category	MAAP CASE	Relative Fraction ⁽⁵⁾	Total Release Frequency (per year)	Time of Plume Release (hr)	Duration of Release (hr) ⁽³⁾	NG ⁽⁴⁾ Release Fraction	CsI ⁽⁴⁾ Release Fraction
1	BOC	BOCsd_nIN_R1	0.500	1.47E-10	0.7	7.45	9.8E-01	7.0E-01
2		BOCdr_nIN_R1	0.500		0.6	5.5	2.6E-01	1.3E-01
3	BYP	T_nIN_BYP_R1	0.026	5.6E-11	0.7	8	9.7E-01	3.0E-01
4		T_nDP_nIN_BYP_R1	0.974		1.3	7.5	6.8E-01	3.5E-02
5	CCID	T_nIN_nD_CCID_R1	0.717	ε	25.8	10	9.1E-01	6.2E-02
6		T_nDP_nIN_nD_CCID_R1	0.283		16.0	2.6	9.6E-01	3.5E-01
7	CCIW	T_nIN_CCIW_R1	0.538	9.9E-11	25.6	10	8.9E-01	1.6E-05
8		T_nDP_nIN_CCIW_R1	0.462		18.4	10	8.3E-01	1.1E-02
9	EVE	T_nIN_nD_EVE_R1	1.000	6.10E-10	7.4	10	8.3E-01	1.5E-01
10	FR	T-AT_nIN_nCHR_FR_R1	1.000	ε	28.9	10	1.0E+00	6.1E-03
11	OPVB	T_nDP_nIN_VB_R1	0.050	6E-12	13.8	10	9.6E-01	4.1E-03
12		T_nIN_VB_R1	0.950		8.7	3	1.0E+00	1.5E-02
13	OPW1	T_nDP_nIN_nCHR_W1_R1	1.000	ε	34.2	10	1.0E+00	1.5E-02
14	OPW2	T_nDP_nIN_nCHR_W2_R1	1.000	ε	53.1	10	1.0E+00	1.5E-02
15	TSL	T_AT_nIN_TSL2x_R1	1.000	1.12E-08	0.5	7.5	2.7E-03	1.6E-04

Notes to Table 10.3-3b

- (1) See Subsection 10.3.3 for definition of parameters in this table.
- (2) For this bounding analysis, release height is ground level and release sensible heat is same as ambient.
- (3) Each MAAP case for the ESBWR was performed for 72 hours after the onset of core damage. MACCS2 limits the duration of an individual plume to a maximum of 10 hours. Source terms in which the release flattens out after a short time (i.e., less than 10 hours) are characterized by a release duration corresponding to the time the release starts to the time the release flattens out. In general, the nuclides with the greatest offsite consequences (i.e., Iodine and Cesium) are conservatively used.
- (4) Noble Gases (NG) and Cesium Iodine (CsI) release fractions are the cumulative release fractions at 72 hours after the onset of core damage.
- (5) Relative Fraction is the relative contribution of each of the representative sequences to their release category
- ϵ Less than 1E-12

Table 10.3-4
MACCS2 Release Groups vs. ESBWR Release Groups

MACCS2 Release Groups	MAAP Release Groups	MAAP Output Parameter
1-Xe/Kr	Noble gases	FREL (1)
2-I	CsI	FREL (2)
73-Cs	CsOH	FREL (6)
4-Te	TeO ₂ ⁽¹⁾ (Sb ⁽¹⁾ & Te ₂ ⁽²⁾ fractions are included)	FREL (3), FREL (10) and FREL (11)
5-Sr	SrO	FREL (4)
6-Ru	MoO ₂ (Mo is in Ru MACCS category)	FREL (5)
7-La	La ₂ O ₃	FREL (8)
8-Ce	CeO ₂ (included UO ₂ ⁽²⁾ in this category)	FREL (9) and FREL (12)
9-Ba	BaO	FREL (7)

⁽¹⁾ The larger release fraction of TeO₂ and Sb is used as input into MACCS2.

⁽²⁾ Te₂ and UO₂ release fractions are negligible.

10.4 COMPARISON OF RESULTS TO GOALS

10.4.1 Goals

Three major offsite consequence-related goals are established in the GE ESBWR Licensing Review Bases based on the NRC Safety Goal Policy Statement. These goals are:

(1) Individual Risk Goal

The risk of prompt fatalities that might result from reactor accidents to an average individual in the "vicinity" of a nuclear power plant should not exceed one tenth of one percent (0.1%) of the sum of "prompt fatality risks" resulting from other accidents to which members of the U.S. Population are generally exposed.

As noted in the Safety Goal Policy statement, "vicinity" is defined as the area within 1.61 km (1 mile) of the plant site boundary. "Prompt Fatality Risks" are defined as those risks to which the average individual residing in the vicinity of the plant is exposed to as a result of normal daily activities. Such risks are the sum of risks that result in fatalities from such activities as driving, household chores, occupational activities, etc.

For this evaluation, the sum of prompt fatality risks is taken as the U.S. accidental death risk value of 39.1 deaths per 100,000 people per year based upon Ref. 10-4.

As a design objective, the Individual Risk Goal is conservatively set to be one order of magnitude lower, which gives an Individual Risk Goal of $3.9E-8$ at 0-1 mile.

(2) Societal Risk Goal

The risk of cancer fatalities that might result from nuclear power plant operation to the population in the area "near" a nuclear power plant should not exceed one tenth of one percent (0.1%) of the sum of the "cancer fatality risks" resulting from all other causes to which members of the U.S. Population are generally exposed.

As noted in the Safety Goal Policy Statement, "near" is defined as within 16.1 km (10 miles) of the plant. The "cancer fatality risk" is taken as 169 deaths per 100,000 people per year based upon 1983 statistics in Ref. 10-5.

Similar to the Individual Risk Goal, for design objective, the Societal Risk Goal is set to be $1.7E-7$ at 0-10 mile

(3) Radiation Dose Goal

The probability of exceeding a whole body dose of 0.25 Sv at a distance of 805 m (one half mile) from the reactor shall be less than one in a million per reactor year.

The design objective for the probability of having 0.25 Sv at 0.5 mile is set at less than 1E-7 which is an order of magnitude lower than the NRC dose goal.

The calculated ESBWR consequence results are compared to these goals in the following subsection.

10.4.2 Results

The mean results from the offsite consequence analysis for each source term are shown in Table 10.4-1a and Table 10.4-1b.

Table 10.4-1a provides the results 24 hours after the onset of core damage, and Table 10.4-1b provides the results 72 hours after the onset of core damage.

The 24 hour mission time after the onset of core damage is the typical time used for probabilistic risk analysis. The 72 hour mission time is the conservative time used for passive ESBWR design evaluation.

These results are multiplied by the annual release frequency for each source term and then summed to obtain the risk weighted mean consequence results. These results are compared to the consequence goals identified in Subsection 10.4.1 and summarized in Table 10.4-2.

The individual risk and societal risk goals are maintained with sufficient margin as shown in Table 10.4-2 and all the risk measures are several orders of magnitude lower than the risk goals.

A plot of whole body dose at a distance of 805 m (one half mile) against cumulative probability is shown in Figure 10.4-1. As can be seen, the whole body dose at 805m (0.5 miles) over the entire dose spectrum from 0.1 Sv to >100 Sv is well below the goal of 1E-6/yr exceedance frequency.

Based upon these results, the ESBWR meets the established consequence related goals with substantial margin.

Table 10.4-1a
MACCS2 Results by Source Term
24 Hour After Onset of Core Damage

Source Term ⁽¹⁰⁾	Individual Risk (0-1 mile) ⁽¹⁾	Weighted Individual Risk (per year) ⁽²⁾	Weighted Individual Risk Contribution (%) ⁽³⁾	Societal Risk (0-10 miles) ⁽⁴⁾	Weighted Societal Risk (per year) ⁽⁵⁾	Weighted Societal Risk Contribution (%) ⁽⁶⁾	Probability of Dose > .2 Sv (0-0.5 mile) ⁽⁷⁾	Weighted Prob of Exceedance (per year) ⁽⁸⁾	Weighted Dose Contribution (%) ⁽⁹⁾
1	1.09E-01	8E-12	10.88%	1.88E-02	1E-12	14.83%	1.00E+00	7.4E-11	3.62%
2	7.96E-02	6E-12	7.95%	7.35E-03	ε	5.80%	1.00E+00	7.4E-11	3.62%
3	9.56E-02	ε	0.19%	1.39E-02	ε	0.22%	1.00E+00	1E-12	0.07%
4	9.17E-02	5E-12	6.81%	4.32E-02	2E-12	25.36%	1.00E+00	5.5E-11	2.70%
5	0	0	0.00%	0	0	0.00%	0	0	0.00%
6	5.64E-02	ε	0.02%	3.27E-03	ε	0.01%	1.00E+00	ε	0.01%
7	0	0	0.00%	0	0	0.00%	0	0	0.00%
8	0	0	0.00%	7.26E-05	ε	0.04%	5.62E-02	3E-12	0.13%
9	8.95E-02	5.5E-11	73.92%	6.79E-03	4E-12	44.30%	1.00E+00	6.10E-10	29.97%
10	0	0	0.00%	0	0	0.00%	0	0	0.00%
11	0	0	0.00%	9.02E-05	ε	0.00%	2.93E-01	ε	0.00%
12	3.10E-02	ε	0.23%	1.22E-03	ε	0.07%	8.06E-01	5E-12	0.22%
13	0	0	0.00%	0	0	0.00%	0	0	0.00%
14	0	0	0.00%	0	0	0.00%	0	0	0.00%
15	0	0	0.00%	7.80E-05	ε	9.38%	1.08E-01	1.21E-09	59.66%
Total	--	7.4E-11	100.00%	--	9E-12	100.00%	--	2.03E-09	100.00%

Notes to Table 10.4-1a

- (1) The individual risk is calculated as the total number of early fatalities within one mile divided by the total one mile population
- (2) The weighted individual risk is the individual risk per year and is calculated as the product of the release category release frequency and the release category individual risk.
- (3) The weighted individual risk contribution is the percentage of a release category's weighted individual risk to the total weighted individual risk.
- (4) The societal risk is calculated as the total number of latent fatalities within ten miles divided by the total ten mile population.
- (5) The weighted societal risk is the societal risk per year and is calculated as the product of the release category release frequency and the release category societal risk.
- (6) The weighted societal risk contribution is the percentage of a release category's weighted societal risk to the total weighted societal risk.
- (7) The probability of dose greater than 0.2 Sv is obtained from the MACCS2 output file and is provided in the form of CCDF tables.
- (8) The weighted probability of exceedance is the probability of exceeding a dose greater than 0.2 Sv per year and is calculated as the product of the release category release frequency and the release category MACCS2 probability of dose greater than 0.2 Sv.
- (9) The weighted dose contribution is the percentage of a release category's weighted societal risk to the total weighted societal risk
- (10) The source term definition is the same as defined in Table 10.3-3a.
- ε Less than 1E-12.

Table 10.4-1b
MACCS2 Results by Source Term
72 Hour After Onset of Core Damage

Source Term ⁽¹⁰⁾	Individual Risk (0-1 mile) ⁽¹⁾	Weighted Individual Risk (per year) ⁽²⁾	Weighted Individual Risk Contribution (%) ⁽³⁾	Societal Risk (0-10 miles) ⁽⁴⁾	Weighted Societal Risk (per year) ⁽⁵⁾	Weighted Societal Risk Contribution (%) ⁽⁶⁾	Probability of Dose > .2 Sv (0-0.5 mile) ⁽⁷⁾	Weighted Prob of Exceedance (per year) ⁽⁸⁾	Weighted Dose Contribution (%) ⁽⁹⁾
1	1.10E-01	8E-12	9.89%	1.85E-02	1E-12	12.64%	1.00E+00	7.4E-11	3.52%
2	8.04E-02	ε	7.23%	7.51E-03	ε	5.13%	1.00E+00	7.4E-11	3.52%
3	9.98E-02	ε	0.18%	1.42E-02	ε	0.19%	1.00E+00	1E-12	0.07%
4	9.21E-02	5E-12	6.17%	4.29E-02	2E-12	21.82%	1.00E+00	5.5E-11	2.62%
5	7.52E-02	ε	0.06%	4.53E-03	ε	0.03%	1.00E+00	ε	0.03%
6	6.85E-02	ε	0.02%	5.94E-03	ε	0.01%	1.00E+00	ε	0.01%
7	3.83E-02	2E-12	2.49%	1.28E-03	ε	0.63%	3.06E-01	1.6E-11	0.78%
8	2.77E-02	1E-12	1.55%	1.57E-03	ε	0.67%	1.00E+00	4.6E-11	2.19%
9	9.66E-02	5.9E-11	71.87%	8.91E-03	5E-12	50.37%	1.00E+00	6.10E-10	29.09%
10	7.87E-02	ε	0.00%	4.19E-03	ε	0.00%	9.36E-01	ε	0.00%
11	5.99E-02	ε	0.02%	2.71E-03	ε	0.01%	1.00E+00	ε	0.01%
12	7.57E-02	ε	0.52%	6.05E-03	ε	0.31%	9.82E-01	5E-12	0.26%
13	3.65E-03	ε	0.00%	7.29E-04	ε	0.00%	1.00E+00	ε	0.00%
14	1.28E-03	ε	0.00%	3.79E-04	ε	0.00%	8.55E-01	ε	0.00%
15	0	0	0.00%	7.85E-05	ε	8.18%	1.08E-01	1.21E-09	57.91%
Total		8.2E-11	100.00%	--	1.1E-11	100.00%	--	2.10E-09	100.00%

Notes to Table 10.4-1b

- (1) The individual risk is calculated as the total number of early fatalities within one mile divided by the total one mile population
- (2) The weighted individual risk is the individual risk per year and is calculated as the product of the release category release frequency and the release category individual risk.
- (3) The weighted individual risk contribution is the percentage of a release category's weighted individual risk to the total weighted individual risk.
- (4) The societal risk is calculated as the total number of latent fatalities within ten miles divided by the total ten mile population.
- (5) The weighted societal risk is the societal risk per year and is calculated as the product of the release category release frequency and the release category societal risk.
- (6) The weighted societal risk contribution is the percentage of a release category's weighted societal risk to the total weighted societal risk.
- (7) The probability of dose greater than 0.2 Sv is obtained from the MACCS2 output file and is provided in the form of CCDF tables.
- (8) The weighted probability of exceedance is the probability of exceeding a dose greater than 0.2 Sv per year and is calculated as the product of the release category release frequency and the release category MACCS2 probability of dose greater than 0.2 Sv.
- (9) The weighted dose contribution is the percentage of a release category's weighted societal risk to the total weighted societal risk
- (10) The source term definition is the same as defined in Table 10.3-3a.
- ε Less than 1E-12..

**Table 10.4-2
Baseline Consequence Goals and Results**

Goal	Risk Goal	ESBWR 24 Hours After Onset of Core Damage (Ground Release)	Safety Goal Achieved 24 Hours After the Onset of Core Damage	ESBWR 72 Hours After Onset of Core Damage (Ground Release)	Safety Goal Achieved 72 Hours After the Onset of Core Damage
Individual Risk (0 – 1 Mile)	$<3.9 \times 10^{-7}$ (0.1%)	7.4E-11	YES	8.2E-11	YES
Societal Risk (0 – 10 Mile)	$<1.7 \times 10^{-6}$ (0.1%)	9E-12	YES	1.1E-11	YES
Radiation Dose Probability at 0.25 Sv (0 – 0.5 Mile)	$<10^{-6}$	2.03E-09	YES	2.10E-09	YES

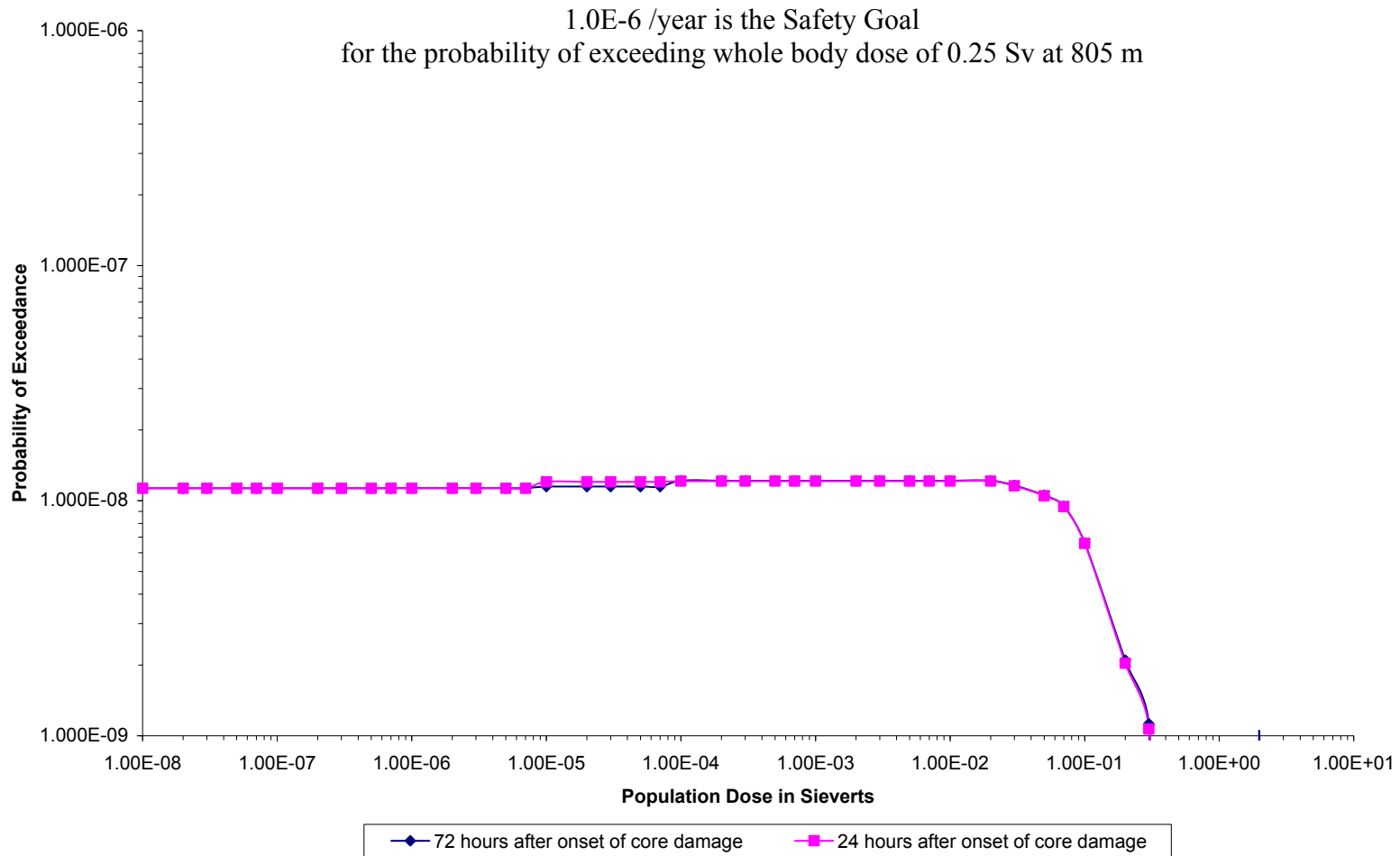


Figure 10.4-1. Whole Body Dose at 805 m (0.5 Mile) as Probability of Exceedance

*The goal of a maximum probability of 1E-6 is well above the entire dose range at 0.5 mile.

10.5 SENSITIVITY STUDY AND INSIGHTS

For this sensitivity study, two meteorological conditions are studied. The first is used for the ESBWR Level 3 base case study and is comparable with the of ALWR URD meteorological reference data.

The second, the sensitivity meteorological condition case, represents a narrower distribution condition. The narrower distribution can represent conservative radiological consequences in certain wind sectors and with certain stability classes. The goal of the sensitivity study is to reveal the radiological consequence insights with regard to the three risk goals.

Elevated release with and without buoyant plume energy rise is studied in this section.

The sensitivity study results show that the three risk goals stated in Subsection 10.4.1 are bounded with substantial margin. In addition, the design goals stated in Subsection 10.4.1, are set at one tenth of the NRC risk goals.

The sensitivity study results show that the baseline case is sufficiently bounding to allow the variation of inputs and assumptions while maintaining several orders of magnitude of design margin relative to the NRC risk goals. Table 10.5-1 through Table 10.5-7b present the sensitivity study results.

Table 10.5-1 shows the sensitivity study results summary. As shown in Table 10.5-1, the three NRC risk goals and the conservative design risk goals are adequate to envelop the variations of MACCS2 input parameters and assumptions, with several orders of magnitude margin. The results also indicate that the variation of certain MACCS2 input parameters, such as the meteorological conditions, would result in minute changes in relation to the three risk goal measures. However, the magnitude of changes due to these input parameter variations are still well bounded by, or still several orders of magnitude lower than, the risk goals. Though the three risk goals are not applicable at 50 miles, to show the impact of elevated release, Table 10.5-2a and 10.5-2b show that the population dose at 50 miles do not vary much for ground vs. elevated release for 24 hour and 72 hour mission time. The risk insights obtained via ground release modeling at 50 miles does not change even with elevated release modeling.

Table 10.5-3a and 10.5-3b show the ground vs. elevated release at 0 to 10 miles for 24 hour and 72 hour mission times. Similar to Table 10.5-2a and 10.5-2b, at 0-10 miles, the risk goal measures are still within the same order of magnitude between ground and elevated releases. The importance here is that the risk insights are maintained whether modeled as ground or elevated releases.

Table 10.5-4 shows the ground release results with hourly meteorological data sampling for the 72 hour mission time. The intent of this case is to show that the risk insights obtained with a different meteorological data sampling method (more conservative hourly sampling method vs. binning sampling method) does not change the risk goal measures results and conclusions.

Table 10.5-5a and 10.5-5b show the ground release with sensitivity meteorological data for 24 hour and 72 hour mission times. The sensitivity meteorological data represents a different and narrower distribution comparing with the base case meteorological data set. The risk goal measures obtained from this different meteorological condition show that both the NRC risk goals and the design risk goals are well maintained with good margin. The important risk insight

is the public health and safety is well maintained as shown from measures of the various risk goals. The intent of the design goals implemented is to maintain the ESBWR design to have a radiological risk as low as reasonably achievable approach.

Table 10.5-6a and 10.5-6b show the elevated release with sensitivity meteorological data for 24 hour and 72 hour mission times. Similar to results presented in Table 10.5-5a and Table 10.5-5b, the elevated release approach is added in Table 10.5-6a and 10.5-6b. The ESBWR already has a very small high point release probability by design, the results indicate again that, the ESBWR maintains a high confidence to protect the health and safety of the public and the risk measures are well within the risk goal setting.

Table 10.5-7a and 10.5-7b show the elevated release with the sensitivity meteorological data and buoyant plume rise for both 24 hour and 72 hour mission times. To further support the conclusion, buoyant plume energy is added to the cases presented in Table 10.5-6a and 10.5-6b. As shown, the added plume rise does not alter the conclusion and risk insights, and again, the results show that public health and safety is well maintained by the ESBWR design.

**Table 10.5-1
Sensitivity Case Results Summary**

Design Goal	Risk Goal	Design Goal (10% of Risk Goal)	Meteorological Data ^{(1), (2)}	24 Hrs. After Onset of Core Damage (Ground Release)	24 Hrs. After Onset of Core Damage (Elevated Release)	24 Hrs. After Onset of Core Damage (Elevated With Buoyant)	72 Hrs. After Onset of Core Damage (Ground Release)	72 Hrs. After Onset of Core Damage (Ground Release with Hourly Sampling)	72 Hrs. After Onset of Core Damage (Elevated Release)	72 Hrs. After Onset of Core Damage (Elevated Release with Buoyant)	Within Design Goal
Individual Risk (0 – 1 Mile)	<3.9x10 ⁻⁷	<3.9x10 ⁻⁸	Case 1	7.4E-11	7.0E-11		8.2E-11	8.2E-11	7.9E-11		YES
			Case 2	9.1E-11	8.8E-11	7.9E-11	9.8E-11		7.9E-11	8.7E-11	YES
Societal Risk (0 – 10 Mile)	<1.7x10 ⁻⁶	<1.7x10 ⁻⁷	Case 1	9E-12	1.0E-11		1.1E-11	1.1E-11	1.2E-11		YES
			Case 2	1.2E-11	1.3E-11	1.4E-11	1.4E-11		1.2E-11	1.6E-11	YES
Radiation Dose Probability at 0.25 Sv (0 – 0.5 Mile)	<10 ⁻⁶	<10 ⁻⁷	Case 1	2.03E-09	1.22E-09		2.10E-09	2.09E-09	1.28E-09		YES
			Case 2	1.41E-09	1.05E-09	1.05E-09	1.49E-09		1.28E-09	1.10E-09	YES

Notes to Table 10.5-1

- (1) Case 1 is using the base meteorological reference data as stated in Subsection 10.2.1.
- (2) Case 2 is using a sensitivity meteorological reference data, which has a narrower meteorological distribution

Table 10.5-2a
Sensitivity Case
Ground vs. Elevated Release at 0-50 miles (24 hrs)

Source Term (24 Hrs)	Population Dose (50 miles) (Ground)	Weighted Population Dose (50 mile, Ground)	Population Dose (0-50 miles) (Elevated)	Weighted Population Dose (50 mile, Elevated)
1	5.65E+05	4.16E-05	6.10E+05	4.50E-05
2	1.11E+05	8.18E-06	1.20E+05	8.84E-06
3	2.29E+05	3.35E-07	2.48E+05	3.63E-07
4	5.53E+05	3.03E-05	6.05E+05	3.32E-05
5	0	0	0	0
6	5.80E+04	1.48E-08	6.33E+04	1.62E-08
7	0	0	0	0
8	7.46E+02	3.42E-08	8.08E+02	3.70E-08
9	1.35E+05	8.23E-05	1.46E+05	8.90E-05
10	0	0	0	0
11	9.90E+02	2.91E-10	1.09E+03	3.21E-10
12	1.36E+04	7.60E-08	1.47E+04	8.22E-08
13	0	0	0	0
14	0	0	0	0
15	7.85E+02	8.82E-06	8.97E+02	1.01E-05
Total		1.72E-04		1.87E-04

Table 10.5-2b
Sensitivity Case
Ground vs. Elevated Release at 0-50 miles (72 hrs)

Source Term (24 Hrs)	Population Dose (50 miles) (Ground)	Weighted Population Dose (50 mile, Ground)	Population Dose (0-50 miles) (Elevated)	Weighted Population Dose (50 mile, Elevated)
1	5.78E+05	4.26E-05	6.25E+05	4.61E-05
2	1.17E+05	8.62E-06	1.27E+05	9.36E-06
3	2.89E+05	4.23E-07	3.13E+05	4.58E-07
4	5.58E+05	3.06E-05	6.09E+05	3.34E-05
5	9.93E+04	6.42E-08	1.08E+05	6.98E-08
6	1.32E+05	3.37E-08	1.42E+05	3.62E-08
7	1.02E+04	5.44E-07	1.10E+04	5.87E-07
8	4.35E+04	1.99E-06	4.71E+04	2.16E-06
9	2.01E+05	1.23E-04	2.17E+05	1.32E-04
10	5.40E+04	5.4E-11	5.90E+04	5.9E-11
11	4.32E+04	1.27E-08	4.66E+04	1.37E-08
12	1.13E+05	6.32E-07	1.23E+05	6.88E-07
13	2.34E+04	2.3E-11	2.58E+04	2.6E-11
14	5.41E+03	5E-12	6.10E+03	6E-12
15	7.89E+02	8.87E-06	9.01E+02	1.01E-05
Total		2.17E-04		2.35E-04

Table 10.5-3a
Sensitivity Case
Ground vs. Elevated Release at 0-10 miles (24 hrs)

Source Term (24 Hrs)	Weighted Individual Risk (0-1 mile) (Ground)	Weighted Individual Risk (0-1 mile) (Elevated)	Weighted Societal Risk (0-10 mile) (Ground)	Weighted Societal Risk (0- 10 mile) (Elevated)	Weighted Probability of Exceedance of 0.2 Sv (0-0.5 mile) (Ground)	Weighted Probability of Exceedance of 0.2 Sv (0-0.5 mile) (Elevated)
1	8E-12	8E-12	1E-12	1E-12	7.4E-11	7.4E-11
2	6E-12	6E-12	ε	ε	7.4E-11	7.4E-11
3	ε	ε	ε	ε	1E-12	1E-12
4	5E-12	5E-12	2E-12	3E-12	5.5E-11	5.5E-11
5	0	0	0	0	0	0
6	ε	ε	ε	ε	ε	ε
7	0	0	0	0	0	0
8	0	0	ε	ε	3E-12	2E-12
9	5.5E-11	5.2E-11	4E-12	5E-12	6.10E-10	6.10E-10
10	0	0	0	0	0	0
11	0	0	ε	ε	ε	ε
12	ε	ε	ε	ε	5E-12	4E-12
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	ε	ε	1.21E-09	4.05E-10
Total	7.4E-11	7.0E-11	9E-12	1.0E-11	2.03E-09	1.22E-09

ε Less than 1E-12.

Table 10.5-3b_[yg22]

Sensitivity Case

Ground vs. Elevated Release at 0-10 miles (72 hrs)

Source Term (24 Hrs)	Weighted Individual Risk (0-1 mile) (Ground)	Weighted Individual Risk (0-1 mile) (Elevated)	Weighted Societal Risk (0-10 mile) (Ground)	Weighted Societal Risk (0-10 mile) (Elevated)	Weighted Probability of Exceedance of 0.2 Sv (0-0.5 mile) (Ground)	Weighted Probability of Exceedance of 0.2 Sv (0-0.5 mile) (Elevated)
1	8E-12	8E-12	1E-12	1E-12	7.4E-11	7.4E-11
2	6E-12	6E-12	ε	ε	7.4E-11	7.4E-11
3	ε	ε	ε	ε	1E-12	1E-12
4	5E-12	5E-12	2E-12	2E-12	5.5E-11	5.5E-11
5	ε	ε	ε	ε	ε	ε
6	ε	ε	ε	ε	ε	ε
7	2E-12	1E-12	ε	ε	1.6E-11	6E-12
8	1E-12	ε	ε	ε	4.6E-11	4.6E-11
9	5.9E-11	5.8E-11	5E-12	6E-12	6.10E-10	6.10E-10
10	ε	ε	ε	ε	ε	ε
11	ε	ε	ε	ε	ε	ε
12	ε	ε	ε	ε	5E-12	5E-12
13	ε	ε	ε	ε	ε	ε
14	ε	ε	ε	ε	ε	ε
15	0	0	ε	ε	1.21E-09	4.05E-10
Total	8.2E-11	7.9E-11	1.1E-11	1.2E-11	2.10E-09	1.28E-09

ε Less than 1E-12.

**Table 10.5-4
Sensitivity Case
Ground Release with Hourly Met Data Sampling (72 hrs)**

Source Term (72 Hrs)	Individual Risk (0-1 mile)	Weighted Individual Risk (per year)	Weighted Individual Risk Contribution (%)	Societal Risk (0-10 miles)	Weighted Societal Risk (per year)	Weighted Societal Risk Contribution (%)	Probability of Dose > .2 Sv (0-0.5 mile)	Weighted Probability of Exceedance (per year)	Weighted Dose Contribution (%)	Release Fraction
1	1.09E-01	8E-12	9.83%	1.83E-02	1E-12	12.57%	1.00E+00	7.4E-11	3.53%	0.5
2	8.06E-02	6E-12	7.27%	7.42E-03	ε	5.10%	1.00E+00	7.4E-11	3.53%	0.5
3	9.90E-02	ε	0.18%	1.41E-02	ε	0.19%	1.00E+00	1E-12	0.07%	0.026
4	9.20E-02	5E-12	6.18%	4.26E-02	2E-12	21.79%	1.00E+00	5.5E-11	2.63%	0.974
5	7.66E-02	ε	0.06%	4.49E-03	ε	0.03%	1.00E+00	ε	0.03%	0.717
6	6.83E-02	ε	0.02%	5.89E-03	ε	0.01%	1.00E+00	ε	0.01%	0.283
7	3.91E-02	2E-12	2.55%	1.29E-03	ε	0.64%	3.22E-01	1.7E-11	0.82%	0.538
8	2.84E-02	1E-12	1.59%	1.59E-03	ε	0.68%	1.00E+00	4.6E-11	2.20%	0.462
Note 1	9.57E-02	ε	0.00%	8.39E-03	ε	0.00%	1.00E+00	ε	0.00%	1
9	9.62E-02	5.9E-11	71.78%	8.88E-03	5E-12	50.48%	1.00E+00	6.10E-10	29.23%	1
10	8.00E-02	ε	0.00%	4.16E-03	ε	0.00%	9.48E-01	ε	0.00%	0.5
Note 2	8.36E-02	ε	0.00%	4.71E-03	ε	0.00%	9.96E-01	ε	0.00%	0.5
11	6.11E-02	ε	0.02%	2.70E-03	ε	0.01%	1.00E+00	ε	0.01%	0.05
12	7.51E-02	ε	0.51%	6.00E-03	ε	0.31%	9.93E-01	6E-12	0.27%	0.95
13	3.45E-03	ε	0.00%	7.35E-04	ε	0.00%	1.00E+00	ε	0.00%	1
14	1.16E-03	ε	0.00%	3.81E-04	ε	0.00%	8.38E-01	ε	0.00%	1
15	0	0	0.00%	7.82E-05	ε	8.19%	1.07E-01	1.20E-09	57.66%	1
Total	--	8.2E-11	100.00%	--	1.1E-11	100.00%	--	2.09E-09	100.00%	

Notes to Table 10.5-4

Note 1 The DCH case is added for the sensitivity study.

Note 2 The T-AT_nIN_nCHR_FR50_R1 case is added for the sensitivity study

ε Less than 1E-12.

Table 10.5-5a_[yg23]
Sensitivity Case
Ground Release With Sensitivity Met Data (24 hrs)

Source Term (24 Hrs)	Individual Risk (0-1 mile)	Weighted Individual Risk (per year)	Weighted Individual Risk Contribution (%)	Societal Risk (0-10 miles)	Weighted Societal Risk (per year)	Weighted Societal Risk Contribution (%)	Probability of Dose > .2 Sv (0- 0.5 mile)	Weighted Probability of x (per year)	Weighted Dose Contribution (%)	Release Fraction
1	1.16E-01	9E-12	9.37%	1.77E-02	1E-12	10.50%	1.00E+00	7.4E-11	5.21%	0.5
2	9.64E-02	7E-12	7.79%	1.06E-02	ε	6.29%	1.00E+00	7.4E-11	5.21%	0.5
3	1.15E-01	ε	0.18%	1.94E-02	ε	0.23%	1.00E+00	1E-12	0.10%	0.026
4	1.13E-01	6E-12	6.80%	6.19E-02	3E-12	27.34%	1.00E+00	5.5E-11	3.88%	0.974
5	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.717
6	7.49E-02	ε	0.02%	4.56E-03	ε	0.01%	1.00E+00	ε	0.02%	0.283
7	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.538
8	0	0	0.00%	8.89E-05	ε	0.03%	2.18E-02	ε	0.07%	0.462
Note 1	1.11E-01	ε	0.00%	7.88E-03	ε	0.00%	1.00E+00	ε	0.00%	1
9	1.13E-01	6.9E-11	75.56%	9.43E-03	6E-12	46.29%	1.00E+00	6.10E-10	43.13%	1
10	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.5
Note 2	3.00E-02	ε	0.00%	1.15E-03	ε	0.00%	2.51E-01	ε	0.00%	0.5
11	0	0	0.00%	1.13E-04	ε	0.00%	1.53E-01	ε	0.00%	0.05
12	4.41E-02	ε	0.27%	1.67E-03	9.34E-1	0.08%	9.87E-01	6E-12	0.39%	0.95
13	0	0	0.00%	0	0	0.00%	0	0	0.00%	1
14	0	0	0.00%	0	0	0.00%	0	0	0.00%	1
15	0	0	0.00%	1.02E-04	1E-12	9.23%	5.28E-02	5.93E-10	41.98%	1
Total	--	9.1E-11	100.00%	--	1.2E-11	100.00%	--	1.41E-09	100.00%	

Notes to Table 10.5-5a

Note 1 The DCH case is added for the sensitivity study.

Note 2 The T-AT_nIN_nCHR_FR50_R1 case is added for the sensitivity study.

ε Less than 1E-12

Table 10.5-5b_[yg24]
Sensitivity Case
Ground Release With Sensitivity Met Data (72 hrs)

Source Term (72 Hrs)	Individual Risk (0-1 mile)	Weighted Individual Risk (per year)	Weighted Individual Risk Contribution (%)	Societal Risk (0-10 miles)	Weighted Societal Risk (per year)	Weighted Societal Risk Contribution (%)	Probability of Dose > .2 Sv (0-0.5 mile)	Weighted Probability of Exceedance (per year)	Weighted Dose Contribution (%)	Release Fraction
1	1.16E-01	9E-12	8.77%	1.69E-02	1E-12	8.73%	1.00E+00	7.4E-11	4.95%	0.5
2	9.66E-02	7E-12	7.30%	1.08E-02	ε	5.58%	1.00E+00	7.4E-11	4.95%	0.5
3	1.16E-01	ε	0.17%	1.85E-02	ε	0.19%	1.00E+00	1E-12	0.10%	0.026
4	1.14E-01	6E-12	6.41%	6.14E-02	3E-12	23.61%	1.00E+00	5.5E-11	3.68%	0.974
5	1.02E-01	ε	0.07%	6.29E-03	ε	0.03%	1.00E+00	ε	0.04%	0.717
6	8.00E-02	ε	0.02%	8.31E-03	ε	0.01%	1.00E+00	ε	0.02%	0.283
7	5.50E-02	3E-12	3.01%	1.79E-03	ε	0.67%	4.03E-01	2.2E-11	1.44%	0.538
8	3.72E-02	2E-12	1.75%	2.03E-03	ε	0.65%	1.00E+00	4.6E-11	3.08%	0.462
Note 1	1.15E-01	ε	0.00%	1.15E-02	ε	0.00%	1.00E+00	ε	0.00%	1
9	1.15E-01	7.0E-11	71.92%	1.22E-02	7E-12	52.15%	1.00E+00	6.10E-10	40.95%	1
10	1.06E-01	ε	0.00%	6.02E-03	ε	0.00%	9.95E-01	ε	0.00%	0.5
Note 2	1.09E-01	ε	0.00%	6.84E-03	ε	0.00%	1.00E+00	ε	0.00%	0.5
11	8.36E-02	ε	0.03%	3.81E-03	ε	0.01%	1.00E+00	ε	0.02%	0.05
12	9.61E-02	ε	0.55%	8.35E-03	ε	0.33%	9.98E-01	6E-12	0.37%	0.95
13	4.94E-04	ε	0.00%	8.74E-04	ε	0.00%	1.00E+00	ε	0.00%	1
14	9.91E-05	ε	0.00%	4.31E-04	ε	0.00%	9.97E-01	ε	0.00%	1
15	0	0	0.00%	1.02E-04	1E-12	8.04%	5.35E-02	6.01E-10	40.39%	1
Total	--	9.8E-11	100.00%	--	1.4E-11	100.00%	--	1.49E-09	100.00%	--

Notes to Table 10.5-5b

Note 1 The DCH case is added for the sensitivity study.

Note 2 The T-AT_nIN_nCHR_FR50_R1 case is added for the sensitivity study.

e Less than 1E-12.

Table 10.5-6a
Sensitivity Case
Elevated Release With Sensitivity Met Data (24 hrs)

Source Term (24 Hrs)	Individual Risk (0-1 mile)	Weighted Individual Risk (per year)	Weighted Individual Risk Contribution (%)	Societal Risk (0-10 miles)	Weighted Societal Risk (per year)	Weighted Societal Risk Contribution (%)	Probability of Dose > .2 Sv (0- 0.5 mile)	Weighted Probability of Exceedance (per year)	Weighted Dose Contribution (%)	Release Fraction
1	1.16E-01	9E-12	9.77%	1.60E-02	1E-12	8.78%	1.00E+00	7.4E-11	7.03%	0.5
2	9.23E-02	7E-12	7.78%	1.17E-02	ε	6.42%	1.00E+00	7.4E-11	7.03%	0.5
3	1.12E-01	ε	0.19%	2.10E-02	ε	0.23%	1.00E+00	1E-12	0.14%	0.026
4	1.08E-01	6E-12	6.77%	6.82E-02	3E-12	27.85%	1.00E+00	5.5E-11	5.23%	0.974
5	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.717
6	6.74E-02	ε	0.02%	5.08E-03	ε	0.01%	1.00E+00	ε	0.02%	0.283
7	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.538
8	0	0	0.00%	8.94E-05	ε	0.03%	6.24E-03	ε	0.03%	0.462
Note 1	1.03E-01	ε	0.00%	8.76E-03	ε	0.00%	1.00E+00	ε	0.00%	1
9	1.08E-01	6.6E-11	75.28%	1.05E-02	6E-12	47.66%	1.00E+00	6.10E-10	58.16%	1
10	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.5
Note 2	1.47E-02	ε	0.00%	1.20E-03	ε	0.00%	4.35E-02	ε	0.00%	0.5
11	0	0	0.00%	1.17E-04	ε	0.00%	2.89E-02	ε	0.00%	0.05
12	2.93E-02	ε	0.19%	1.81E-03	ε	0.08%	9.22E-01	5E-12	0.49%	0.95
13	0	0	0.00%	0	0	0.00%	0	0	0.00%	1
14	0	0	0.00%	0	0	0.00%	0	0	0.00%	1
15	0	0	0.00%	1.07E-04	1E-12	8.95%	2.04E-02	2.29E-10	21.87%	1
Total	--	8.8E-11	100.00%	--	1.3E-11	100.00%	--	1.05E-09	100.00%	--

Notes to Table 10.5-6a

Note 1 The DCH case is added for the sensitivity study.

Note 2 The T-AT_nIN_nCHR_FR50_R1 case is added for the sensitivity study.

ε Less than 1E-12

Table 10.5-6b
Sensitivity Case
Elevated Release With Sensitivity Met Data (72 hrs)

Source Term (72 Hrs)	Individual Risk (0-1 mile)	Weighted Individual Risk (per year)	Weighted Individual Risk Contribution (%)	Societal Risk (0-10 miles)	Weighted Societal Risk (per year)	Weighted Societal Risk Contribution (%)	Probability of Dose > .2 Sv (0-0.5 mile)	Weighted Probability of Exceedance (per year)	Weighted Dose Contribution (%)	Release Fraction
1	1.10E-01	8E-12	10.30%	1.74E-02	1E-12	11.12%	1.00E+00	7.4E-11	5.77%	0.5
2	7.58E-02	6E-12	7.10%	8.75E-03	ε	5.59%	1.00E+00	7.4E-11	5.77%	0.5
3	9.84E-02	ε	0.18%	1.44E-02	ε	0.18%	1.00E+00	1E-12	0.11%	0.026
4	8.78E-02	5E-12	6.12%	4.77E-02	3E-12	22.70%	1.00E+00	5.5E-11	4.30%	0.974
5	6.65E-02	ε	0.05%	5.36E-03	ε	0.03%	1.00E+00	ε	0.05%	0.717
6	6.56E-02	ε	0.02%	6.65E-03	ε	0.01%	1.00E+00	ε	0.02%	0.283
7	2.52E-02	1E-12	1.71%	1.56E-03	ε	0.72%	1.15E-01	6E-12	0.48%	0.538
8	1.62E-02	ε	0.94%	1.78E-03	ε	0.71%	1.00E+00	4.6E-11	3.59%	0.462
Note 1	9.34E-02	ε	0.00%	9.13E-03	ε	0.00%	1.00E+00	ε	0.00%	1
9	9.43E-02	5.8E-11	73.04%	9.51E-03	6E-12	50.31%	1.00E+00	6.10E-10	47.76%	1
10	7.10E-02	ε	0.00%	4.98E-03	ε	0.00%	9.36E-01	ε	0.00%	0.5
Note 2	7.56E-02	ε	0.00%	5.62E-03	ε	0.00%	9.88E-01	ε	0.00%	0.5
11	4.67E-02	ε	0.02%	3.22E-03	ε	0.01%	1.00E+00	ε	0.02%	0.05
12	7.37E-02	ε	0.52%	6.33E-03	ε	0.31%	9.82E-01	5E-12	0.43%	0.95
13	2.02E-04	ε	0.00%	7.63E-04	ε	0.00%	1.00E+00	ε	0.00%	1
14	3.98E-05	ε	0.00%	3.94E-04	ε	0.00%	6.49E-01	ε	0.00%	1
15	0	0	0.00%	8.51E-05	ε	8.30%	3.60E-02	4.05E-10	31.69%	1
Total	--	7.9E-11	100.00%	--	1.2E-11	100.00%	--	1.28E-09	100.00%	--

Notes to Table 10.5-6b

Note 1 The DCH case is added for the sensitivity study.

Note 2 The T-AT_nIN_nCHR_FR50_R1 case is added for the sensitivity study

ε Less than 1E-12

Table 10.5-7a_[yg26]
Sensitivity Case
Elevated Release Sensitivity Met Data & Plume (24 hrs)

Source Term (24 Hrs)	Individual Risk (0-1 mile)	Weighted Individual Risk (per year)	Weighted Individual Risk Contribution (%)	Societal Risk (0-10 miles)	Weighted Societal Risk (per year)	Weighted Societal Risk Contribution (%)	Probability of Dose > .2 Sv (0-0.5 mile)	Weighted of Exceedance (per year)	Weighted Dose Contribution (%)	Release Fraction
1	1.15E-01	8E-12	10.72%	1.56E-02	1E-12	8.22%	1.00E+00	7.4E-11	7.04%	0.5
2	8.31E-02	6E-12	7.74%	1.23E-02	ε	6.48%	1.00E+00	7.4E-11	7.04%	0.5
3	1.04E-01	ε	0.19%	2.17E-02	ε	0.23%	1.00E+00	1E-12	0.14%	0.026
4	9.82E-02	5E-12	6.81%	7.15E-02	4E-12	28.05%	1.00E+00	5.5E-11	5.24%	0.974
5	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.717
6	5.42E-02	ε	0.02%	5.34E-03	ε	0.01%	1.00E+00	ε	0.02%	0.283
7	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.538
8	0	0	0.00%	8.71E-05	ε	0.03%	6.24E-03	ε	0.03%	0.462
Note 1	8.99E-02	ε	0.00%	9.22E-03	ε	0.00%	1.00E+00	ε	0.00%	1
9	9.65E-02	5.9E-11	74.41%	1.11E-02	6E-12	48.40%	1.00E+00	6.10E-10	58.24%	1
10	0	0	0.00%	0	0	0.00%	0	0	0.00%	0.5
Note 2	3.97E-03	ε	0.00%	1.12E-03	ε	0.00%	1.08E-02	ε	0.00%	0.5
11	0	0	0.00%	1.16E-04	ε	0.00%	4.24E-02	ε	0.00%	0.05
12	1.58E-02	ε	0.11%	1.79E-03	ε	0.07%	6.71E-01	4E-12	0.36%	0.95
13	0	0	0.00%	0	0	0.00%	0	0	0.00%	1
14	0	0	0.00%	0	0	0.00%	0	0	0.00%	1
15	0	0	0.00%	1.06E-04	1E-12	8.52%	2.04E-02	2.29E-10	21.90%	1
Total	--	7.9E-11	100.00%	--	1.4E-11	100.00%	--	1.05E-09	100.00%	--

Notes to Table 10.5-7a

Note 1 The DCH case is added for the sensitivity study.

Note 2 The T-AT_nIN_nCHR_FR50_R1 case is added for the sensitivity study.

ε Less than 1E-12

Table 10.5-7b
Sensitivity Case
Elevated Release Sensitivity Met Data & Plume (72 hrs)

Source Term (72 Hrs)	Individual Risk (0-1 mile)	Weighted Individual Risk (per year)	Weighted Individual Risk Contribution (%)	Societal Risk (0-10 miles)	Weighted Societal Risk (per year)	Weighted Societal Risk Contribution (%)	Probability of Dose > .2 Sv (0-0.5 mile)	Weighted Probability of Exceedance (per year)	Weighted Dose Contribution (%)	Release Fraction
1	1.15E-01	8E-12	9.77%	1.49E-02	1E-12	7.04%	1.00E+00	7.4E-11	6.68%	0.5
2	8.42E-02	6E-12	7.15%	1.25E-02	ε	5.91%	1.00E+00	7.4E-11	6.68%	0.5
3	1.09E-01	ε	0.18%	1.86E-02	ε	0.17%	1.00E+00	1E-12	0.13%	0.026
4	9.89E-02	5E-12	6.25%	7.05E-02	4E-12	24.80%	1.00E+00	5.5E-11	4.98%	0.974
5	7.11E-02	ε	0.05%	7.50E-03	ε	0.03%	1.00E+00	ε	0.06%	0.717
6	7.37E-02	ε	0.02%	9.52E-03	ε	0.02%	1.00E+00	ε	0.02%	0.283
7	1.85E-02	ε	1.14%	1.94E-03	ε	0.66%	1.38E-01	7E-12	0.67%	0.538
8	6.87E-03	ε	0.36%	2.05E-03	ε	0.60%	1.00E+00	4.6E-11	4.15%	0.462
9	1.06E-01	ε	0.00%	1.30E-02	ε	0.00%	1.00E+00	ε	0.00%	1
10	1.06E-01	6.5E-11	74.50%	1.35E-02	8E-12	52.79%	1.00E+00	6.10E-10	55.30%	1
11	7.77E-02	ε	0.00%	7.18E-03	ε	0.00%	9.95E-01	ε	0.00%	0.5
12	8.45E-02	ε	0.00%	8.05E-03	ε	0.00%	1.00E+00	ε	0.00%	0.5
13	4.57E-02	ε	0.02%	4.38E-03	ε	0.01%	1.00E+00	ε	0.03%	0.05
14	8.44E-02	ε	0.54%	9.09E-03	ε	0.33%	9.98E-01	6E-12	0.51%	0.95
15	5.91E-06	ε	0.00%	8.29E-04	ε	0.00%	1.00E+00	ε	0.00%	1
16	8.58E-07	ε	0.00%	4.07E-04	ε	0.00%	4.79E-01	ε	0.00%	1
17	0	0	0.00%	1.06E-04	1E-12	7.64%	2.04E-02	2.29E-10	20.79%	1
Total	--	8.7E-11	100.00%	--	1.6E-11	100.00%	--	1.10E-09	100.00%	--

Notes to Table 10.5-7b

Note 1 The DCH case is added for the sensitivity study.

Note 2 The T-AT_nIN_nCHR_FR50_R1 case is added for the sensitivity study

ε Less than 1E-12

10.6 REFERENCES

- 10-1 Chanin, D. and Young, M., Code Manual for MACCS2: User's Guide, NUREG/CR-6613, Vol. 1 (SAND97-0594), May 1998.
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- 10-5 1986 Cancer Facts and Figures, American Cancer Society, 90 Park Ave, New York, NY 10016.