Nine Mile Point Unit 1
Alternative Source Term

Calculation H21C090

"U1 FHA, AST Methodology"
(Fuel Handling Accident)

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Project: NINE MILE POINT NUCLEAR STATION — Unit (1,2 or 0=Both): 1 — Discipline: CR

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Purpose

The purpose of this calculation is to provide an analysis of the Fuel Handling Accident (FHA) for Nine Mile Point Nuclear Station. This update provides (1) implementation of the Reference 1 (AST) source terms and (2) both offsite and control room doses.

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Summary of Results

Table 1 shows the results of this calculation:

Table 1 Dose Results	TEDE (rem)	Limit[1] (rem)
Control Room	8.47E-01	5
EAB	4.47E-01	6.3
LPZ	3.84E-02	6.3

[1] per Reference 1

The results show that the applicable limits are met at all locations.

Methodology

This dose analysis fully complies with NRC Regulatory Guide 1.183 [Ref 1]. Following accident initiation (24 hours after shutdown), the radionuclide inventory from the damaged fuel pins is assumed to leak out to the environment instantaneously (even though releases to the environment could be assumed to occur over a 2-hour period [Ref 1]).

In no case is RBEVS filtration credited. Due to these simplifying, conservative assumptions, a spreadsheet is used to calculate the control room, EAB, and LPZ doses.

Releases account for:

- a 1.02 multiplier on licensed power,
- a radial peaking factor of 1.8,
- 5% gap activity (except 10% for Kr85 and 8% for I131),
- a pin failure fraction of 0.376% corresponding to 2 assemblies out of 532 assemblies,
- an overall iodine DF of 200 for the refueling pool (where elemental iodine has a DF of 268) and an infinite DF for other radionuclides except for noble gas.

The TEDE values obtained from the revised analysis are compared with the 6.3 rem FHA TEDE limit for offsite doses and the 5 rem TEDE limit for the control room [Ref 1].

Assumptions

Assumption 1: The accident is assumed to occur 24 hours after shutdown. Consequently, core inventories were calculated for that decay time.

Justification: Reference 2, Item 1.4

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Assumption 2: The release to the environment from the refueling floor occurs within two hours.

Justification: Reference 1

Assumption 3: The DF in the refueling pool does not exceed 200 for iodine, (DF of 268 is used for elemental iodine). No DF is applied to noble gas, and the DF for other radionuclides is assumed to be infinite.

Justification: Reference 1

Assumption 4: No credit is needed (or taken) for RBEVS filters.

Justification: Conservative

References

1. "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", US NRC Regulatory Guide 1.183, Revision 0, July 2000

2. PSAT 4026CF.QA.03, "Design Data Base for Application of the Revised DBA Source Term to Nine Mile Point", Revision 0

3. S. L. Humphries et al, "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", NUREG/CR-6604, Sandia National Laboratories, December 1997.

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Design Inputs

Design Input Data (Reference 2 for all inputs, Item numbers given in brackets)

Power Level: 1887 MWt [1.1]

Core inventory at shutdown [1.2]

Total number of fuel assemblies in core: 532 assemblies [2.5]

Number of damaged pins: 125 (63 for dropped assembly +62 for struck assembly) pins [2.11]
*8x8 assembly is bounding

Gap release fractions:

Radio-nuclide Group	Release Fraction from Gap to Coolant
Kr-85	10%
Other NG	5%
I-131	8%
Other Iodines	5%

[1.5]

Peaking factor: 1.8 [1.3]

Control Room Free Volume: 1.35E+05 ft^3 [3.9]

X/Q values in sec/m^3:

EAB:	1.9E-04	[5.1]
LPZ:	1.63E-05	[5.2]
CR:	4.82E-04	[5.3]

Breathing Rate in m^3/s (from start of release for CR): 3.5E-4 [5.4]

Iodine Species: 99.85% elemental, 0.15% organic** [4.5]

** Iodine chemical form not critical since control room filters are not used. Elemental iodine DF adjusted to obtain overall iodine of DF of 200 per Reference 1. No DF applied to organic iodine

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Calculation

Core inventories at 24hrs after shutdown are calculated using a spreadsheet methodology. The starting point of the calculation was the t = 0 shutdown inventories (Ci/MWt) from Reference 2, Item 1.2. To get the total curies of the isotope of interest one must add the curies resulting from its direct decay plus the curies resulting from decay in chains in which it is a daughter product. The final activities are shown in Table 2.

Table 2 – Core Inventories (per MWt) for FHA

Nuclide	Shutdown (Ci/MWt)	Adjusted[1] (Ci/MWt)	Branching Fraction [2]	24 Hours[3] (Ci/MWt)	K Decay /sec
Kr85m	6.82E+03	same	N/A	1.66E+02	4.30E-05
Kr85	3.93E+02	7.86E+02	N/A	7.86E+02	2.05E-09
Kr87	1.30E+04	same	N/A	2.81E-02	1.51E-04
Kr88	1.83E+04	same	N/A	5.23E+01	6.78E-05
Te131m	3.97E+03	*	*	*	6.42E-06
I131	2.71E+04	4.34E+04	N/A	4.00E+04	9.98E-07
Xe131m	3.04E+02	same	0.011	3.03E+02	6.74E-07
Te132	3.85E+04	*	*	*	2.46E-06
I132	3.92E+04	same	N/A	3.21E+04	8.37E-05
I133	5.51E+04	same	N/A	2.48E+04	9.26E-06
Xe133m	1.63E+03	same	0.029	1.48E+03	3.67E-06
Xe133	5.27E+04	same	0.971	5.09E+04	1.53E-06
I135	5.16E+04	same	N/A	4.18E+03	2.91E-05
Xe135m	1.09E+04	*	*	*	7.56E-04
Xe135	1.91E+04	same	0.835	1.23E+04	2.12E-05

'*' denotes where a nuclide is considered as a parent only

1. The adjusted column multiplies Kr85 by 2 and I131 by 1.6 to account for the gap release fractions (Kr85=10%, I131=8%, all other noble gases and iodines=5%)[Ref 1]. 'Same' refers to the fact that it is the same as the value listed for shutdown.
2. Branching fractions 'F_B', multiplier applied to the iodine parent of the specific Xe radionuclide.
3. Calculated using the decay expression : $a_t = a_0 * e^{-Kt}$

I131, Xe131m, I132, Xe133m, Xe133 and Xe135 also consider parent nuclide decay in determining their total (Ci/MWt). The following equation is used for these radionuclides:

$$a_t = a_0 * e^{-Kt} + \frac{F_B \cdot a_{p0} \cdot K}{K - K_p} \cdot (e^{-K_p t} - e^{-Kt})$$

'p' denotes parent value, and 'a' is activity in(Ci/MWt) and K is the decay constant

- It should be noted that the above equation is expanded for Xe133 and Xe135 to accommodate the presence of two parent nuclides.

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Note:

- For Kr83m, Kr89, Xe135m, Xe137, Xe138 and I134, the activity left after 24 hrs is negligible.
- No credit is taken for the RBEVS filtration.

Offsite and control room doses are analyzed using a spreadsheet methodology as discussed in Appendix A. The spreadsheet inputs are described below.

Scaling Factors (Rows 4, 5 & 6):
Scaling Factor 1 is the Power Level in MW(t), used to convert the core inventory concentration to total activity. Scaling Factor 2 is the peaking factor. Scaling Factor 3 is the gap fraction, multiplied by the failure fraction (2 of 532 assemblies).

DF (Row 7)
DF for Elemental I and Alkali metals are 268 and 1 respectively.

Source in Ci/MW(t) (column 2):
Values are taken from the core inventories adjusted for 24 hours, presented in column 3 of Table 2.

Nuclide Specific Scaling Factor (column 3):
No additional Nuclide Specific Scaling Factor is needed, the values in this column are set to unity for this calculation.

The results of this calculation can be seen in Table 3.

Results

An EXCEL spreadsheet calculation has been carried out to obtain the dose results for a FHA. . The spreadsheet methodology used is described in Appendix A with the following notable exceptions:

- The Source values have been decayed 24 hours as described in the Calculations section of this document.
- The Nuclide Specific Scaling Factor has been set to 1 for all nuclides because the scaling has already been credited, as can be seen in the 'Adjusted' column of Table 2.

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TABLE 3: Doses after a Fuel Handling Accident

NMP1 FHA	EAB	LPZ	CR	
Dispersion (X/Qs) =	1.90E-04	1.63E-05	4.82E-04	sec/m3

CR Vol = 135000 ft3 w/ finite volume gamma correction = 0.046212

Scaling Factor 1 = 1887 MW(t)

Scaling Factor 2 = 1.8 Peaking Factor

Scaling Factor 3 = 1.88E-04 (0.05 gap fract x 2 assy out of 532)

DF for Elemental I = 268 DF for Alkali Metals = 1

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Units Nuclide	Source: Ci/MW(t)	Nuclide-Specific Scaling Factor	WB DCF rem-m3/Ci-sec	CEDE DCF rem/Ci	TEDE DCF rem-m3/Ci-sec	CR DCF rem-m3/Ci-sec	EAB TEDE rem	LPZ TEDE rem	CR TEDE rem
Kr83m	0	1	5.55E-06	0	5.55E-06	2.56E-07	0.00E+00	0.00E+00	0.00E+00
Kr85m	1.66E+02	1	0.0277	0	0.0277	0.00128	5.58E-04	4.79E-05	6.54E-05
Kr85	7.86E+02	1	0.00044	0	0.00044	2.03E-05	4.20E-05	3.60E-06	4.92E-06
Kr87	2.81E-02	1	0.152	0	0.152	0.007024	5.18E-07	4.45E-08	6.08E-08
Kr88	5.23E+01	1	0.501	8.36E+01	0.53026	0.052412	3.36E-03	2.89E-04	8.44E-04
Kr89	0	1	0.323	0	0.323	0.014926	0.00E+00	0.00E+00	0.00E+00
Xe131m	3.03E+02	1	0.00144	0	0.00144	6.65E-05	5.29E-05	4.54E-06	6.21E-06
Xe133m	1.48E+03	1	0.00507	0	0.00507	0.000234	9.10E-04	7.81E-05	1.07E-04
Xe133	5.09E+04	1	0.00577	0	0.00577	0.000267	3.56E-02	3.06E-03	4.18E-03
Xe135m	0	1	0.0755	0	0.0755	0.003489	0.00E+00	0.00E+00	0.00E+00
Xe135	1.23E+04	1	0.044	0	0.044	0.002033	6.57E-02	5.63E-03	7.70E-03
Xe137	0	1	0.0303	0	0.0303	0.0014	0.00E+00	0.00E+00	0.00E+00
Xe138	0	1	0.213	0	0.213	0.009843	0.00E+00	0.00E+00	0.00E+00
I131Org	6.00E+01	1	0.0673	3.29E+04	11.5823	11.51811	8.43E-02	7.23E-03	2.13E-01
I132Org	4.81E+01	1	0.414	3.81E+02	0.54735	0.152482	3.19E-03	2.74E-04	2.26E-03
I133Org	3.71E+01	1	0.109	5.85E+03	2.1565	2.052537	9.71E-03	8.33E-04	2.34E-02
I134Org	0.00E+00	1	0.481	1.31E+02	5.27E-01	0.068078	0.00E+00	0.00E+00	0.00E+00
I135Org	6.26E+00	1	0.307	1.23E+03	0.7375	0.444687	5.60E-04	4.81E-05	8.57E-04
I131Elem	4.00E+04	1	0.0673	3.29E+04	11.5823	11.51811	2.10E-01	1.80E-02	5.29E-01
I132Elem	3.20E+04	1	0.414	3.81E+02	0.54735	0.152482	7.93E-03	6.80E-04	5.60E-03
I133Elem	2.47E+04	1	0.109	5.85E+03	2.1565	2.052537	2.41E-02	2.07E-03	5.82E-02
I134Elem	0.00E+00	1	0.481	1.31E+02	0.52685	0.068078	0.00E+00	0.00E+00	0.00E+00
I135Elem	4.17E+03	1	0.307	1.23E+03	7.38E-01	0.444687	1.39E-03	1.19E-04	2.13E-03
Rb86	0	1	0.0178	6.62E+03	2.3348	2.317823	0.00E+00	0.00E+00	0.00E+00
Cs134	0	1	0.28	4.63E+04	16.485	16.21794	0.00E+00	0.00E+00	0.00E+00
Cs136	0	1	0.392	7.33E+03	2.9575	2.583615	0.00E+00	0.00E+00	0.00E+00
Cs137	0	1	0.101	3.19E+04	11.266	11.16967	0.00E+00	0.00E+00	0.00E+00
Cs138	0	1	0.4255	1.15E+02	0.465904	0.060067	0.00E+00	0.00E+00	0.00E+00
						Total TEDE	**4.47E-01**	**3.84E-02**	**8.47E-01**

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The control room dose limit is 5 rem TEDE and that the offsite dose limit for the FHA is 6.3 rem TEDE [Ref 1]. The results from Tables 3 through 6 can be compared to these limits. Note that there is considerable margin for the doses.

Conclusions

The FHA control room and offsite doses are well within their Reference 1 limits.

Appendix A
A Spreadsheet for the Calculation of Offsite and Control Room Doses

Background/Methodology

It is desirable for simplicity in many cases to calculate a bounding radiation dose for a given accident using several basic assumptions. These are as follows:

- It is assumed that the release of activity may be defined at the outset (i.e., there are no time-dependent mechanisms that modify the amount of activity that's released; e.g., no delayed filtration or holdup).
- It is assumed that the release is instantaneous and complete, and the transport to the receptor is instantaneous, as well. Therefore, no radioactive decay needs to be considered. Note that the activity release, A, may, in fact, occur over a given time duration, t, at a rate A/t. As long as the exposure time is equal to duration of the release, time cancels out of the integrated dose analysis.
- It is assumed that the release is limited to coolant and/or gap activity (i.e., only a limited number of radionuclides are included in the sheet).
- It is assumed that the chemical/physical form of the iodine as it is released is limited to organic and elemental.
- No credit for control room emergency ventilation (i.e., filtration) is assumed.
- It is assumed that the atmospheric dispersion for the duration of the release may be characterized by a single value of X/Q for each location (EAB, LPZ, and control room).
- It is assumed that the exchange rate of the control room with the environment is infinite so that the concentration of activity inside the control room is equal to that in the atmosphere.
- It is assumed that the breathing rate of exposed individuals is a constant 3.5E-4 m^3/sec. Effectively, this means the release actually must occur over a period of no more than eight hours in order for the LPZ dose not to be overstated.
- It is assumed that the control room occupancy factor is unity.

In addition, for the spreadsheet to be consistent with Reference 1, Dose Conversion Factors (DCFs) based on References 2 and 3 must be used. These are taken from the default TID.INP and FGR60.INP default files of Reference 4. Breathing rates and occupancy factors are taken from Reference 1.

The following section describes the development of such an Excel spreadsheet.

Spreadsheet Development

The spreadsheet is displayed at the end of this section, just before the references.

At the top of the spreadsheet (in the first row) is the title. An example might be "NMP1 MSLB". In the second row may be found the EAB, LPZ, and control room X/Qs in units of seconds/m^3. The control room volume in ft^3 is given in the third column. It is included to provide the basis for the finite volume correction factor for gamma shine dose provided by Reference 1 (calculated to the right of the control room volume).

The next three rows provide scaling factors that apply equally to all of the radionuclides listed and to all of the calculated doses (EAB, LPZ, and control room). For example, in an FHA analysis, if the core-wide activity available for release is expressed as Ci/MWt, one scaling factor may be the power of the core, a second may be the peaking factor to account for the fact that the specific activity in the affected fuel bundles may be greater than the core average, and the third may be the fraction of the core's activity that is released from the damaged bundles (i.e., the fraction of the core activity assumed to be in the gap multiplied by the fraction of the core fuel bundles that are damaged by the drop). Space is available next to each scaling factor to annotate what each value represents.

DFs are specifically provided in the next row after the scaling factors. One DF is provided for elemental iodine and one for alkali metals (i.e., Cs and Rb).

The "Source" column (i.e., the second column) has already been mentioned. One space is provided under "Source" to identify the units of "Source". For each of the coolant and/or gap release radionuclides identified in the first column, a "Source" entry may be made.

In the third column, there is a place for scaling factors unique to individual radionuclides. For example, gap fractions that differ from the general gap fraction may be accommodated using these radionuclide-specific scaling factors. If the I-131 gap fraction is 8% vs. the general value of 5%, then the "Source" for I-131 would have to be increased by a factor of 1.6 to account for that difference. That factor may be entered in the third column.

In the fourth column, the DCFs for immersion dose are provided. As noted previously, these are taken from Reference 4 TID.INP and FGR60.INP with the multiplication of "Cloudshine-Effective" by 3.7E12 to convert Sv-m^3/Bq-sec to rem-m^3/Ci-sec. In the fifth column, the "Inhaled-Chronic-Effective" values from FGR60.INP have been multiplied by the same 3.7E12 to convert Sv/Bq to rem/Ci. Note that these DCFs include short-lived decay daughters as long as (1) the daughter has a half-life less than 90 minutes and (2) the daughter has a half-life less than 0.1 times the parent. One exception has been made to this rule. Because of its importance as a decay daughter, the DCFs for Rb-88 have been added to those for Kr-88 even though the half-life of Rb-88 (17.8 minutes) is

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slightly greater than 10% of its parent Kr-88 (170.4 minutes).

In the sixth column, a TEDE DCF is prepared which is the sum of the immersion DCF and the inhalation DCF times the assumed breathing rate of 3.5E-4 m^3/sec.

In the seventh column, a control room DCF is defined which is similar to the TEDE DCF. However, the immersion DSF is diminished by the finite volume correction factor defined as the following in Reference 1:

$$DDE_{finite} = \frac{DDE_{\infty} V^{0.338}}{1173}$$

For a control room volume of 135,000 ft^3, for example, the factor is 0.0462. Note that this factor appears next to the control room volume at the top of the spreadsheet. It is ~unity for a control room volume of 1.2E9 ft^3.

The eighth column is the EAB dose, the product of Columns 2, 3, and 6, the three general scaling factors, and the EAB X/Q. Note that if a release of the activity, A, in Column 2 occurs over time, t, the release rate is A/t assuming a unit scaling factor in Column 3. When multiplied by the X/Q, the product is the concentration present at the X/Q location for the time, t (i.e., for the duration of the release). When multiplied by the DCF (Column 6) in units of rem-volume/Ci-time, the result is a dose rate for the duration, t. As long as it is assumed that the exposure duration, t', is the same as release duration, t, then the immersion + inhalation dose is simply the product as just described. In the last row of Column 8, the EAB dose is summed for all radionuclides in Column 1. Note that in calculating the EAB dose, the elemental iodine dose is reduced by the DF for elemental iodine and the alkali metal dose is reduced by the DF for alkali metals.

In Column 9, the Column 8 results are adjusted by the ratio of the LPZ X/Q to the EAB X/Q to obtain the LPZ dose.

Finally, in Column 10, the Column 8 results are adjusted by the ratio of the control room X/Q to the EAB X/Q and by the ratio of the control room DCF to the TEDE DCF to obtain the control room dose contribution for each radionuclide. As with the EAB and the LPZ doses, these are summed at the bottom of column to obtain the total control room TEDE.

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Spreadsheet for Simplified Dose Evaluation

TITLE		EAB	LPZ	CR		
Dispersion (X/Qs) =		x.xxE-xx	x.xxE-xx	x.xxE-xx	sec/m3	
CR Vol =	1.20E+09	ft3 w/ finite volume gamma correction =				0.999
Scaling Factor 1 =		1				
Scaling Factor 2 =		1				
Scaling Factor 3 =		1				
DF for Elemental I =		1	DF for Alkali Metals =		1	

Units >> Nuclide	Source:	Nuclide-Specific Scaling Factor	WB DCF rem-m3 Ci-sec	CEDE DCF rem/Ci	TEDE DCF rem-m3 Ci-sec	CR DCF rem-m3 Ci-sec	EAB TEDE rem	LPZ TEDE rem	CR TEDE rem
Kr83m	0	1	5.55E-06	0	5.55E-06	5.54E-06	0.00E+00	0.00E+00	0.00E+00
Kr85m	0	1	0.0277	0	0.0277	0.027666	0.00E+00	0.00E+00	0.00E+00
Kr85	0	1	0.00044	0	0.00044	0.000439	0.00E+00	0.00E+00	0.00E+00
Kr87	0	1	0.152	0	0.152	0.151813	0.00E+00	0.00E+00	0.00E+00
Kr88	0	1	0.501	8.36E+01	0.53026	0.529643	0.00E+00	0.00E+00	0.00E+00
Kr89	0	1	0.323	0	0.323	0.322603	0.00E+00	0.00E+00	0.00E+00
Xe131m	0	1	0.00144	0	0.00144	0.001438	0.00E+00	0.00E+00	0.00E+00
Xe133m	0	1	0.00507	0	0.00507	0.005064	0.00E+00	0.00E+00	0.00E+00
Xe133	0	1	0.00577	0	0.00577	0.005763	0.00E+00	0.00E+00	0.00E+00
Xe135m	0	1	0.0755	0	0.0755	0.075407	0.00E+00	0.00E+00	0.00E+00
Xe135	0	1	0.044	0	0.044	0.043946	0.00E+00	0.00E+00	0.00E+00
Xe137	0	1	0.0303	0	0.0303	0.030263	0.00E+00	0.00E+00	0.00E+00
Xe138	0	1	0.213	0	0.213	0.212738	0.00E+00	0.00E+00	0.00E+00
I131Org	0	1	0.0673	3.29E+04	11.5823	11.58222	0.00E+00	0.00E+00	0.00E+00
I132Org	0	1	0.414	3.81E+02	0.54735	0.546841	0.00E+00	0.00E+00	0.00E+00
I133Org	0	1	0.109	5.85E+03	2.1565	2.156366	0.00E+00	0.00E+00	0.00E+00
I134Org	0	1	0.481	1.31E+02	5.27E-01	0.526258	0.00E+00	0.00E+00	0.00E+00
I135Org	0	1	0.307	1.23E+03	0.7375	0.737122	0.00E+00	0.00E+00	0.00E+00
I131Elem	0	1	0.0673	3.29E+04	11.5823	11.58222	0.00E+00	0.00E+00	0.00E+00
I132Elem	0	1	0.414	3.81E+02	0.54735	0.546841	0.00E+00	0.00E+00	0.00E+00
I133Elem	0	1	0.109	5.85E+03	2.1565	2.156366	0.00E+00	0.00E+00	0.00E+00
I134Elem	0	1	0.481	1.31E+02	0.52685	0.526258	0.00E+00	0.00E+00	0.00E+00
I135Elem	0	1	0.307	1.23E+03	7.38E-01	0.737122	0.00E+00	0.00E+00	0.00E+00
Rb86	0	1	0.0178	6.62E+03	2.3348	2.334778	0.00E+00	0.00E+00	0.00E+00
Cs134	0	1	0.28	4.63E+04	16.485	16.48466	0.00E+00	0.00E+00	0.00E+00
Cs136	0	1	0.392	7.33E+03	2.9575	2.957018	0.00E+00	0.00E+00	0.00E+00
Cs137	0	1	0.101	3.19E+04	11.266	11.26588	0.00E+00	0.00E+00	0.00E+00
Cs138	0	1	0.4255	1.15E+02	0.465904	0.46538	0.00E+00	0.00E+00	0.00E+00
						Total TEDE	**0.00E+00**	**0.00E+00**	**0.00E+00**

Project: Nine Mile Point Nuclear Station   Unit: __1__   Disposition: N/A

Originator/Date	Reviewer/Date	Calculation No.	Revision
H. Pustulka 12/12/06	M. Berg 12/13/06	H21C090	0

Ref.

References

A-1 Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", July 2000

A-2 K.F. Eckerman et al., "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Federal Guidance Report 11, EPA-520/1-88-020, Environmental Protection Agency, 1988.

A-3 K.F. Eckerman and J.C. Ryman, "External Exposure to Radionuclides in Air, Water, and Soil," Federal Guidance Report 12, EPA-402-R-93-081, Environmental Protection Agency, 1993

A-4 NUREG/CR-6604, "RADTRAD: A Simplified Model for RADionuclide Transport and Removal And Dose Estimation", December 1997

ATTACHMENT 1: DESIGN VERIFICATION REPORT

Document being design-verified: ☐ DCP ☒ Calc ☐ Spec ☐ NER ☐ DBD ☐ Other

Doc#, Rev and Title: H21C090, Revision 0 : U1 FHA, AST Methodology

Extent of Design Verification (Briefly describe):
This calculation was design verified by 1) validating all input with respect to the input database (with the exception of the Dose Conversion Factors which were validated utilizing the FGR 11 and 12 parent documents), making sure that the appropriate input values were used; 2) assuring that all assumptions are conservative and conform to the Reg.Guide 1.183 AST requirements; 3) validating the calculation methodology and calculation tools (i.e. spreadsheet) as being acceptable for the task; and 4) validating final results to make sure that they are as expected.

Method of Design Verification:

☒ Design Review ☐ Qualification Testing
☐ Alternate Calculations ☐ Applicability of Proven Design

Results of Design Verification:

☒ Fully acceptable with no issues identified
☐ Fully acceptable based on the following issues identified and resolved:

All input were appropriate and all assumptions valid (no further validation of assumptions are required). The calculation methodologies were appropriate for the task. All calculated values conform to as expected results. The calculation made several assumptions which simplified the analysis, and also added significant conservatism. Among these conservatisms is the control room being essentially open to the environment, so that no Habitability Zone protections were taken into account (such as filtration, delayed inflow, etc.). Minor issues were commented upon and corrected prior to final draft of the calculation.

☐ Continuation Page Follows

Discipline Involvement and Approvals:

	Name	Signature	Date
Lead Design Verifier:	M. Berg	Marc C. Berg	12/13/06

Discipline Design Verifiers, if required:

Discipline	Name	Signature	Date
N/A			

ATTACHMENT 2: DESIGN VERIFICATION CHECKLIST

The following questions are required to be addressed based on the Nine Mile Point commitment to NQA-1 (1983) for design verification activities. This checklist is intended to assist when using the Design Review method of design verification to ensure relevant items are addressed in the verification effort. Each "No" answer will require correction or resolution by the originator of the document being verified prior to full acceptance by the design verifier(s).

Doc #: H21C090, Rev 0

Lead Design Verifiers Name: M. Berg

Items Addressed with Basis of Review Answer	Review Check		
	Yes	No	N/A
1. Were the inputs correctly selected ?	X		
2. Are assumptions necessary to perform the design activity adequately described and reasonable ? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed activities are completed ?	X		
3. Was an appropriate design method used?	X		
4. Were the design inputs correctly incorporated into the design ?	X		
5. Is the design output reasonable compared to design inputs ?	X		
6. Are the necessary design input and verification requirements for interfacing organizations specified in the design documents or in supporting procedures or instructions ?			X