ATTACHMENT 11

EXELON/AMERGEN

RESPONSE TO THE REQUEST FOR ADDITIONAL INFORMATION

EP-EAL-0611, Criteria for Choosing Containment Radiation Monitor Reading Indicative of loss of the RCS Barrier

Criteria for Choosing Containment Radiation Monitor Reading Indicative of loss of the RCS Barrier

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Criteria for Choosing Containment Radiation Monitor Reading Indicative of Loss of RCS Barrier

1. Purpose

The purpose of this calculation is to document the logic and assumptions used in choosing the Emergency Action Level (EAL) threshold values for Containment Radiation Monitor Readings corresponding to a Loss of the Reactor Coolant System Fission Product Barrier.

2. Background

To support the implementation of NEI 99-01 Revision 4 methodology for development of Emergency Action Levels for Exelon stations, it was deemed beneficial to provide additional technical documentation describing the methodology for determining the containment radiation monitor values indicating a loss of the RCS barrier.

The generic guidance provided in NEI 99-01, Revision 4 is not intended to be used by plants "as is". The generic guidance is intended to give the logic for developing site-specific IC/EALs (Section 5.3 of NEI 99-01). Plant specific wording and values must be developed. If specific guidance provided in NEI 99-01 Revision 4 cannot be used as presented, documentation must be provided to show how Exelon Corporation implemented the intent of the guidance.

3. Discussion

The Loss of the RCS Fission Product Barrier as indicated by Containment Radiation Monitoring NEI 99-01 Revision 4 provides the following guidance:

> "The (site-specific) reading is a value which indicates the release of reactor coolant to the containment. The reading should be calculated assuming the instantaneous release and dispersal of the reactor coolant noble gas and iodine inventory associated with normal operating concentrations (i.e., within T/S) into the containment atmosphere. This reading will be less than that specified for Fuel Clad Barrier EAL #5. Thus, this EAL would be indicative of an RCS leak only. If the radiation monitor reading increased to that specified by Fuel Clad Barrier EAL #5, fuel damage would also be indicated."
>
> "However, if the site specific physical location of the containment radiation monitor is such that radiation from a cloud of released RCS gases could not be distinguished from radiation from nearby piping and components containing elevated reactor coolant activity, this EAL should be omitted and other site specific indications of RCS leakage substituted."

Calculations were performed to estimate the containment radiation dose rates resulting in a release of all the RCS inventory to the containment atmosphere with the Maximum Technical Specification coolant activity. See Attachment 1 (BWR) and Attachment 2 (PWR) for all assumptions and calculation results.

4. Conclusions

Refer to Attachments 1 and 2 for BWR and PWR results respectively.

5. References

a. Software Requirements Specification, Exelon MAROG BWR Core Damage Assessment (BWRCDAM), Version 1.1, February 2005.

b. Software Requirements Specification, (Exelon Clinton, Dresden, LaSalle, and Quad Cities Core Damage Assessment), Midwest Region BWR CDAM Version 1.0/1.1, December 2002.

c. Software Requirements Specification, Exelon TMI Core Damage Assessment (TMICDAM), Version 1.0, April 2003.

d. Software Requirements Specification, (Exelon Braidwood/Byron Core Damage Assessment), Midwest Region PWR CDAM Version 1.0/1.1. July 2002.

e. Federal Guidance Report No. 11 (FGR 11), "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion", Second Printing, 1989 (with corrections).

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

g. Micro-Shield Computer Program, Version 5.03.

h. Calculation Number BYR04-046 & BRW-04-0040-M Rev. 1, "Re-analysis of Main Steam Line Break (MSLB) Accident Using Alternative Source Terms"

i. Braidwood/Byron Stations UFSAR, Rev. 10, December 2004

j. Clinton Station UFSAR, Rev. 11, January 2005

k. Dresden Station UFSAR, Rev. 6, June 2005

l. LaSalle County Station UFSAR, Rev. 6, April 2006

m. Limerick Station UFSAR, Rev. 12, September 2004

n. Oyster Creek UFSAR, Update 14, October 2005

o. Peach Bottom UFSAR, Rev. 20, April 2005

p. Quad Cities Station UFSAR, Rev. 8, October 2005

q. Calculation C-1101-900-E000-087 (TMI), "Post-LOCA EAB, LPZ, TSC, and CR Doses Using AST and RG 1.183 Requirements", Rev 1.

r. NEDO-22215, "Procedures for the Determination of the Extent of Core Damage Under Accident conditions, General Electric, August 1982.

Attachment 1
BWR

Assumptions:

- RCS Liquid and Free-Air volumes were obtained from the BWR Core Damage Assessment Model (CDAM) Requirements Specification:
  - Mid-Atlantic Version 1.1, Section 7.2.2, "Normal System Volumes"
  - Mid-West Version 1.0/1.1, Section 7.2.2 "Normal System Volumes"

  with the following exceptions:
  - None

- It is assumed the entire Liquid RCS volume is instantaneously released to the Drywell and all entrained Iodine immediately disperses homogeneously throughout the free air space.

- Only the Drywell volumes are used in the calculation. Although some of the released material may ultimately find its way into other areas such as the Suppression Pool air volumes, it is assumed the initial release will be confined to only the Drywell space.

- The RCS Dose Equivalent I-131 values of interest (0.2 uCi/gm and 4.0 uCi) were obtained from the sites' Technical Specifications and were specifically requested by the Revision 4 EAL implementation team for this calculation. These are standard Technical Specification values for Boiling Water Reactors.

- Only isotopes of Iodine were used in the calculation. Although noble gasses will be released to the containment atmosphere, their dose rate contribution is small compared to that of the Iodines because noble gasses in a BWR are only contained within the steam space of the RCS and are continuously being off-gassed. As such, the calculated dose rate will be conservative.

- Dose Conversion factors used to calculate "Isotopic Concentrations" were obtained from "FGR 11". Though these factors are for Alternative Source Term (AST) calculations, when normalized to I-131 they adequately represent the mixture of Iodines in the coolant. The Dose Conversion Factors from FGR 11 were obtained from Table 2.1, column "Effective". The choice of using values from the Effective column was based on the methodology used for AST calculations and section 4.1.2 of Regulator Guide 1.183 which states:

  > "The exposure-to-CEDE factor for inhalation of radioactive material should be derived from data provided in ICRP Publication 30, *Limits for Intakes of radionuclides by Workers* (Ref. 19). Table 2.1 of Federal

Guidance Report 11, *Limiting values of Radionuclide Intake and Air Concentration and Dose Conversion factors for Inhalation, Submersion, and Ingestion* (Ref. 20), provides tables of conversion factors acceptable to the NRC staff. The factors in the column headed *Effective* yield doses corresponding to the CEDE."

Since only the Normalized ratios are used in the calculation, unit conversion is not required, however the international units of Sv/Bq were converted to Rem/Ci for ease of understanding.

Additional calculations were performed using the FGR 11 Table 2.1, column "Thyroid" Dose Conversion Factors for comparison purposes. The calculations were limited to the 4.0 uCi/gm DEI-131 values. The results of these calculations are included in the Results table at the end of this attachment.

- MicroShield Model:

  A generic approach was taken when constructing the MicroShield model since each site's actual configuration is different. Even though the entire free air space volume is available for dilution of the released radioactive isotopes, the radiation detectors located within the drywell are not exposed to the entire volume. Therefore a cylindrical source representing the entire drywell was not used. Instead, a "box" was constructed in the MicroShield model that approximates the size of the area that a detector would be exposed to. The box measured 20 feet in depth (distance from the vessel support wall to the drywell wall), 40 feet tall, and 40 feet wide. Forty feet square is considered a reasonable representation of the free air space around the detector. A dose receptor point, representing the detector, was placed on the outer edge of the box (representing the drywell wall) halfway up and across the box. This best represents the location of a radiation detector within the drywell mounted on the outer or inner wall. No attempt was made to simulate shielding from components within the drywell nor was any credit taken for backscatter from the surrounding walls or components. The box was then filled with the calculated isotopic concentrations to determine a dose rate at the given point.

Methodology:

MicroShield requires a given concentration in uCi/cc or uCi/gm for each isotope of interest. To obtain those concentrations requires converting the I-131 Dose Equivalent concentration (0.2 uCi/gm and 4.0 uCi/gm) to their individual isotopic components. In this case an equivalent for I-131, I-132, I-133, I-134 and I-135.

Individual calculation sheets, MicroShield runs and supporting documents are included in this attachment for reference purposes for each site. The following provides an explanation of the calculations performed.

Normalized I-131 Equivalent Activity Distribution

A normalized I-131 equivalent activity distribution for each isotope was calculated using the relative mix of the isotopes of interest for each facility. These ratios vary from site to site and are listed on the individual sites' calculation spreadsheets. Copies of the source documents are contained within this calculation. The normalized value is calculated using the following equation:

$$\frac{DCF_{(i)}}{DCF_{(I-131)}} = NDCF_{(i)}$$

Where:

$DCF_{(i)}$ = Isotopes' FGR-11 Dose Conversion Factor (See Assumptions for details)

$DCF_{(I\text{-}131)}$ = I-131 FGR-11 Dose Conversion Factor (See Assumptions for details)

$NDCF_{(i)}$ = The Isotopes' ratio normalized to the I-131 DCF.

Since only the normalized DCF values are used in the calculation, no unit conversion is necessary.

$$AD_{(i)} * NDCF_{(i)} = NC_{(i)}$$

Where:

$AD_{(i)}$ = Activity Distribution (See the included calculation data for individual sites distribution numbers)

$NC_{(i)}$ = Normalized I-131 Equivalent Activity Distribution

Calculate the fraction of each isotopes' normalized activity distribution.

$$\frac{NC_{(i)}}{\sum NC_{(i)}} = f_{(i)}$$

Where:

$f_{(i)}$ = Fraction of each isotope's normalized activity distribution.

Calculate the Dose Equivalent I-131 activity (uCi/gm) for each Isotope.

$$f_{(i)} * DE_{(I-131)} = DEI-131_{(i)}$$

Where:

$DE_{(I\text{-}131)}$ = 0.2 or 4.0 uCi/gm

$DEI\text{-}131_{(i)}$ = the Dose Equivalent I-131 activity (uCi/gm) for each isotope.

Calculate the Isotopic Concentration

$$\frac{DEI-131_{(i)}}{NDCF_{(i)}} = IC_{(i)}$$

Where:

$IC_{(i)}$ = Isotope's RCS Concentration (uCi/gm)

Calculate Total Isotopic RCS Activity for each isotope

$$IC_i * V_{(RCS)} = A_{(i)}$$

Where:

$V_{(RCS)}$ = RCS Liquid Volume

$A_{(i)}$ = Isotopes total activity (uCi) in the RCS

Calculate the Drywell Airborne Concentration

$$\frac{A_i}{V_{(f)}} = AC_{(i)}$$

Where:

$V_{(f)}$ = Free-air space as defined in the assumptions

$AC_{(i)}$ = Isotopes concentration (uCi/cc) in the Dry Well free-air space.

Calculation

The Drywell Airborne Concentrations ($AC_{(i)}$) were entered into the MicroShield program for each RCS Dose Equivalent Iodine –131 values of interest (0.2 and 4.0 uCi/gm).

Results:

The following table summarizes the results of each calculation by site.

Site	Calculated Dose Rate (0.2 uCi/gm) R/hr (FGR 11 Effective DCF)	Calculated Dose Rate (4.0 uCi/gm) R/hr (FGR 11 Effective DCF)	Calculated Dose Rate (4.0 uCi/gm) R/hr (FGR 11 Thyroid DCF)
Clinton	7.5	151	167
Dresden	8.5	169	187
LaSalle	9.7	195	215
Limerick	6.6	132	146
Oyster Creek	9.2	185	204
Peach Bottom	5.4	109	118
Quad Cities	8.5	169	187

Clinton

Clinton

(Effective DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0150	3.29E+04	1.00E+00	1.50E-02	0.363	0.2	7.26E-02	7.26E-02	3.16E+08	2.29E+07	6.970E+09	3.29E-03
I-132	0.1500	3.81E+02	1.16E-02	1.74E-03	0.042		8.41E-03	7.26E-01		2.29E+08		3.29E-02
I-133	0.1000	5.85E+03	1.78E-01	1.78E-02	0.430		8.61E-02	4.84E-01		1.53E+08		2.19E-02
I-134	0.3000	1.31E+02	3.98E-03	1.19E-03	0.029		5.78E-03	1.45E+00		4.59E+08		6.58E-02
I-135	0.1500	1.23E+03	3.74E-02	5.61E-03	0.136		2.71E-02	7.26E-01		2.29E+08		3.29E-02
				4.13E-02	1.000		2.00E-01					1.57E-01
I-131	0.0150	3.29E+04	1.00E+00	1.50E-02	0.363	4.0	1.45E+00	1.45E+00		4.59E+08		6.58E-02
I-132	0.1500	3.81E+02	1.16E-02	1.74E-03	0.042		1.68E-01	1.45E+01		4.59E+09		6.58E-01
I-133	0.1000	5.85E+03	1.78E-01	1.78E-02	0.430		1.72E+00	9.68E+00		3.06E+09		4.39E-01
I-134	0.3000	1.31E+02	3.98E-03	1.19E-03	0.029		1.16E-01	2.90E+01		9.18E+09		1.32E+00
I-135	0.1500	1.23E+03	3.74E-02	5.61E-03	0.136		5.43E-01	1.45E+01		4.59E+09		6.58E-01
				4.13E-02	1.000		4.00E+00					3.14E+00

(2) The second is based on assumptions considered to provide a realistic conservative estimate of the radiological consequences. This analysis is referred to as the "realistic analysis".

A schematic of the release path is shown in Figure 15.6.4-1.

15.6.4.5.1 Design Basis Analysis

The design basis analysis is based on NRC Standard Review Plan 15.6.4 and NRC Regulatory Guide 1.5. The specific models, assumptions and the program used for computer evaluation are described in Reference 2. Specific values of parameters used in the evaluation are presented in Table 15.6.4-2.

15.6.4.5.1.1 Fission Product Release from Fuel

There is no fuel damage as a result of this accident. The only activity available for release from the break is that which is present in the reactor coolant and steam lines prior to the break. This level of activity is consistent with an offgas release rate of 100 μCi/sec - MWT after 30 minutes delay (approximately 300,000 μCi/sec). The iodine concentrations in the reactor coolant are three times the design basis concentrations which are given by (μCi/gm):

I-131	0.015
I-132	0.15
I-133	0.10
I-134	0.30
I-135	0.15

Because of its short half-life, N-16 is not considered in the analysis.

15.6.4.5.1.2 Fission Product Transport to the Environment

The transport pathway is a direct unfiltered release to the environment. The MSLIV detection and closure time of 5.5 sec results in a discharge of 42,500 lb of steam and 53,750 lb of liquid from the break. The mass release is limited by choked flow through the main steam line flow restrictors and the MSLIV closure time. Neither of the limitations are power related, so the mass release is applicable at both the original and current licensed power. Assuming all the activity in this discharge becomes airborne, the release of activity to the environment is presented in Table 15.6.4-3.

15.6.4.5.1.3 Results

The calculated exposures for the design basis analysis are presented in Table 15.6.4-4 and are a small fraction of the guidelines of 10 CFR 100.

ATTACHMENT 1
BWR CDAM METHODOLOGIES

7.2.2 Normal System Volumes

Normal system volumes are used as default values, since operator actions or accident events can significantly change actual volumes, the program shall allow end user to manually enter values based on conditions at time of accident.

Location	Clinton	Dresden	LaSalle	Quad Cities	Reference
RCS (ml)	3.16E+08	2.61E+08	4.11E+08	2.61E+08	Clinton USAR Fig 5.1-2 Dresden/Quad Cities taken from NEDO 22215.
Suppression Pool Liquid (ml)	4.15E+09	3.26E+09	3.68E+09	3.26E+09	DR/QC UFSAR Section 6 (1.15E+05 Ft^3, 3.26E+09 ml) LS UFSAR Cont Design Param (1.30E+05 Ft^3, 3.68E+09 ml)
Drywell Atmosphere (cc)	6.97E+09	4.47E+09	6.51E+09	4.47E+09	DR/QC UFSAR Section 6 LS UFSAR Cont Design Param
Containment Atmosphere (cc)	4.39E+10	N/A	N/A	N/A	
Suppression Pool Atmosphere (cc)	N/A	3.32E+09	4.67E+09	3.40E+09	DR/QC UFSAR Section 6 (1.15E+05 Ft^3, 3.26E+09 ml) LS UFSAR Cont Design Param (1.30E+05 Ft^3, 3.68E+09 ml)

A. Volume Corrections

A volume correction is necessary whenever a single sample is taken and the two locations (Reactor Coolant and Containment Sump) are not in a state of equilibrium (when the released activity is not assumed to be spread throughout both sample locations). The volume correction is as follows:

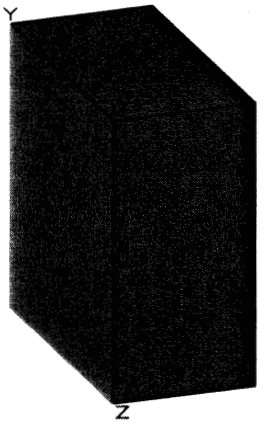
$$VC = \frac{\text{Volume}_{\text{Sampled Location}}}{\text{Volume}_{\text{Both Locations}}}$$

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: CL-02UCI.MS5
Run Date: October 16, 2006
Run Time: 2:14:27 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Clinton 0.2 uCi/g
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	2.9812e+000	1.1030e+011	3.2900e-003	1.2173e+002
I-132	2.9812e+001	1.1030e+012	3.2900e-002	1.2173e+003
I-133	1.9844e+001	7.3424e+011	2.1900e-002	8.1030e+002
I-134	5.9624e+001	2.2061e+012	6.5800e-002	2.4346e+003
I-135	2.9812e+001	1.1030e+012	3.2900e-002	1.2173e+003

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	5.196e+10	5.393e+02	6.385e+02	5.345e+00	6.328e+00
0.08	2.888e+09	8.607e+01	9.900e+01	1.362e-01	1.567e-01
0.15	1.087e+11	6.152e+03	6.776e+03	1.013e+01	1.116e+01
0.2	8.824e+10	6.693e+03	7.203e+03	1.181e+01	1.271e+01
0.3	9.258e+10	1.061e+04	1.122e+04	2.013e+01	2.128e+01

DOS File: CL-02UCI.MS5
Run Date: October 16, 2006
Run Time: 2:14:27 PM
Duration: 00:00:02

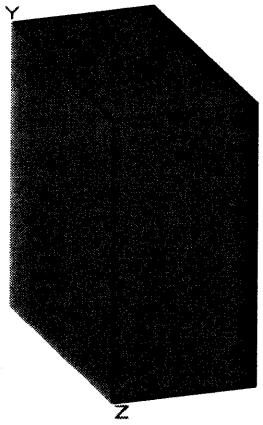
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	4.547e+11	6.986e+04	7.307e+04	1.361e+02	1.424e+02
0.5	1.288e+12	2.483e+05	2.579e+05	4.873e+02	5.063e+02
0.6	2.182e+12	5.062e+05	5.234e+05	9.881e+02	1.022e+03
0.8	5.071e+12	1.576e+06	1.619e+06	2.998e+03	3.079e+03
1.0	1.649e+12	6.425e+05	6.574e+05	1.184e+03	1.212e+03
1.5	1.082e+12	6.360e+05	6.468e+05	1.070e+03	1.088e+03
2.0	3.344e+11	2.630e+05	2.666e+05	4.067e+02	4.122e+02
TOTALS:	1.240e+13	3.966e+06	4.070e+06	7.318e+03	7.513e+03

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: CL-4UCI.MS5
Run Date: October 16, 2006
Run Time: 2:15:56 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Clinton 4 uCi/g
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	5.9624e+001	2.2061e+012	6.5800e-002	2.4346e+003
I-132	5.9624e+002	2.2061e+013	6.5800e-001	2.4346e+004
I-133	3.9780e+002	1.4718e+013	4.3900e-001	1.6243e+004
I-134	1.1961e+003	4.4256e+013	1.3200e+000	4.8840e+004
I-135	5.9624e+002	2.2061e+013	6.5800e-001	2.4346e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.041e+12	1.081e+04	1.280e+04	1.071e+02	1.268e+02
0.08	5.776e+10	1.721e+03	1.980e+03	2.724e+00	3.133e+00
0.15	2.181e+12	1.234e+05	1.359e+05	2.032e+02	2.238e+02
0.2	1.769e+12	1.342e+05	1.444e+05	2.368e+02	2.548e+02
0.3	1.853e+12	2.124e+05	2.245e+05	4.029e+02	4.259e+02

DOS File: CL-4UCI.MS5
Run Date: October 16, 2006
Run Time: 2:15:56 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	9.111e+12	1.400e+06	1.464e+06	2.727e+03	2.853e+03
0.5	2.581e+13	4.975e+06	5.168e+06	9.764e+03	1.014e+04
0.6	4.368e+13	1.013e+07	1.048e+07	1.978e+04	2.045e+04
0.8	1.017e+14	3.159e+07	3.245e+07	6.009e+04	6.172e+04
1.0	3.302e+13	1.287e+07	1.317e+07	2.373e+04	2.427e+04
1.5	2.165e+13	1.273e+07	1.295e+07	2.142e+04	2.178e+04
2.0	6.699e+12	5.269e+06	5.340e+06	8.148e+03	8.257e+03
TOTALS:	2.485e+14	7.946e+07	8.154e+07	1.466e+05	1.505e+05

Clinton

(Thyroid DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0150	1.08E+06	1.00E+00	1.50E-02	0.403	0.2	8.07E-02	8.07E-02	3.16E+08	2.55E+07	6.970E+09	3.66E-03
I-132	0.1500	6.44E+03	5.96E-03	8.94E-04	0.024		4.81E-03	8.07E-01		2.55E+08		3.66E-02
I-133	0.1000	1.80E+05	1.66E-01	1.66E-02	0.448		8.95E-02	5.38E-01		1.70E+08		2.44E-02
I-134	0.3000	1.07E+03	9.86E-04	2.96E-04	0.008		1.59E-03	1.61E+00		5.10E+08		7.32E-02
I-135	0.1500	3.13E+04	2.90E-02	4.35E-03	0.117		2.34E-02	8.07E-01		2.55E+08		3.66E-02
				3.72E-02	1.000		2.00E-01					1.74E-01
I-131	0.0150	1.08E+06	1.00E+00	1.50E-02	0.403	4.0	1.61E+00	1.61E+00		5.10E+08		7.32E-02
I-132	0.1500	6.44E+03	5.96E-03	8.94E-04	0.024		9.62E-02	1.61E+01		5.10E+09		7.32E-01
I-133	0.1000	1.80E+05	1.66E-01	1.66E-02	0.448		1.79E+00	1.08E+01		3.40E+09		4.88E-01
I-134	0.3000	1.07E+03	9.86E-04	2.96E-04	0.008		3.18E-02	3.23E+01		1.02E+10		1.46E+00
I-135	0.1500	3.13E+04	2.90E-02	4.35E-03	0.117		4.68E-01	1.61E+01		5.10E+09		7.32E-01
				3.72E-02	1.000		4.00E+00					3.49E+00

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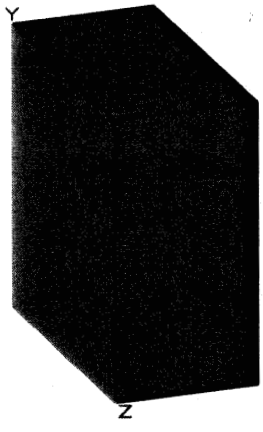
PECO Energy

Page : 1
DOS File: CL-4UCII.MS5
Run Date: October 24, 2006
Run Time: 2:04:44 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Clinton 4 uCi/g
Description: D/W Rad Monitor (Thyroid DCF)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	6.6329e+001	2.4542e+012	7.3200e-002	2.7084e+003
I-132	6.6329e+002	2.4542e+013	7.3200e-001	2.7084e+004
I-133	4.4220e+002	1.6361e+013	4.8800e-001	1.8056e+004
I-134	1.3230e+003	4.8950e+013	1.4600e+000	5.4020e+004
I-135	6.6329e+002	2.4542e+013	7.3200e-001	2.7084e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.154e+12	1.198e+04	1.418e+04	1.187e+02	1.406e+02
0.08	6.426e+10	1.915e+03	2.203e+03	3.030e+00	3.486e+00
0.15	2.412e+12	1.365e+05	1.504e+05	2.248e+02	2.476e+02
0.2	1.959e+12	1.486e+05	1.599e+05	2.623e+02	2.823e+02
0.3	2.059e+12	2.360e+05	2.495e+05	4.478e+02	4.733e+02

age : 2
OS File: CL-4UCII.MS5
un Date: October 24, 2006
un Time: 2:04:44 PM
uration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	1.010e+13	1.552e+06	1.623e+06	3.023e+03	3.163e+03
0.5	2.866e+13	5.525e+06	5.739e+06	1.084e+04	1.127e+04
0.6	4.850e+13	1.125e+07	1.163e+07	2.196e+04	2.271e+04
0.8	1.126e+14	3.499e+07	3.594e+07	6.656e+04	6.836e+04
1.0	3.663e+13	1.428e+07	1.461e+07	2.632e+04	2.692e+04
1.5	2.405e+13	1.414e+07	1.438e+07	2.379e+04	2.420e+04
2.0	7.430e+12	5.843e+06	5.922e+06	9.036e+03	9.158e+03
TOTALS:	2.756e+14	8.811e+07	9.042e+07	1.626e+05	1.669e+05

Dresden

Dresden

(Effective DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0250	3.29E+04	1.00E+00	2.50E-02	0.446	0.2	8.93E-02	8.93E-02	2.61E+08	2.33E+07	4.470E+09	5.21E-03
I-132	0.2500	3.81E+02	1.16E-02	2.90E-03	0.052		1.03E-02	8.93E-01		2.33E+08		5.21E-02
I-133	0.1000	5.85E+03	1.78E-01	1.78E-02	0.317		6.35E-02	3.57E-01		9.32E+07		2.08E-02
I-134	0.2500	1.31E+02	3.98E-03	9.95E-04	0.018		3.55E-03	8.93E-01		2.33E+08		5.21E-02
I-135	0.2500	1.23E+03	3.74E-02	9.35E-03	0.167		3.34E-02	8.93E-01		2.33E+08		5.21E-02
				5.60E-02	1.000		2.00E-01					1.82E-01
I-131	0.0250	3.29E+04	1.00E+00	2.50E-02	0.446	4.0	1.79E+00	1.79E+00		4.66E+08		1.04E-01
I-132	0.2500	3.81E+02	1.16E-02	2.90E-03	0.052		2.07E-01	1.79E+01		4.66E+09		1.04E+00
I-133	0.1000	5.85E+03	1.78E-01	1.78E-02	0.317		1.27E+00	7.14E+00		1.86E+09		4.17E-01
I-134	0.2500	1.31E+02	3.98E-03	9.95E-04	0.018		7.11E-02	1.79E+01		4.66E+09		1.04E+00
I-135	0.2500	1.23E+03	3.74E-02	9.35E-03	0.167		6.67E-01	1.79E+01		4.66E+09		1.04E+00
				5.60E-02	1.000		4.00E+00					3.65E+00

The MCHFR throughout the transient was calculated using a digital computer code. The code calculates the thermal hydraulic response of a single nuclear reactor coolant channel, consisting of an array of cylindrical fuel rods surrounded by channel walls. The code includes provisions for pressure losses, fluid expansion, inlet flow variations, axial power shape, and various heat transfer modes. The MCHFR throughout the transient was calculated for the case of normal ac power available and the degraded case of simultaneous loss of normal ac power, which would cause a recirculation pump trip. The core flowrates both with and without recirculation pumps were calculated using the five-node digital computer code used to calculate internal forces. These results are shown on Figure 15.6-3 which includes the sweep time of the core. The calculated MCHFR would not go below 2.0 (Figure 15.6-3) throughout the transient even if the isolation valves were closed at the longest time; therefore, core integrity is maintained throughout the accident and no fuel damage should result. (MCHFR has been replaced in later analyses by MCPR. Since these quantities are not interchangeable, the terminology in this analysis has not been revised.)

15.6.4.5 Radiological Consequences

The following section describes main steam line break radiological dose analysis performed for the initial licensing of the plant, i.e., 7x7 fuel arrays.

The predominant activity in the discharged coolant would be N-16, which would be significantly reduced by decay due to its short half-life (about 7 seconds). If the reactor contained fuel with cladding leaks, the water released through the break would contain some fission products.

15.6.4.5.1 [HISTORICAL]

During 1964, the Dresden Unit 1 reactor was operated with a significant number of cladding leaks. Analysis of reactor water samples indicated the following yearly average fission product contents:

Fission Product	Activity (μCi/cc)
I-131	0.025
I-133	0.1
Other halogens	0.25
Other fission products	0.25

With separate reactor water cleanup systems for Unit 2 and Unit 3, it is estimated that the maximum coolant activity in each unit would be approximately 2.4 μCi/cc at a 100,000 μCi/s normal off-gas release rate and would have the following fission product contents:

Fission Product	Activity (μCi/cc)
I-131	0.04
I-133	0.3
Other halogens	1.9
Other fission products	0.2

ATTACHMENT 1
BWR CDAM METHODOLOGIES

7.2.2 Normal System Volumes

Normal system volumes are used as default values, since operator actions or accident events can significantly change actual volumes, the program shall allow end user to manually enter values based on conditions at time of accident.

Location	Clinton	Dresden	LaSalle	Quad Cities	Reference
RCS (ml)	3.16E+08	2.61E+08	4.11E+08	2.61E+08	Clinton USAR Fig 5.1-2 Dresden/Quad Cities taken from NEDO 22215.
Suppression Pool Liquid (ml)	4.15E+09	3.26E+09	3.68E+09	3.26E+09	DR/QC UFSAR Section 6 (1.15E+05 Ft^3, 3.26E+09 ml) LS UFSAR Cont Design Param (1.30E+05 Ft^3, 3.68E+09 ml)
Drywell Atmosphere (cc)	6.97E+09	4.47E+09	6.51E+09	4.47E+09	DR/QC UFSAR Section 6 LS UFSAR Cont Design Param
Containment Atmosphere (cc)	4.39E+10	N/A	N/A	N/A	
Suppression Pool Atmosphere (cc)	N/A	3.32E+09	4.67E+09	3.40E+09	DR/QC UFSAR Section 6 (1.15E+05 Ft^3, 3.26E+09 ml) LS UFSAR Cont Design Param (1.30E+05 Ft^3, 3.68E+09 ml)

A. Volume Corrections

A volume correction is necessary whenever a single sample is taken and the two locations (Reactor Coolant and Containment Sump) are not in a state of equilibrium (when the released activity is not assumed to be spread throughout both sample locations). The volume correction is as follows:

$$VC = \frac{Volume_{\text{Sampled Location}}}{Volume_{\text{Both Locations}}}$$

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PECO Energy

Page : 1
DOS File: DR-02UCI.MS5
Run Date: October 16, 2006
Run Time: 2:09:26 PM
Duration: 00:00:02

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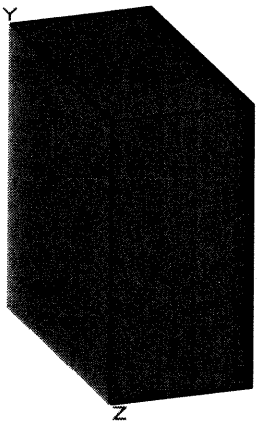
Date: _____
By: _____
Checked: _____

Case Title: Dresden 0.2 uCi/g
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm	609.6 cm	609.6 cm
	20 ft 1.2 in	20 ft 0.0 in	20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	uCi/cm³	Bq/cm³
I-131	4.7210e+000	1.7468e+011	5.2100e-003	1.9277e+002
I-132	4.7210e+001	1.7468e+012	5.2100e-002	1.9277e+003
I-133	1.8848e+001	6.9736e+011	2.0800e-002	7.6960e+002
I-134	4.7210e+001	1.7468e+012	5.2100e-002	1.9277e+003
I-135	4.7210e+001	1.7468e+012	5.2100e-002	1.9277e+003

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	5.328e+10	5.530e+02	6.547e+02	5.481e+00	6.489e+00
0.08	4.573e+09	1.363e+02	1.568e+02	2.157e-01	2.481e-01
0.15	8.815e+10	4.988e+03	5.494e+03	8.214e+00	9.047e+00
0.2	8.857e+10	6.718e+03	7.230e+03	1.186e+01	1.276e+01
0.3	1.326e+11	1.521e+04	1.607e+04	2.884e+01	3.049e+01

DOS File: DR-02UCI.MS5
Run Date: October 16, 2006
Run Time: 2:09:26 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	4.966e+11	7.629e+04	7.980e+04	1.486e+02	1.555e+02
0.5	1.395e+12	2.690e+05	2.794e+05	5.280e+02	5.485e+02
0.6	2.857e+12	6.630e+05	6.855e+05	1.294e+03	1.338e+03
0.8	4.921e+12	1.529e+06	1.571e+06	2.909e+03	2.988e+03
1.0	1.926e+12	7.505e+05	7.679e+05	1.383e+03	1.415e+03
1.5	1.467e+12	8.625e+05	8.772e+05	1.451e+03	1.476e+03
2.0	3.896e+11	3.064e+05	3.105e+05	4.738e+02	4.802e+02
TOTALS:	1.382e+13	4.485e+06	4.601e+06	8.242e+03	8.460e+03

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PECO Energy

Page : 1
DOS File: DR-4UCI.MS5
Run Date: October 16, 2006
Run Time: 2:06:35 PM
Duration: 00:00:02

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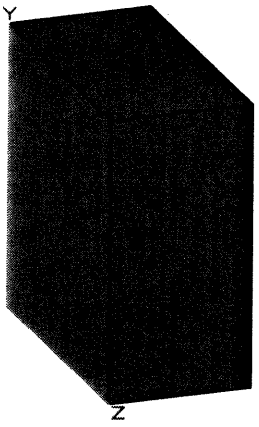
Date: _____
By: _____
Checked: _____

Case Title: Dresden 4 uCi/g
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	uCi/cm³	Bq/cm³
I-131	9.4238e+001	3.4868e+012	1.0400e-001	3.8480e+003
I-132	9.4238e+002	3.4868e+013	1.0400e+000	3.8480e+004
I-133	3.7786e+002	1.3981e+013	4.1700e-001	1.5429e+004
I-134	9.4238e+002	3.4868e+013	1.0400e+000	3.8480e+004
I-135	9.4238e+002	3.4868e+013	1.0400e+000	3.8480e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.064e+12	1.104e+04	1.307e+04	1.094e+02	1.296e+02
0.08	9.129e+10	2.721e+03	3.130e+03	4.306e+00	4.953e+00
0.15	1.760e+12	9.957e+04	1.097e+05	1.640e+02	1.806e+02
0.2	1.768e+12	1.341e+05	1.443e+05	2.367e+02	2.547e+02
0.3	2.648e+12	3.036e+05	3.209e+05	5.758e+02	6.087e+02

DOS File: DR-4UCI.MS5
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Run Time: 2:06:35 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	9.913e+12	1.523e+06	1.593e+06	2.967e+03	3.104e+03
0.5	2.791e+13	5.380e+06	5.589e+06	1.056e+04	1.097e+04
0.6	5.704e+13	1.323e+07	1.368e+07	2.583e+04	2.671e+04
0.8	9.823e+13	3.053e+07	3.136e+07	5.807e+04	5.964e+04
1.0	3.844e+13	1.498e+07	1.533e+07	2.762e+04	2.826e+04
1.5	2.929e+13	1.722e+07	1.751e+07	2.897e+04	2.946e+04
2.0	7.777e+12	6.117e+06	6.199e+06	9.459e+03	9.586e+03
TOTALS:	2.759e+14	8.953e+07	9.185e+07	1.646e+05	1.689e+05

Dresden

(Thyroid DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0250	1.08E+06	1.00E+00	2.50E-02	0.494	0.2	9.88E-02	9.88E-02	2.61E+08	2.58E+07	4.470E+09	5.77E-03
I-132	0.2500	6.44E+03	5.96E-03	1.49E-03	0.029		5.89E-03	9.88E-01		2.58E+08		5.77E-02
I-133	0.1000	1.80E+05	1.66E-01	1.66E-02	0.329		6.58E-02	3.95E-01		1.03E+08		2.31E-02
I-134	0.2500	1.07E+03	9.86E-04	2.47E-04	0.005		9.74E-04	9.88E-01		2.58E+08		5.77E-02
I-135	0.2500	3.13E+04	2.90E-02	7.24E-03	0.143		2.86E-02	9.88E-01		2.58E+08		5.77E-02
				5.06E-02	1.000		2.00E-01					2.02E-01
I-131	0.0250	1.08E+06	1.00E+00	2.50E-02	0.494	4.0	1.98E+00	1.98E+00		5.16E+08		1.15E-01
I-132	0.2500	6.44E+03	5.96E-03	1.49E-03	0.029		1.18E-01	1.98E+01		5.16E+09		1.15E+00
I-133	0.1000	1.80E+05	1.66E-01	1.66E-02	0.329		1.32E+00	7.90E+00		2.06E+09		4.61E-01
I-134	0.2500	1.07E+03	9.86E-04	2.47E-04	0.005		1.95E-02	1.98E+01		5.16E+09		1.15E+00
I-135	0.2500	3.13E+04	2.90E-02	7.24E-03	0.143		5.72E-01	1.98E+01		5.16E+09		1.15E+00
				5.06E-02	1.000		4.00E+00					4.04E+00

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PECO Energy

Page : 1
DOS File: DR-4UCII.MS5
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Run Time: 1:27:54 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

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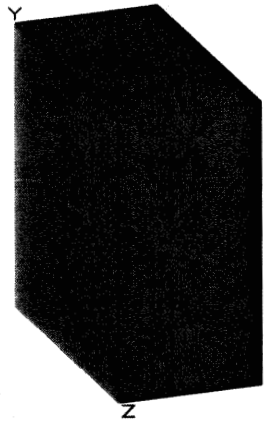
Description: D/W Rad Monitor (Thyroid DCF)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	1.0421e+002	3.8556e+012	1.1500e-001	4.2550e+003
I-132	1.0421e+003	3.8556e+013	1.1500e+000	4.2550e+004
I-133	4.1773e+002	1.5456e+013	4.6100e-001	1.7057e+004
I-134	1.0421e+003	3.8556e+013	1.1500e+000	4.2550e+004
I-135	1.0421e+003	3.8556e+013	1.1500e+000	4.2550e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.176e+12	1.221e+04	1.446e+04	1.210e+02	1.433e+02
0.08	1.009e+11	3.009e+03	3.461e+03	4.761e+00	5.476e+00
0.15	1.946e+12	1.101e+05	1.213e+05	1.813e+02	1.997e+02
0.2	1.955e+12	1.483e+05	1.596e+05	2.617e+02	2.817e+02
0.3	2.928e+12	3.357e+05	3.548e+05	6.367e+02	6.731e+02

age : 2
OS File: DR-4UCII.MS5
un Date: October 24, 2006
un Time: 1:27:54 PM
uration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	1.096e+13	1.684e+06	1.762e+06	3.281e+03	3.432e+03
0.5	3.086e+13	5.948e+06	6.179e+06	1.168e+04	1.213e+04
0.6	6.307e+13	1.463e+07	1.513e+07	2.856e+04	2.953e+04
0.8	1.086e+14	3.376e+07	3.467e+07	6.421e+04	6.595e+04
1.0	4.251e+13	1.657e+07	1.695e+07	3.054e+04	3.124e+04
1.5	3.238e+13	1.904e+07	1.936e+07	3.203e+04	3.258e+04
2.0	8.599e+12	6.763e+06	6.855e+06	1.046e+04	1.060e+04
TOTALS:	3.051e+14	9.900e+07	1.016e+08	1.820e+05	1.868e+05

LaSalle

LaSalle

(Effective DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0390	3.29E+04	1.00E+00	3.90E-02	0.359	0.2	7.18E-02	7.18E-02	4.11E+08	2.95E+07	6.510E+09	4.53E-03
I-132	0.3600	3.81E+02	1.16E-02	4.17E-03	0.038		7.68E-03	6.63E-01		2.72E+08		4.18E-02
I-133	0.2700	5.85E+03	1.78E-01	4.80E-02	0.442		8.84E-02	4.97E-01		2.04E+08		3.14E-02
I-134	0.7200	1.31E+02	3.98E-03	2.87E-03	0.026		5.28E-03	1.33E+00		5.45E+08		8.37E-02
I-135	0.3900	1.23E+03	3.74E-02	1.46E-02	0.134		2.68E-02	7.18E-01		2.95E+08		4.53E-02
				1.09E-01	1.000		2.00E-01					2.07E-01
I-131	0.0390	3.29E+04	1.00E+00	3.90E-02	0.359	4.0	1.44E+00	1.44E+00		5.90E+08		9.07E-02
I-132	0.3600	3.81E+02	1.16E-02	4.17E-03	0.038		1.54E-01	1.33E+01		5.45E+09		8.37E-01
I-133	0.2700	5.85E+03	1.78E-01	4.80E-02	0.442		1.77E+00	9.94E+00		4.09E+09		6.28E-01
I-134	0.7200	1.31E+02	3.98E-03	2.87E-03	0.026		1.06E-01	2.65E+01		1.09E+10		1.67E+00
I-135	0.3900	1.23E+03	3.74E-02	1.46E-02	0.134		5.37E-01	1.44E+01		5.90E+09		9.07E-01
				1.09E-01	1.000		4.00E+00					4.14E+00

for computer evaluation are described in Reference 4. Specific values of parameters used in the evaluation are presented in Table 15.6-5.

There is no fuel damage as a result of this event. The only activity available for release from the break is that which is present in the reactor coolant and steamlines prior to the break. The iodine concentration in the reactor coolant is then given by (μCi/gm):

I-131	0.039
I-132	0.360
I-133	0.270
I-134	0.720
I-135	0.390

Because of its short half-life, N-16 is not considered in the analysis.

The transport pathway is a direct, unfiltered release to the steam tunnel, which is a part of the secondary containment. The MSIV detection and closure time of 5.5 seconds results in a discharge of 14,000 pounds of steam and 86,000 pounds of liquid from the break. Assuming all the activity in this discharge becomes airborne, the release of activity to the environment is presented in Table 15.6-6.

This level of activity is consistent with an off-gas release rate of 300,000 μCi/sec after a 30-minute delay.

The calculated exposures for the design-basis analysis are presented in Table 15.6-8 and are a small fraction of the guidelines of 10 CFR 100.

Realistic Analysis

The realistic analysis is based on a plausible but still conservative assessment of this event. The specific models and assumptions and the program used for computer evaluation are described in Reference 2. Specific values of parameters used in the evaluation are presented in Table 15.6-5.

Since there is no fuel rod damage as a consequence of this event, the only activity released to the environment is that associated with the steam and liquid discharged from the break.

The activity released from the event is a function of the coolant activity, valve closure time, and mass of coolant released. A portion of the released coolant exists as steam prior to the blowdown, and as such does not contain the same concentration per unit of mass as does the steam generated as a consequence of the blowdown. Therefore, it is necessary to subtract the initial steam mass from the

ATTACHMENT 1
BWR CDAM METHODOLOGIES

7.2.2 Normal System Volumes

Normal system volumes are used as default values, since operator actions or accident events can significantly change actual volumes, the program shall allow end user to manually enter values based on conditions at time of accident.

Location	Clinton	Dresden	LaSalle	Quad Cities	Reference
RCS (ml)	3.16E+08	2.61E+08	4.11E+08	2.61E+08	Clinton USAR Fig 5.1-2 Dresden/Quad Cities taken from NEDO 22215.
Suppression Pool Liquid (ml)	4.15E+09	3.26E+09	3.68E+09	3.26E+09	DR/QC UFSAR Section 6 (1.15E+05 Ft^3, 3.26E+09 ml) LS UFSAR Cont Design Param (1.30E+05 Ft^3, 3.68E+09 ml)
Drywell Atmosphere (cc)	6.97E+09	4.47E+09	6.51E+09	4.47E+09	DR/QC UFSAR Section 6 LS UFSAR Cont Design Param
Containment Atmosphere (cc)	4.39E+10	N/A	N/A	N/A	
Suppression Pool Atmosphere (cc)	N/A	3.32E+09	4.67E+09	3.40E+09	DR/QC UFSAR Section 6 (1.15E+05 Ft^3, 3.26E+09 ml) LS UFSAR Cont Design Param (1.30E+05 Ft^3, 3.68E+09 ml)

A. Volume Corrections

A volume correction is necessary whenever a single sample is taken and the two locations (Reactor Coolant and Containment Sump) are not in a state of equilibrium (when the released activity is not assumed to be spread throughout both sample locations). The volume correction is as follows:

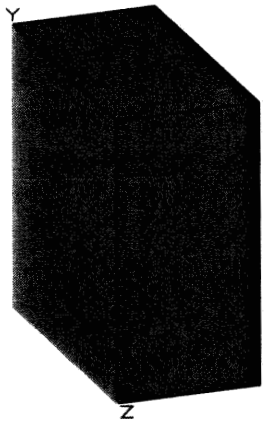
$$VC = \frac{\text{Volume}_{\text{Sampled Location}}}{\text{Volume}_{\text{Both Locations}}}$$

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: LS-02UCI.MS5
Run Date: October 16, 2006
Run Time: 1:57:42 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: LaSalle 0.2uCi/gm
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm	609.6 cm	609.6 cm
	20 ft 1.2 in	20 ft 0.0 in	20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	4.1048e+000	1.5188e+011	4.5300e-003	1.6761e+002
I-132	3.7877e+001	1.4014e+012	4.1800e-002	1.5466e+003
I-133	2.8453e+001	1.0528e+012	3.1400e-002	1.1618e+003
I-134	7.5844e+001	2.8062e+012	8.3700e-002	3.0969e+003
I-135	4.1048e+001	1.5188e+012	4.5300e-002	1.6761e+003

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	6.754e+10	7.011e+02	8.300e+02	6.948e+00	8.226e+00
0.08	3.976e+09	1.185e+02	1.363e+02	1.875e-01	2.157e-01
0.15	1.383e+11	7.825e+03	8.619e+03	1.289e+01	1.419e+01
0.2	1.146e+11	8.689e+03	9.351e+03	1.534e+01	1.650e+01
0.3	1.233e+11	1.413e+04	1.494e+04	2.681e+01	2.834e+01

DOS File: LS-02UCI.MS5
Run Date: October 16, 2006
Run Time: 1:57:42 PM
Duration: 00:00:02

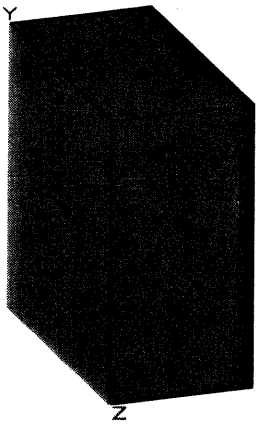
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	5.943e+11	9.130e+04	9.551e+04	1.779e+02	1.861e+02
0.5	1.752e+12	3.377e+05	3.508e+05	6.629e+02	6.887e+02
0.6	2.776e+12	6.441e+05	6.660e+05	1.257e+03	1.300e+03
0.8	6.467e+12	2.010e+06	2.064e+06	3.823e+03	3.927e+03
1.0	2.147e+12	8.369e+05	8.563e+05	1.543e+03	1.578e+03
1.5	1.441e+12	8.474e+05	8.618e+05	1.426e+03	1.450e+03
2.0	4.381e+11	3.445e+05	3.492e+05	5.328e+02	5.400e+02
TOTALS:	1.606e+13	5.143e+06	5.278e+06	9.484e+03	9.737e+03

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: LS-4UCI.MS5
Run Date: October 16, 2006
Run Time: 1:59:55 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: LaSalle 4 uCi/gm
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	8.2187e+001	3.0409e+012	9.0700e-002	3.3559e+003
I-132	7.5844e+002	2.8062e+013	8.3700e-001	3.0969e+004
I-133	5.6906e+002	2.1055e+013	6.2800e-001	2.3236e+004
I-134	1.5133e+003	5.5990e+013	1.6700e+000	6.1790e+004
I-135	8.2187e+002	3.0409e+013	9.0700e-001	3.3559e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.349e+12	1.400e+04	1.658e+04	1.388e+02	1.643e+02
0.08	7.962e+10	2.373e+03	2.729e+03	3.755e+00	4.319e+00
0.15	2.759e+12	1.561e+05	1.720e+05	2.571e+02	2.832e+02
0.2	2.288e+12	1.735e+05	1.868e+05	3.063e+02	3.296e+02
0.3	2.467e+12	2.828e+05	2.990e+05	5.365e+02	5.672e+02

DOS File: LS-4UCI.MS5
Run Date: October 16, 2006
Run Time: 1:59:55 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	1.188e+13	1.824e+06	1.908e+06	3.555e+03	3.718e+03
0.5	3.503e+13	6.753e+06	7.015e+06	1.326e+04	1.377e+04
0.6	5.552e+13	1.288e+07	1.332e+07	2.514e+04	2.600e+04
0.8	1.291e+14	4.014e+07	4.122e+07	7.634e+04	7.841e+04
1.0	4.292e+13	1.673e+07	1.711e+07	3.083e+04	3.155e+04
1.5	2.883e+13	1.695e+07	1.724e+07	2.852e+04	2.901e+04
2.0	8.755e+12	6.886e+06	6.979e+06	1.065e+04	1.079e+04
TOTALS:	3.210e+14	1.028e+08	1.055e+08	1.895e+05	1.946e+05

LaSalle

(Thyroid DCF)

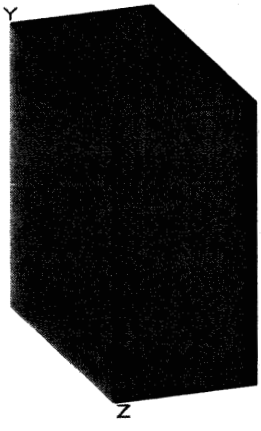
Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0390	1.08E+06	1.00E+00	3.90E-02	0.398	0.2	7.95E-02	7.95E-02	4.11E+08	3.27E+07	6.510E+09	5.02E-03
I-132	0.3600	6.44E+03	5.96E-03	2.15E-03	0.022		4.37E-03	7.34E-01		3.02E+08		4.63E-02
I-133	0.2700	1.80E+05	1.66E-01	4.49E-02	0.458		9.16E-02	5.50E-01		2.26E+08		3.48E-02
I-134	0.7200	1.07E+03	9.86E-04	7.10E-04	0.007		1.45E-03	1.47E+00		6.03E+08		9.27E-02
I-135	0.3900	3.13E+04	2.90E-02	1.13E-02	0.115		2.30E-02	7.95E-01		3.27E+08		5.02E-02
				9.81E-02	1.000		2.00E-01					2.29E-01
I-131	0.0390	1.08E+06	1.00E+00	3.90E-02	0.398	4.0	1.59E+00	1.59E+00		6.54E+08		1.00E-01
I-132	0.3600	6.44E+03	5.96E-03	2.15E-03	0.022		8.75E-02	1.47E+01		6.03E+09		9.27E-01
I-133	0.2700	1.80E+05	1.66E-01	4.49E-02	0.458		1.83E+00	1.10E+01		4.53E+09		6.95E-01
I-134	0.7200	1.07E+03	9.86E-04	7.10E-04	0.007		2.90E-02	2.94E+01		1.21E+10		1.85E+00
I-135	0.3900	3.13E+04	2.90E-02	1.13E-02	0.115		4.61E-01	1.59E+01		6.54E+09		1.00E+00
				9.81E-02	1.000		4.00E+00					4.58E+00

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: LS-4UCII.MS5
Run Date: October 24, 2006
Run Time: 1:23:09 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: LaSalle 4 uCi/gm
Description: D/W Rad Monitor (Thyroid)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	9.0614e+001	3.3527e+012	1.0000e-001	3.7000e+003
I-132	8.3999e+002	3.1080e+013	9.2700e-001	3.4299e+004
I-133	6.2977e+002	2.3301e+013	6.9500e-001	2.5715e+004
I-134	1.6764e+003	6.2025e+013	1.8500e+000	6.8450e+004
I-135	9.0614e+002	3.3527e+013	1.0000e+000	3.7000e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.493e+12	1.550e+04	1.835e+04	1.536e+02	1.819e+02
0.08	8.778e+10	2.616e+03	3.009e+03	4.140e+00	4.762e+00
0.15	3.057e+12	1.730e+05	1.905e+05	2.848e+02	3.137e+02
0.2	2.531e+12	1.920e+05	2.066e+05	3.389e+02	3.647e+02
0.3	2.726e+12	3.125e+05	3.304e+05	5.928e+02	6.267e+02

age : 2
OS File: LS-4UCII.MS5
un Date: October 24, 2006
un Time: 1:23:09 PM
uration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	1.313e+13	2.018e+06	2.111e+06	3.931e+03	4.112e+03
0.5	3.877e+13	7.474e+06	7.765e+06	1.467e+04	1.524e+04
0.6	6.149e+13	1.427e+07	1.475e+07	2.785e+04	2.879e+04
0.8	1.430e+14	4.446e+07	4.566e+07	8.456e+04	8.685e+04
1.0	4.747e+13	1.850e+07	1.893e+07	3.411e+04	3.490e+04
1.5	3.185e+13	1.873e+07	1.905e+07	3.150e+04	3.204e+04
2.0	9.681e+12	7.614e+06	7.717e+06	1.177e+04	1.193e+04
TOTALS:	3.553e+14	1.138e+08	1.167e+08	2.098e+05	2.154e+05

Limerick

Limerick

(Effective DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0455	3.29E+04	1.00E+00	4.55E-02	0.361	0.2	7.22E-02	7.22E-02	2.93E+08	2.11E+07	6.900E+09	3.06E-03
I-132	0.4200	3.81E+02	1.16E-02	4.86E-03	0.039		7.71E-03	6.66E-01		1.95E+08		2.83E-02
I-133	0.3115	5.85E+03	1.78E-01	5.54E-02	0.439		8.78E-02	4.94E-01		1.45E+08		2.10E-02
I-134	0.8400	1.31E+02	3.98E-03	3.34E-03	0.027		5.30E-03	1.33E+00		3.90E+08		5.66E-02
I-135	0.4550	1.23E+03	3.74E-02	1.70E-02	0.135		2.70E-02	7.22E-01		2.11E+08		3.06E-02
				1.26E-01	1.000		2.00E-01					1.40E-01
I-131	0.0455	3.29E+04	1.00E+00	4.55E-02	0.361	4.0	1.44E+00	1.44E+00		4.23E+08		6.13E-02
I-132	0.4200	3.81E+02	1.16E-02	4.86E-03	0.039		1.54E-01	1.33E+01		3.90E+09		5.66E-01
I-133	0.3115	5.85E+03	1.78E-01	5.54E-02	0.439		1.76E+00	9.88E+00		2.89E+09		4.20E-01
I-134	0.8400	1.31E+02	3.98E-03	3.34E-03	0.027		1.06E-01	2.66E+01		7.81E+09		1.13E+00
I-135	0.4550	1.23E+03	3.74E-02	1.70E-02	0.135		5.40E-01	1.44E+01		4.23E+09		6.13E-01
				1.26E-01	1.000		4.00E+00					2.79E+00

15.6.4.5.1 Design Basis Analysis

The design basis analysis is based on SRP 15.6.4 and Regulatory Guide 1.5. The specific models and assumptions and the program used for computer evaluation are described in Section 15.10. Specific values of parameters used in the evaluation are presented in Table 15.6-9.

The only activity released from the reactor vessel is that contained in the coolant as a result of normal operation. The integrated mass leaving the RPV through the steam line break is 108,785 lb, including 20,452 lb in the initial steam that existed prior to the blowdown. All activity in the discharge becomes airborne. It is assumed that an equilibrium coolant concentration consistent with a 30 minute offgas release rate of 0.35 Ci/sec exists prior to the accident. Although there will be some activation and corrosion products released, the isotopes of primary importance are the iodine isotopes. The iodine isotopes and noble gas activity released from the break and to the environment prior to isolation valve closure time are presented in Table 15.6-10.

The iodine concentration in the reactor coolant is given below:

ISOTOPE	ACTIVITY (μCi/g)
I-131	0.0455
I-132	0.420
I-133	0.3115
I-134	0.84
I-135	0.455

Because of its short half-life, N-16 is not considered in the analysis.

15.6.4.5.2 Realistic Analysis

This information has not been updated to reflect updated to reflect the current licensing design basis. The information should be used for historical reference only and not to support the design basis of the plant.

The realistic analysis is based on a realistic but still conservative assessment of this accident. The specific models and assumptions and the program used for computer evaluation are described in Reference 15.6-3. Specific values of parameters used in the evaluation are presented in Table 15.6-9. The leakage path used in these calculations is shown in Figure 15.6-2.

Using the most probable operating condition prior to the postulated break and realistic assumptions, the calculated mixture level in the RPV does not reach the steam line before isolation is complete. Therefore, only steam will issue from the break during the entire transient. The total integrated mass leaving the break is 37,548

ATTACHMENT 1
BWR CDAM METHODOLOGIES

7.2.2 Normal System Volumes

Normal system volumes are used as default values, since operator actions or accident events can significantly change actual volumes, the program shall allow end user to manually enter values based on conditions at time of accident.

Location	Limerick	Peach Bottom	Oyster Creek	References
RCS Liquid (ml)	2.93E+08	2.67E+08	2.91E+08	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-243-E610-081 R0
Suppression Pool Liquid (ml)	3.81E+09	3.48E+09	2.46E+09[1]	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0
Drywell Atmosphere (cc)	6.90E+09	4.98E+09	5.10E+09	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0
Suppression Pool Atmosphere (cc)	4.18E+09	3.74E+09	3.51E+09[1]	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0

1) Average of Minimum and Maximum from referenced calculation

A. Volume Corrections

A volume correction is necessary whenever a single sample is taken and the two locations (Reactor Coolant and Containment Sump) are not in a state of equilibrium (when the released activity is not assumed to be spread throughout both sample locations). The volume correction is as follows:

$$VC = \frac{Volume_{\text{Sampled Location}}}{Volume_{\text{Both Locations}}}$$

7.2.3 Pressure/Temperature Correction

The pressure/temperature correction is applied to gaseous samples and is used to account for differences between system pressure and temperature, and sample pressure and temperature. The pressure/temperature correction is as follows:

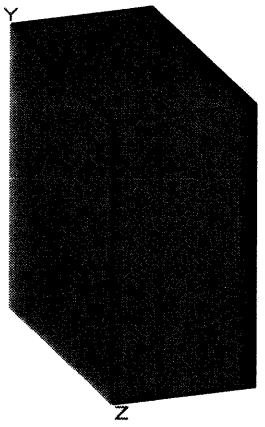
$$PTC = \frac{(P_{\text{System}} + 14.7) \times (T_{\text{Sample}} + 460)}{(P_{\text{Sample}} + 14.7) \times (T_{\text{System}} + 460)}$$

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: LG-02UCI.MS5
Run Date: October 16, 2006
Run Time: 1:44:05 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: LGS 0.2uCi/gm
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	2.7728e+000	1.0259e+011	3.0600e-003	1.1322e+002
I-132	2.5644e+001	9.4882e+011	2.8300e-002	1.0471e+003
I-133	1.9029e+001	7.0407e+011	2.1000e-002	7.7700e+002
I-134	5.1287e+001	1.8976e+012	5.6600e-002	2.0942e+003
I-135	2.7728e+001	1.0259e+012	3.0600e-002	1.1322e+003

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	4.563e+10	4.736e+02	5.607e+02	4.694e+00	5.557e+00
0.08	2.686e+09	8.005e+01	9.208e+01	1.267e-01	1.457e-01
0.15	9.352e+10	5.292e+03	5.829e+03	8.714e+00	9.598e+00
0.2	7.745e+10	5.874e+03	6.322e+03	1.037e+01	1.116e+01
0.3	8.332e+10	9.551e+03	1.010e+04	1.812e+01	1.915e+01

DOS File: LG-02UCI.MS5
Run Date: October 16, 2006
Run Time: 1:44:05 PM
Duration: 00:00:02

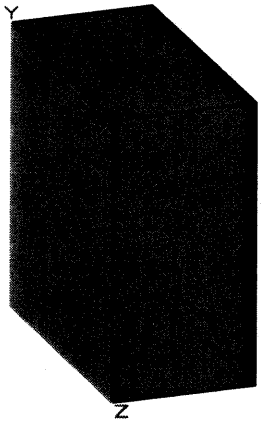
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	4.017e+11	6.172e+04	6.456e+04	1.203e+02	1.258e+02
0.5	1.178e+12	2.271e+05	2.359e+05	4.457e+02	4.630e+02
0.6	1.879e+12	4.359e+05	4.507e+05	8.508e+02	8.797e+02
0.8	4.374e+12	1.359e+06	1.396e+06	2.585e+03	2.656e+03
1.0	1.452e+12	5.658e+05	5.789e+05	1.043e+03	1.067e+03
1.5	9.741e+11	5.726e+05	5.824e+05	9.634e+02	9.799e+02
2.0	2.961e+11	2.329e+05	2.361e+05	3.602e+02	3.650e+02
TOTALS:	1.086e+13	3.477e+06	3.568e+06	6.411e+03	6.582e+03

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: LG-4UCI.MS5
Run Date: October 16, 2006
Run Time: 1:46:11 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: LGS 4 uCi/gm
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	5.5546e+001	2.0552e+012	6.1300e-002	2.2681e+003
I-132	5.1287e+002	1.8976e+013	5.6600e-001	2.0942e+004
I-133	3.8058e+002	1.4081e+013	4.2000e-001	1.5540e+004
I-134	1.0239e+003	3.7886e+013	1.1300e+000	4.1810e+004
I-135	5.5546e+002	2.0552e+013	6.1300e-001	2.2681e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	9.118e+11	9.465e+03	1.121e+04	9.380e+01	1.111e+02
0.08	5.381e+10	1.604e+03	1.845e+03	2.538e+00	2.919e+00
0.15	1.867e+12	1.057e+05	1.164e+05	1.740e+02	1.916e+02
0.2	1.548e+12	1.174e+05	1.263e+05	2.072e+02	2.230e+02
0.3	1.667e+12	1.911e+05	2.020e+05	3.626e+02	3.833e+02

DOS File: LG-4UCI.MS5
Run Date: October 16, 2006
Run Time: 1:46:11 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	8.031e+12	1.234e+06	1.291e+06	2.404e+03	2.515e+03
0.5	2.355e+13	4.540e+06	4.717e+06	8.912e+03	9.258e+03
0.6	3.755e+13	8.713e+06	9.008e+06	1.701e+04	1.758e+04
0.8	8.736e+13	2.715e+07	2.789e+07	5.164e+04	5.304e+04
1.0	2.902e+13	1.131e+07	1.157e+07	2.085e+04	2.133e+04
1.5	1.949e+13	1.146e+07	1.165e+07	1.928e+04	1.961e+04
2.0	5.921e+12	4.657e+06	4.720e+06	7.201e+03	7.298e+03
TOTALS:	2.170e+14	6.949e+07	7.131e+07	1.281e+05	1.315e+05

Limerick

(Thyroid DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0455	1.08E+06	1.00E+00	4.55E-02	0.400	0.2	7.99E-02	7.99E-02	2.93E+08	2.34E+07	6.900E+09	3.39E-03
I-132	0.4200	6.44E+03	5.96E-03	2.50E-03	0.022		4.40E-03	7.38E-01		2.16E+08		3.13E-02
I-133	0.3115	1.80E+05	1.66E-01	5.18E-02	0.455		9.11E-02	5.47E-01		1.60E+08		2.32E-02
I-134	0.8400	1.07E+03	9.86E-04	8.28E-04	0.007		1.46E-03	1.48E+00		4.32E+08		6.27E-02
I-135	0.4550	3.13E+04	2.90E-02	1.32E-02	0.116		2.32E-02	7.99E-01		2.34E+08		3.39E-02
				1.14E-01	1.000		2.00E-01					1.55E-01
I-131	0.0455	1.08E+06	1.00E+00	4.55E-02	0.400	4.0	1.60E+00	1.60E+00		4.68E+08		6.79E-02
I-132	0.4200	6.44E+03	5.96E-03	2.50E-03	0.022		8.79E-02	1.48E+01		4.32E+09		6.27E-01
I-133	0.3115	1.80E+05	1.66E-01	5.18E-02	0.455		1.82E+00	1.09E+01		3.21E+09		4.65E-01
I-134	0.8400	1.07E+03	9.86E-04	8.28E-04	0.007		2.91E-02	2.95E+01		8.65E+09		1.25E+00
I-135	0.4550	3.13E+04	2.90E-02	1.32E-02	0.116		4.63E-01	1.60E+01		4.68E+09		6.79E-01
				1.14E-01	1.000		4.00E+00					3.09E+00

MicroShield v5.03 (5.03-00095)
PECO Energy

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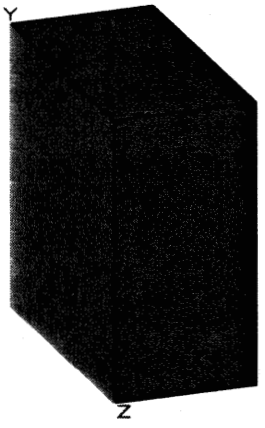
.un Date: October 24, 2006
.un Time: 1:19:37 PM
)uration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Limerick 4 uCi/gm
Description: D/W Rad Monitor (Thyroid DCF)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	6.1527e+001	2.2765e+012	6.7900e-002	2.5123e+003
I-132	5.6815e+002	2.1022e+013	6.2700e-001	2.3199e+004
I-133	4.2135e+002	1.5590e+013	4.6500e-001	1.7205e+004
I-134	1.1327e+003	4.1909e+013	1.2500e+000	4.6250e+004
I-135	6.1527e+002	2.2765e+013	6.7900e-001	2.5123e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.009e+12	1.047e+04	1.240e+04	1.038e+02	1.229e+02
0.08	5.960e+10	1.776e+03	2.043e+03	2.811e+00	3.233e+00
0.15	2.065e+12	1.169e+05	1.287e+05	1.925e+02	2.120e+02
0.2	1.713e+12	1.299e+05	1.398e+05	2.293e+02	2.467e+02
0.3	1.847e+12	2.117e+05	2.238e+05	4.015e+02	4.244e+02

DOS File: LG-4UCII.MS5
Run Date: October 24, 2006
Run Time: 1:19:37 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	8.888e+12	1.365e+06	1.428e+06	2.661e+03	2.783e+03
0.5	2.607e+13	5.026e+06	5.222e+06	9.866e+03	1.025e+04
0.6	4.158e+13	9.647e+06	9.974e+06	1.883e+04	1.947e+04
0.8	9.667e+13	3.004e+07	3.086e+07	5.714e+04	5.869e+04
1.0	3.213e+13	1.252e+07	1.281e+07	2.308e+04	2.361e+04
1.5	2.158e+13	1.269e+07	1.290e+07	2.135e+04	2.171e+04
2.0	6.554e+12	5.155e+06	5.224e+06	7.971e+03	8.079e+03
TOTALS:	2.402e+14	7.692e+07	7.893e+07	1.418e+05	1.456e+05

Oyster Creek

Oyster Creek (Effective DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0468	3.29E+04	1.00E+00	4.68E-02	0.364	0.2	7.28E-02	7.28E-02	2.91E+08	2.12E+07	5.100E+09	4.16E-03
I-132	0.4420	3.81E+02	1.16E-02	5.12E-03	0.040		7.97E-03	6.88E-01		2.00E+08		3.92E-02
I-133	0.3120	5.85E+03	1.78E-01	5.55E-02	0.432		8.63E-02	4.86E-01		1.41E+08		2.77E-02
I-134	0.9100	1.31E+02	3.98E-03	3.62E-03	0.028		5.64E-03	1.42E+00		4.12E+08		8.08E-02
I-135	0.4680	1.23E+03	3.74E-02	1.75E-02	0.136		2.72E-02	7.28E-01		2.12E+08		4.16E-02
				1.29E-01	1.000		2.00E-01					1.93E-01
I-131	0.0468	3.29E+04	1.00E+00	4.68E-02	0.364	4.0	1.46E+00	1.46E+00		4.24E+08		8.31E-02
I-132	0.4420	3.81E+02	1.16E-02	5.12E-03	0.040		1.59E-01	1.38E+01		4.00E+09		7.85E-01
I-133	0.3120	5.85E+03	1.78E-01	5.55E-02	0.432		1.73E+00	9.71E+00		2.83E+09		5.54E-01
I-134	0.9100	1.31E+02	3.98E-03	3.62E-03	0.028		1.13E-01	2.83E+01		8.24E+09		1.62E+00
I-135	0.4680	1.23E+03	3.74E-02	1.75E-02	0.136		5.45E-01	1.46E+01		4.24E+09		8.31E-01
				1.29E-01	1.000		4.00E+00					3.87E+00

TABLE 11.1-3B
(Sheet 1 of 1)

REACTOR COOLANT ACTIVITY CONCENTRATION*
(Design Basis)

Isotope	uCi/ml	Isotope	uCi/ml
N-13	3.70(-2)	Cs-134	5.46(-4)
N-16	5.30(+1)	Cs-136	3.64(-4)
F-18	4.00(-3)	Cs-137	6.24(-4)
		Cs-138	7.54(-1)
Br-83	5.46(-2)	Ba-139	6.24(-1)
Br-84	1.04(-1)	Ba-140	3.12(-2)
Br-85	6.76(-2)	Ba-141	7.02(-1)
Sr-89	1.07(-2)	Ba-142	6.76(-1)
Sr-90	8.06(-4)	Ce-141	1.38(-4)
Sr-91	2.50(-1)	Ce-143	1.22(-4)
Sr-92	4.16(-1)	Ce-144	1.22(-4)
Zr-95	1.38(-4)	Pr-143	1.33(-4)
Zr-97	1.14(-4)	Nd-147	4.94(-5)
Nb-95	1.43(-4)		
Mo-99	7.80(-2)	Np-239	3.3(-1)
Tc-99m	1.04(+0)	Na-24	2.0(-3)
Tc-101	5.46(-1)	P-32	2.0(-5)
Ru-103	6.76(-5)	Cr-51	5.0(-4)
Ru-106	9.10(-6)	Mn-54	4.0(-5)
Te-129m	1.38(-4)	Mn-56	5.0(-2)
Te-132	1.69(-1)	Co-58	5.0(-3)
I-131	4.68(-2)	Co-60	5.0(-4)
I-132	4.42(-1)	Fe-59	8.0(-5)
I-133	3.12(-1)	Ni-65	3.0(-4)
I-134	9.10(-1)	Zn-65	2.0(-6)
I-135	4.68(-1)	Zn-69m	3.0(-5)
		Ag-110M	6.0(-5)
		W-187	3.0(-3)

*General Electric Document 22A2703E, Revision 3

ATTACHMENT 1
BWR CDAM METHODOLOGIES

7.2.2 Normal System Volumes

Normal system volumes are used as default values, since operator actions or accident events can significantly change actual volumes, the program shall allow end user to manually enter values based on conditions at time of accident.

Location	Limerick	Peach Bottom	Oyster Creek	References
RCS Liquid (ml)	2.93E+08	2.67E+08	2.91E+08	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-243-E610-081 R0
Suppression Pool Liquid (ml)	3.81E+09	3.48E+09	2.46E+09[1]	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0
Drywell Atmosphere (cc)	6.90E+09	4.98E+09	5.10E+09	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0
Suppression Pool Atmosphere (cc)	4.18E+09	3.74E+09	3.51E+09[1]	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0

1) Average of Minimum and Maximum from referenced calculation

A. Volume Corrections

A volume correction is necessary whenever a single sample is taken and the two locations (Reactor Coolant and Containment Sump) are not in a state of equilibrium (when the released activity is not assumed to be spread throughout both sample locations). The volume correction is as follows:

$$VC = \frac{Volume_{Sampled\ Location}}{Volume_{Both\ Locations}}$$

7.2.3 Pressure/Temperature Correction

The pressure/temperature correction is applied to gaseous samples and is used to account for differences between system pressure and temperature, and sample pressure and temperature. The pressure/temperature correction is as follows:

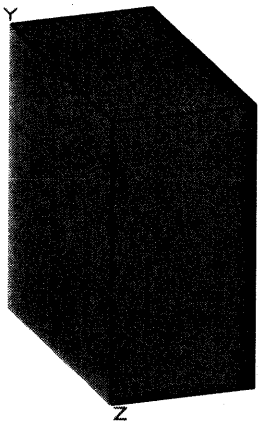
$$PTC = \frac{(P_{System} + 14.7) \times (T_{Sample} + 460)}{(P_{Sample} + 14.7) \times (T_{System} + 460)}$$

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: OC-02UCI.MS5
Run Date: October 16, 2006
Run Time: 1:51:59 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: OCNGS 0.2uCi/gm
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	uCi/cm³	Bq/cm³
I-131	3.7695e+000	1.3947e+011	4.1600e-003	1.5392e+002
I-132	3.5521e+001	1.3143e+012	3.9200e-002	1.4504e+003
I-133	2.5100e+001	9.2870e+011	2.7700e-002	1.0249e+003
I-134	7.3216e+001	2.7090e+012	8.0800e-002	2.9896e+003
I-135	3.7695e+001	1.3947e+012	4.1600e-002	1.5392e+003

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	6.399e+10	6.642e+02	7.864e+02	6.583e+00	7.794e+00
0.08	3.652e+09	1.088e+02	1.252e+02	1.722e-01	1.981e-01
0.15	1.334e+11	7.549e+03	8.315e+03	1.243e+01	1.369e+01
0.2	1.091e+11	8.276e+03	8.906e+03	1.461e+01	1.572e+01
0.3	1.145e+11	1.313e+04	1.388e+04	2.491e+01	2.633e+01

DOS File: OC-02UCI.MS5
Run Date: October 16, 2006
Run Time: 1:51:59 PM
Duration: 00:00:02

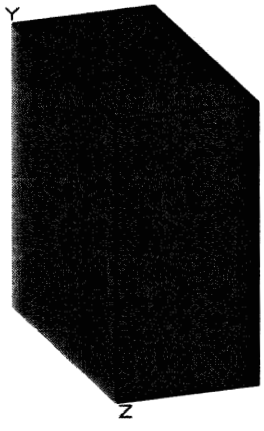
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	5.629e+11	8.648e+04	9.046e+04	1.685e+02	1.763e+02
0.5	1.599e+12	3.082e+05	3.202e+05	6.050e+02	6.286e+02
0.6	2.629e+12	6.099e+05	6.306e+05	1.190e+03	1.231e+03
0.8	6.194e+12	1.925e+06	1.977e+06	3.662e+03	3.761e+03
1.0	2.030e+12	7.912e+05	8.095e+05	1.458e+03	1.492e+03
1.5	1.345e+12	7.905e+05	8.040e+05	1.330e+03	1.353e+03
2.0	4.137e+11	3.254e+05	3.298e+05	5.032e+02	5.100e+02
TOTALS:	1.520e+13	4.866e+06	4.994e+06	8.976e+03	9.215e+03

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: OC-4UCI.MS5
Run Date: October 16, 2006
Run Time: 1:54:02 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: OCNGS 4 uCi/gm
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	7.5300e+001	2.7861e+012	8.3100e-002	3.0747e+003
I-132	7.1132e+002	2.6319e+013	7.8500e-001	2.9045e+004
I-133	5.0200e+002	1.8574e+013	5.5400e-001	2.0498e+004
I-134	1.4679e+003	5.4314e+013	1.6200e+000	5.9940e+004
I-135	7.5300e+002	2.7861e+013	8.3100e-001	3.0747e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.282e+12	1.331e+04	1.575e+04	1.319e+02	1.561e+02
0.08	7.295e+10	2.174e+03	2.501e+03	3.440e+00	3.957e+00
0.15	2.675e+12	1.513e+05	1.667e+05	2.492e+02	2.745e+02
0.2	2.185e+12	1.658e+05	1.784e+05	2.926e+02	3.149e+02
0.3	2.291e+12	2.626e+05	2.776e+05	4.982e+02	5.266e+02

)S File: OC-4UCI.MS5
ın Date: October 16, 2006
ın Time: 1:54:02 PM
ıration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	1.127e+13	1.732e+06	1.811e+06	3.374e+03	3.529e+03
0.5	3.200e+13	6.169e+06	6.409e+06	1.211e+04	1.258e+04
0.6	5.266e+13	1.222e+07	1.263e+07	2.385e+04	2.466e+04
0.8	1.242e+14	3.858e+07	3.963e+07	7.339e+04	7.538e+04
1.0	4.064e+13	1.584e+07	1.621e+07	2.920e+04	2.988e+04
1.5	2.690e+13	1.581e+07	1.608e+07	2.660e+04	2.706e+04
2.0	8.283e+12	6.515e+06	6.602e+06	1.007e+04	1.021e+04
'OTALS:	3.044e+14	9.747e+07	1.000e+08	1.798e+05	1.846e+05

Oyster Creek (Thyroid DCF)

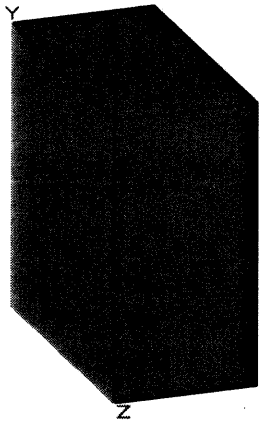
Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0468	1.08E+06	1.00E+00	4.68E-02	0.404	0.2	8.08E-02	8.08E-02	2.91E+08	2.35E+07	5.100E+09	4.61E-03
I-132	0.4420	6.44E+03	5.96E-03	2.63E-03	0.023		4.55E-03	7.63E-01		2.22E+08		4.36E-02
I-133	0.3120	1.80E+05	1.66E-01	5.19E-02	0.448		8.97E-02	5.39E-01		1.57E+08		3.07E-02
I-134	0.9100	1.07E+03	9.86E-04	8.98E-04	0.008		1.55E-03	1.57E+00		4.57E+08		8.97E-02
I-135	0.4680	3.13E+04	2.90E-02	1.36E-02	0.117		2.34E-02	8.08E-01		2.35E+08		4.61E-02
				1.16E-01	1.000		2.00E-01					2.15E-01
I-131	0.0468	1.08E+06	1.00E+00	4.68E-02	0.404	4.0	1.62E+00	1.62E+00		4.70E+08		9.22E-02
I-132	0.4420	6.44E+03	5.96E-03	2.63E-03	0.023		9.10E-02	1.53E+01		4.44E+09		8.71E-01
I-133	0.3120	1.80E+05	1.66E-01	5.19E-02	0.448		1.79E+00	1.08E+01		3.14E+09		6.15E-01
I-134	0.9100	1.07E+03	9.86E-04	8.98E-04	0.008		3.10E-02	3.14E+01		9.15E+09		1.79E+00
I-135	0.4680	3.13E+04	2.90E-02	1.36E-02	0.117		4.68E-01	1.62E+01		4.70E+09		9.22E-01
				1.16E-01	1.000		4.00E+00					4.29E+00

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: OC-4UCII.MS5
Run Date: October 24, 2006
Run Time: 1:17:23 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: OCNGS 4 uCi/gm
Description: D/W Rad Monitor (Thyroid DCF)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	uCi/cm³	Bq/cm³
I-131	8.3546e+001	3.0912e+012	9.2200e-002	3.4114e+003
I-132	7.8925e+002	2.9202e+013	8.7100e-001	3.2227e+004
I-133	5.5728e+002	2.0619e+013	6.1500e-001	2.2755e+004
I-134	1.6220e+003	6.0014e+013	1.7900e+000	6.6230e+004
I-135	8.3546e+002	3.0912e+013	9.2200e-001	3.4114e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.418e+12	1.472e+04	1.743e+04	1.459e+02	1.728e+02
0.08	8.093e+10	2.412e+03	2.775e+03	3.817e+00	4.391e+00
0.15	2.956e+12	1.672e+05	1.842e+05	2.754e+02	3.033e+02
0.2	2.417e+12	1.834e+05	1.973e+05	3.236e+02	3.483e+02
0.3	2.541e+12	2.912e+05	3.079e+05	5.524e+02	5.840e+02

DOS File: OC-4UCII.MS5
Run Date: October 24, 2006
Run Time: 1:17:23 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	1.247e+13	1.916e+06	2.005e+06	3.734e+03	3.906e+03
0.5	3.548e+13	6.840e+06	7.106e+06	1.343e+04	1.395e+04
0.6	5.834e+13	1.354e+07	1.400e+07	2.642e+04	2.732e+04
0.8	1.373e+14	4.267e+07	4.383e+07	8.117e+04	8.337e+04
1.0	4.500e+13	1.754e+07	1.795e+07	3.233e+04	3.308e+04
1.5	2.981e+13	1.752e+07	1.782e+07	2.949e+04	2.999e+04
2.0	9.170e+12	7.212e+06	7.310e+06	1.115e+04	1.130e+04
TOTALS:	3.370e+14	1.079e+08	1.107e+08	1.990e+05	2.043e+05

Peach Bottom

Peach Bottom (Effective DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.1700	3.29E+04	1.00E+00	1.70E-01	0.404	0.2	8.07E-02	8.07E-02	2.67E+08	2.16E+07	4.980E+09	4.33E-03
I-132	1.0200	3.81E+02	1.16E-02	1.18E-02	0.028		5.61E-03	4.84E-01		1.29E+08		2.60E-02
I-133	1.0400	5.85E+03	1.78E-01	1.85E-01	0.439		8.78E-02	4.94E-01		1.32E+08		2.65E-02
I-134	1.4700	1.31E+02	3.98E-03	5.85E-03	0.014		2.78E-03	6.98E-01		1.86E+08		3.74E-02
I-135	1.3000	1.23E+03	3.74E-02	4.86E-02	0.115		2.31E-02	6.17E-01		1.65E+08		3.31E-02
				4.21E-01	1.000		2.00E-01					1.27E-01
I-131	0.1700	3.29E+04	1.00E+00	1.70E-01	0.404	4.0	1.61E+00	1.61E+00		4.31E+08		8.66E-02
I-132	1.0200	3.81E+02	1.16E-02	1.18E-02	0.028		1.12E-01	9.69E+00		2.59E+09		5.19E-01
I-133	1.0400	5.85E+03	1.78E-01	1.85E-01	0.439		1.76E+00	9.88E+00		2.64E+09		5.30E-01
I-134	1.4700	1.31E+02	3.98E-03	5.85E-03	0.014		5.56E-02	1.40E+01		3.73E+09		7.48E-01
I-135	1.3000	1.23E+03	3.74E-02	4.86E-02	0.115		4.62E-01	1.23E+01		3.30E+09		6.62E-01
				4.21E-01	1.000		4.00E+00					2.55E+00

After the MSIV's close (10.5 sec), depressurization stops and natural convection is established through the reactor core. No fuel cladding perforation occurs even if the stored thermal energy in the fuel were simply redistributed while natural convection is being established; cladding temperature would be about 1,000°F, well below the temperatures at which cladding can fail. Thus, it is concluded that even for a 10.5-sec MSIV closure, fuel rod perforations due to high temperature do not occur. For shorter valve closure times, the accident is less severe. After the MSIV's are closed, the reactor can be cooled by operation of any of the normal or standby cooling systems. Reference 14.6.18 shows that adequate core cooling can be accomplished with no high pressure injection, manual initiation of ADS 10 minutes after MSIV closure, and either LPCI or Core Spray injection. The core flow and MCHFR during the first 10.5 sec of the accident are shown in Figures 14.6.17 and 14.6.18. Since the MCHFR never drops below 1.0, the core is always cooled by very effective nucleate boiling.

14.6.5.2 Radioactive Material Release (See note at the beginning of Section 14.6.5.)

14.6.5.2.1 Assumptions

The following assumptions are used in the calculation of the quantity and types of radioactive material released from the nuclear system process barriers outside the secondary containment.

1. The amounts of steam and liquid discharged are as calculated from the analysis of the nuclear system transient.

2. The concentration of biologically significant radionuclides contained in the coolant are as follows and are based on an off-gas release rate of 0.35 Ci/sec:

Iodine 131	0.17 μCi/cc
Iodine 132	1.02 μCi/cc
Iodine 133	1.04 μCi/cc
Iodine 134	1.47 μCi/cc
Iodine 135	1.30 μCi/cc

Because the steam-to-water halogen concentration ratio is on the order of 3×10^{-5}[8], only the halogens carried out of the reactor vessel by the liquid phase during the discharge of the steam-water mixture are significant. Because the coolant activity contents are based on data derived from reactor operation with an unusually large number of cladding failures, and because high normal stack gas discharge rate is assumed, considerable conservatism is inserted into the analysis.

ATTACHMENT 1
BWR CDAM METHODOLOGIES

7.2.2 Normal System Volumes

Normal system volumes are used as default values, since operator actions or accident events can significantly change actual volumes, the program shall allow end user to manually enter values based on conditions at time of accident.

Location	Limerick	Peach Bottom	Oyster Creek	References
RCS Liquid (ml)	2.93E+08	2.67E+08	2.91E+08	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-243-E610-081 R0
Suppression Pool Liquid (ml)	3.81E+09	3.48E+09	2.46E+09[1]	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0
Drywell Atmosphere (cc)	6.90E+09	4.98E+09	5.10E+09	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0
Suppression Pool Atmosphere (cc)	4.18E+09	3.74E+09	3.51E+09[1]	FSAR Table 6.2-4A FSAR Table 1.7.4 C-1302-900-E610-026 R0

1) Average of Minimum and Maximum from referenced calculation

A. Volume Corrections

A volume correction is necessary whenever a single sample is taken and the two locations (Reactor Coolant and Containment Sump) are not in a state of equilibrium (when the released activity is not assumed to be spread throughout both sample locations). The volume correction is as follows:

$$VC = \frac{Volume_{\text{Sampled Location}}}{Volume_{\text{Both Locations}}}$$

7.2.3 Pressure/Temperature Correction

The pressure/temperature correction is applied to gaseous samples and is used to account for differences between system pressure and temperature, and sample pressure and temperature. The pressure/temperature correction is as follows:

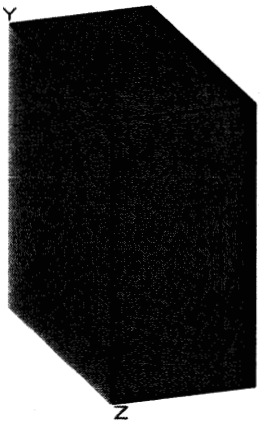
$$PTC = \frac{(P_{\text{System}} + 14.7) \times (T_{\text{Sample}} + 460)}{(P_{\text{Sample}} + 14.7) \times (T_{\text{System}} + 460)}$$

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: PB-02UCI.MS5
Run Date: October 16, 2006
Run Time: 1:48:33 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: PBAPS 0.2uCi/gm
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	3.9236e+000	1.4517e+011	4.3300e-003	1.6021e+002
I-132	2.3560e+001	8.7171e+011	2.6000e-002	9.6200e+002
I-133	2.4013e+001	8.8847e+011	2.6500e-002	9.8050e+002
I-134	3.3890e+001	1.2539e+012	3.7400e-002	1.3838e+003
I-135	2.9993e+001	1.1097e+012	3.3100e-002	1.2247e+003

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	3.859e+10	4.005e+02	4.742e+02	3.969e+00	4.699e+00
0.08	3.801e+09	1.133e+02	1.303e+02	1.793e-01	2.062e-01
0.15	6.237e+10	3.529e+03	3.888e+03	5.812e+00	6.402e+00
0.2	6.026e+10	4.570e+03	4.919e+03	8.067e+00	8.681e+00
0.3	8.409e+10	9.639e+03	1.019e+04	1.828e+01	1.933e+01

DOS File: PB-02UCI.MS5
Run Date: October 16, 2006
Run Time: 1:48:33 PM
Duration: 00:00:02

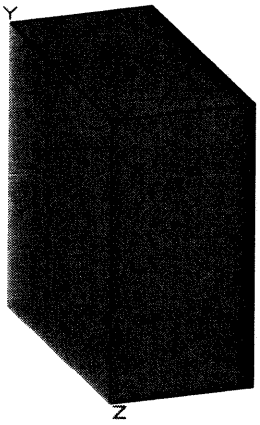
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	3.584e+11	5.506e+04	5.760e+04	1.073e+02	1.122e+02
0.5	1.244e+12	2.399e+05	2.492e+05	4.709e+02	4.892e+02
0.6	1.568e+12	3.638e+05	3.761e+05	7.101e+02	7.342e+02
0.8	3.190e+12	9.913e+05	1.018e+06	1.885e+03	1.937e+03
1.0	1.220e+12	4.755e+05	4.865e+05	8.765e+02	8.967e+02
1.5	9.257e+11	5.442e+05	5.535e+05	9.156e+02	9.313e+02
2.0	2.512e+11	1.976e+05	2.003e+05	3.056e+02	3.097e+02
TOTALS:	9.006e+12	2.886e+06	2.961e+06	5.308e+03	5.449e+03

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: PB-4UCI.MS5
Run Date: October 16, 2006
Run Time: 1:50:05 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: PBAPS 4 uCi/gm
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	7.8472e+001	2.9035e+012	8.6600e-002	3.2042e+003
I-132	4.7029e+002	1.7401e+013	5.1900e-001	1.9203e+004
I-133	4.8025e+002	1.7769e+013	5.3000e-001	1.9610e+004
I-134	6.7779e+002	2.5078e+013	7.4800e-001	2.7676e+004
I-135	5.9986e+002	2.2195e+013	6.6200e-001	2.4494e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	7.715e+11	8.008e+03	9.481e+03	7.937e+01	9.396e+01
0.08	7.602e+10	2.266e+03	2.606e+03	3.585e+00	4.124e+00
0.15	1.247e+12	7.058e+04	7.775e+04	1.162e+02	1.280e+02
0.2	1.205e+12	9.141e+04	9.837e+04	1.613e+02	1.736e+02
0.3	1.681e+12	1.927e+05	2.037e+05	3.655e+02	3.864e+02

DOS File: PB-4UCI.MS5
Run Date: October 16, 2006
Run Time: 1:50:05 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	7.168e+12	1.101e+06	1.152e+06	2.146e+03	2.244e+03
0.5	2.488e+13	4.796e+06	4.983e+06	9.415e+03	9.781e+03
0.6	3.132e+13	7.266e+06	7.513e+06	1.418e+04	1.466e+04
0.8	6.376e+13	1.982e+07	2.035e+07	3.769e+04	3.871e+04
1.0	2.439e+13	9.506e+06	9.726e+06	1.752e+04	1.793e+04
1.5	1.851e+13	1.088e+07	1.107e+07	1.831e+04	1.862e+04
2.0	5.024e+12	3.951e+06	4.004e+06	6.110e+03	6.192e+03
TOTALS:	1.800e+14	5.768e+07	5.919e+07	1.061e+05	1.089e+05

Peach Bottom (Thyroid DCF)

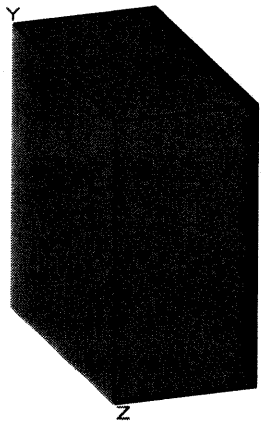
Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.1700	1.08E+06	1.00E+00	1.70E-01	0.438	0.2	8.76E-02	8.76E-02	2.67E+08	2.34E+07	4.980E+09	4.69E-03
I-132	1.0200	6.44E+03	5.96E-03	6.08E-03	0.016		3.13E-03	5.25E-01		1.40E+08		2.82E-02
I-133	1.0400	1.80E+05	1.66E-01	1.73E-01	0.446		8.92E-02	5.36E-01		1.43E+08		2.87E-02
I-134	1.4700	1.07E+03	9.86E-04	1.45E-03	0.004		7.47E-04	7.57E-01		2.02E+08		4.06E-02
I-135	1.3000	3.13E+04	2.90E-02	3.77E-02	0.097		1.94E-02	6.70E-01		1.79E+08		3.59E-02
				3.88E-01	1.000		2.00E-01					1.38E-01
I-131	0.1700	1.08E+06	1.00E+00	1.70E-01	0.438	4.0	1.75E+00	1.75E+00		4.68E+08		9.39E-02
I-132	1.0200	6.44E+03	5.96E-03	6.08E-03	0.016		6.26E-02	1.05E+01		2.81E+09		5.63E-01
I-133	1.0400	1.80E+05	1.66E-01	1.73E-01	0.446		1.78E+00	1.07E+01		2.86E+09		5.74E-01
I-134	1.4700	1.07E+03	9.86E-04	1.45E-03	0.004		1.49E-02	1.51E+01		4.04E+09		8.12E-01
I-135	1.3000	3.13E+04	2.90E-02	3.77E-02	0.097		3.88E-01	1.34E+01		3.58E+09		7.18E-01
				3.88E-01	1.000		4.00E+00					2.76E+00

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: PB-4UCII.MS5
Run Date: October 24, 2006
Run Time: 1:14:46 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: PBAPS 4 uCi/gm
Description: D/W Rad Monitor (Throid DCF)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	uCi/cm³	Bq/cm³
I-131	8.5086e+001	3.1482e+012	9.3900e-002	3.4743e+003
I-132	5.1016e+002	1.8876e+013	5.6300e-001	2.0831e+004
I-133	5.2012e+002	1.9245e+013	5.7400e-001	2.1238e+004
I-134	7.3578e+002	2.7224e+013	8.1200e-001	3.0044e+004
I-135	6.5061e+002	2.4072e+013	7.1800e-001	2.6566e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	8.370e+11	8.688e+03	1.029e+04	8.610e+01	1.019e+02
0.08	8.243e+10	2.457e+03	2.826e+03	3.887e+00	4.472e+00
0.15	1.354e+12	7.662e+04	8.440e+04	1.262e+02	1.390e+02
0.2	1.308e+12	9.919e+04	1.067e+05	1.751e+02	1.884e+02
0.3	1.823e+12	2.090e+05	2.209e+05	3.964e+02	4.190e+02

age : 2
OS File: PB-4UCII.MS5
un Date: October 24, 2006
un Time: 1:14:46 PM
uration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	7.777e+12	1.195e+06	1.250e+06	2.328e+03	2.435e+03
0.5	2.696e+13	5.198e+06	5.400e+06	1.020e+04	1.060e+04
0.6	3.398e+13	7.883e+06	8.151e+06	1.539e+04	1.591e+04
0.8	6.920e+13	2.151e+07	2.209e+07	4.090e+04	4.201e+04
1.0	2.646e+13	1.031e+07	1.055e+07	1.901e+04	1.945e+04
1.5	2.008e+13	1.180e+07	1.201e+07	1.986e+04	2.020e+04
2.0	5.451e+12	4.287e+06	4.345e+06	6.629e+03	6.719e+03
TOTALS:	1.953e+14	6.258e+07	6.422e+07	1.151e+05	1.182e+05

Quad Cities

Quad Cities

(Effective DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0250	3.29E+04	1.00E+00	2.50E-02	0.446	0.2	8.93E-02	8.93E-02	2.61E+08	2.33E+07	4.470E+09	5.21E-03
I-132	0.2500	3.81E+02	1.16E-02	2.90E-03	0.052		1.03E-02	8.93E-01		2.33E+08		5.21E-02
I-133	0.1000	5.85E+03	1.78E-01	1.78E-02	0.317		6.35E-02	3.57E-01		9.32E+07		2.08E-02
I-134	0.2500	1.31E+02	3.98E-03	9.95E-04	0.018		3.55E-03	8.93E-01		2.33E+08		5.21E-02
I-135	0.2500	1.23E+03	3.74E-02	9.35E-03	0.167		3.34E-02	8.93E-01		2.33E+08		5.21E-02
				5.60E-02	1.000		2.00E-01					1.82E-01
I-131	0.0250	3.29E+04	1.00E+00	2.50E-02	0.446	4.0	1.79E+00	1.79E+00		4.66E+08		1.04E-01
I-132	0.2500	3.81E+02	1.16E-02	2.90E-03	0.052		2.07E-01	1.79E+01		4.66E+09		1.04E+00
I-133	0.1000	5.85E+03	1.78E-01	1.78E-02	0.317		1.27E+00	7.14E+00		1.86E+09		4.17E-01
I-134	0.2500	1.31E+02	3.98E-03	9.95E-04	0.018		7.11E-02	1.79E+01		4.66E+09		1.04E+00
I-135	0.2500	1.23E+03	3.74E-02	9.35E-03	0.167		6.67E-01	1.79E+01		4.66E+09		1.04E+00
				5.60E-02	1.000		4.00E+00					3.65E+00

15.6.4.5 Radiological Consequences

The following describes main steam line break radiological dose analyses performed for the initial licensing of the plant, i.e., 7x7 fuel arrays.

The predominant activity in the discharged coolant would be N-16, which would be significantly reduced by decay due to its short half-life (about 7 seconds). If the reactor contained fuel with cladding leaks, the water released through the break would contain some fission products. [15.6-18]

During 1964 the Dresden Unit 1 reactor was operated with a significant number of cladding leaks. Analysis of reactor water samples indicated the following yearly average fission product content:

Fission Product	Activity (μCi/cc)
I-131	0.025
I-133	0.1
Other halogens	0.25
Other fission products	0.25

With a separate reactor cleanup system for each unit, it is estimated that the maximum coolant activity would be approximately 2.3 μCi/cc at 100,000 μCi/s release rate, and would have the following fission product contents:

Fission Product	Activity (μCi/cc)
I-131	0.067
I-132	0.38
I-133	0.40
I-134	0.53
I-135	0.49
Other halogens	0.14
Other fission products	0.28

Measurements of halogen concentrations in the Dresden Unit 1 reactor water and condensate showed that the steam to water halogen concentration ratio was in the range of 3×10^{-5} to 1×10^{-5}. The only halogens carried out through the break would therefore be those absorbed in the water. Thus, 116 curies, including 3.4 curies of I-131, 19.1 curies of I-132, 20.2 curies of I-33, 27.0 curies of I-134, and 24.9 curies of I-135 would be carried out through the break.

Based on operating experience, the above fission product concentrations in the reactor coolant would occur when the off-gas emission was at about 100,000 μCi/s measured after 30 minutes decay in the off-gas system. The noble gas activity discharged from the break, assuming a 10.5 seconds MSIV closure time, would be 5.4 Ci (calculated for 2 minutes decay time).

ATTACHMENT 1
BWR CDAM METHODOLOGIES

7.2.2 Normal System Volumes

Normal system volumes are used as default values, since operator actions or accident events can significantly change actual volumes, the program shall allow end user to manually enter values based on conditions at time of accident.

Location	Clinton	Dresden	LaSalle	Quad Cities	Reference
RCS (ml)	3.16E+08	2.61E+08	4.11E+08	2.61E+08	Clinton USAR Fig 5.1-2 Dresden/Quad Cities taken from NEDO 22215.
Suppression Pool Liquid (ml)	4.15E+09	3.26E+09	3.68E+09	3.26E+09	DR/QC UFSAR Section 6 (1.15E+05 Ft^3, 3.26E+09 ml) LS UFSAR Cont Design Param (1.30E+05 Ft^3, 3.68E+09 ml)
Drywell Atmosphere (cc)	6.97E+09	4.47E+09	6.51E+09	4.47E+09	DR/QC UFSAR Section 6 LS UFSAR Cont Design Param
Containment Atmosphere (cc)	4.39E+10	N/A	N/A	N/A	
Suppression Pool Atmosphere (cc)	N/A	3.32E+09	4.67E+09	3.40E+09	DR/QC UFSAR Section 6 (1.15E+05 Ft^3, 3.26E+09 ml) LS UFSAR Cont Design Param (1.30E+05 Ft^3, 3.68E+09 ml)

A. Volume Corrections

A volume correction is necessary whenever a single sample is taken and the two locations (Reactor Coolant and Containment Sump) are not in a state of equilibrium (when the released activity is not assumed to be spread throughout both sample locations). The volume correction is as follows:

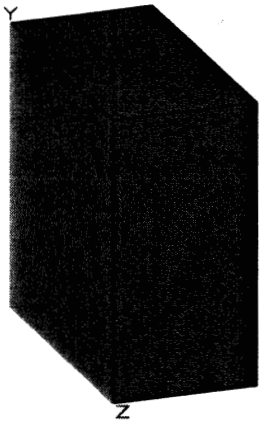
$$VC = \frac{\text{Volume}_{\text{Sampled Location}}}{\text{Volume}_{\text{Both Locations}}}$$

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: QC-02UCI.MS5
Run Date: October 16, 2006
Run Time: 2:02:51 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Quad Cities 0.2uCi/g
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	4.7210e+000	1.7468e+011	5.2100e-003	1.9277e+002
I-132	4.7210e+001	1.7468e+012	5.2100e-002	1.9277e+003
I-133	1.8848e+001	6.9736e+011	2.0800e-002	7.6960e+002
I-134	4.7210e+001	1.7468e+012	5.2100e-002	1.9277e+003
I-135	4.7210e+001	1.7468e+012	5.2100e-002	1.9277e+003

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	5.328e+10	5.530e+02	6.547e+02	5.481e+00	6.489e+00
0.08	4.573e+09	1.363e+02	1.568e+02	2.157e-01	2.481e-01
0.15	8.815e+10	4.988e+03	5.494e+03	8.214e+00	9.047e+00
0.2	8.857e+10	6.718e+03	7.230e+03	1.186e+01	1.276e+01
0.3	1.326e+11	1.521e+04	1.607e+04	2.884e+01	3.049e+01

DOS File: QC-02UCI.MS5
Run Date: October 16, 2006
Run Time: 2:02:51 PM
Duration: 00:00:02

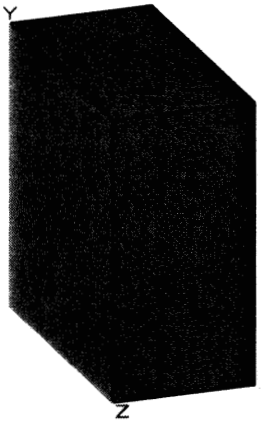
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	4.966e+11	7.629e+04	7.980e+04	1.486e+02	1.555e+02
0.5	1.395e+12	2.690e+05	2.794e+05	5.280e+02	5.485e+02
0.6	2.857e+12	6.630e+05	6.855e+05	1.294e+03	1.338e+03
0.8	4.921e+12	1.529e+06	1.571e+06	2.909e+03	2.988e+03
1.0	1.926e+12	7.505e+05	7.679e+05	1.383e+03	1.415e+03
1.5	1.467e+12	8.625e+05	8.772e+05	1.451e+03	1.476e+03
2.0	3.896e+11	3.064e+05	3.105e+05	4.738e+02	4.802e+02
TOTALS:	1.382e+13	4.485e+06	4.601e+06	8.242e+03	8.460e+03

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: QC-4UCI.MS5
Run Date: October 16, 2006
Run Time: 2:04:31 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Quad Cities 4 uCi/g
Description: D/W Rad Monitor
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	9.4238e+001	3.4868e+012	1.0400e-001	3.8480e+003
I-132	9.4238e+002	3.4868e+013	1.0400e+000	3.8480e+004
I-133	3.7786e+002	1.3981e+013	4.1700e-001	1.5429e+004
I-134	9.4238e+002	3.4868e+013	1.0400e+000	3.8480e+004
I-135	9.4238e+002	3.4868e+013	1.0400e+000	3.8480e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.064e+12	1.104e+04	1.307e+04	1.094e+02	1.296e+02
0.08	9.129e+10	2.721e+03	3.130e+03	4.306e+00	4.953e+00
0.15	1.760e+12	9.957e+04	1.097e+05	1.640e+02	1.806e+02
0.2	1.768e+12	1.341e+05	1.443e+05	2.367e+02	2.547e+02
0.3	2.648e+12	3.036e+05	3.209e+05	5.758e+02	6.087e+02

DOS File: QC-4UCI.MS5
Run Date: October 16, 2006
Run Time: 2:04:31 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	9.913e+12	1.523e+06	1.593e+06	2.967e+03	3.104e+03
0.5	2.791e+13	5.380e+06	5.589e+06	1.056e+04	1.097e+04
0.6	5.704e+13	1.323e+07	1.368e+07	2.583e+04	2.671e+04
0.8	9.823e+13	3.053e+07	3.136e+07	5.807e+04	5.964e+04
1.0	3.844e+13	1.498e+07	1.533e+07	2.762e+04	2.826e+04
1.5	2.929e+13	1.722e+07	1.751e+07	2.897e+04	2.946e+04
2.0	7.777e+12	6.117e+06	6.199e+06	9.459e+03	9.586e+03
TOTALS:	2.759e+14	8.953e+07	9.185e+07	1.646e+05	1.689e+05

Quad Cities

(Thyroid DCF)

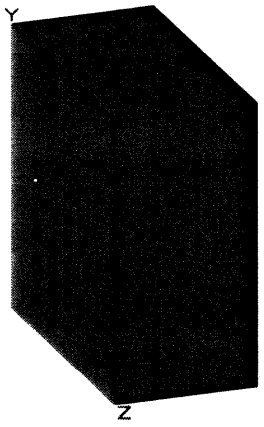
Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Drywell Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.0250	1.08E+06	1.00E+00	2.50E-02	0.494	0.2	9.88E-02	9.88E-02	2.61E+08	2.58E+07	4.470E+09	5.77E-03
I-132	0.2500	6.44E+03	5.96E-03	1.49E-03	0.029		5.89E-03	9.88E-01		2.58E+08		5.77E-02
I-133	0.1000	1.80E+05	1.66E-01	1.66E-02	0.329		6.58E-02	3.95E-01		1.03E+08		2.31E-02
I-134	0.2500	1.07E+03	9.86E-04	2.47E-04	0.005		9.74E-04	9.88E-01		2.58E+08		5.77E-02
I-135	0.2500	3.13E+04	2.90E-02	7.24E-03	0.143		2.86E-02	9.88E-01		2.58E+08		5.77E-02
				5.06E-02	1.000		2.00E-01					2.02E-01
I-131	0.0250	1.08E+06	1.00E+00	2.50E-02	0.494	4.0	1.98E+00	1.98E+00		5.16E+08		1.15E-01
I-132	0.2500	6.44E+03	5.96E-03	1.49E-03	0.029		1.18E-01	1.98E+01		5.16E+09		1.15E+00
I-133	0.1000	1.80E+05	1.66E-01	1.66E-02	0.329		1.32E+00	7.90E+00		2.06E+09		4.61E-01
I-134	0.2500	1.07E+03	9.86E-04	2.47E-04	0.005		1.95E-02	1.98E+01		5.16E+09		1.15E+00
I-135	0.2500	3.13E+04	2.90E-02	7.24E-03	0.143		5.72E-01	1.98E+01		5.16E+09		1.15E+00
				5.06E-02	1.000		4.00E+00					4.04E+00

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: QC-4UCII.MS5
Run Date: October 24, 2006
Run Time: 1:26:03 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Quad Cities 4 uCi/g
Description: D/W Rad Monitor (Thyroid DCF)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	609.6 cm	20 ft 0.0 in
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	612.648 cm 20 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.20e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	1.0421e+002	3.8556e+012	1.1500e-001	4.2550e+003
I-132	1.0421e+003	3.8556e+013	1.1500e+000	4.2550e+004
I-133	4.1773e+002	1.5456e+013	4.6100e-001	1.7057e+004
I-134	1.0421e+003	3.8556e+013	1.1500e+000	4.2550e+004
I-135	1.0421e+003	3.8556e+013	1.1500e+000	4.2550e+004

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.176e+12	1.221e+04	1.446e+04	1.210e+02	1.433e+02
0.08	1.009e+11	3.009e+03	3.461e+03	4.761e+00	5.476e+00
0.15	1.946e+12	1.101e+05	1.213e+05	1.813e+02	1.997e+02
0.2	1.955e+12	1.483e+05	1.596e+05	2.617e+02	2.817e+02
0.3	2.928e+12	3.357e+05	3.548e+05	6.367e+02	6.731e+02

DOS File: QC-4UCII.MS5
Run Date: October 24, 2006
Run Time: 1:26:03 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	1.096e+13	1.684e+06	1.762e+06	3.281e+03	3.432e+03
0.5	3.086e+13	5.948e+06	6.179e+06	1.168e+04	1.213e+04
0.6	6.307e+13	1.463e+07	1.513e+07	2.856e+04	2.953e+04
0.8	1.086e+14	3.376e+07	3.467e+07	6.421e+04	6.595e+04
1.0	4.251e+13	1.657e+07	1.695e+07	3.054e+04	3.124e+04
1.5	3.238e+13	1.904e+07	1.936e+07	3.203e+04	3.258e+04
2.0	8.599e+12	6.763e+06	6.855e+06	1.046e+04	1.060e+04
TOTALS:	3.051e+14	9.900e+07	1.016e+08	1.820e+05	1.868e+05

Attachment 2
PWR

Assumptions:

- RCS Liquid and Free-Air volumes were obtained from the PWR Core Damage Assessment Model (CDAM) Requirements Specification
    - Mid-Atlantic Version 1.0, Section 7.2.2, "Sample Volume Calculations and Corrections"
    - Mid-West Version 1.0, Section 7.2.2 "Sample Volume Calculations and Corrections"

  with the following exceptions:
    - None

  It is assumed the entire Liquid RCS volume is instantaneously released to the Containment volume and all entrained Iodine and Noble Gas immediately disperses homogeneously throughout the free air space.

- Free Air Volumes are as described in the CDAM documentation included in this calculation.

- The RCS Dose Equivalent I-131 values of interest (0.35 uCi/gm and 60.0 uCi/gm) were obtained from the sites' Technical Specifications and were specifically requested by the Revision 4 EAL implementation team for this calculation. These are standard Technical Specification values for Pressurized Water Reactors.

- Isotopes of Iodine and Noble Gas were used in the calculation. Unlike BWRs, which are constantly degassing, a considerable amount of Noble Gas is entrained within the Reactor Coolant that will be released to the free air volume upon depressurization. RCS Noble Gas concentrations are based on 1% failed fuel and will remain constant despite changes in the Dose Equivalent Iodine values

- Dose Conversion factors used to calculate "Isotopic Concentrations" were obtained from "FGR 11". Though these factors are for Alternative Source Term (AST) calculations, when normalized to I-131 they adequately represent the mixture of Iodines in the coolant. The Dose Conversion Factors from FGR 11 were obtained from Table 2.1, column "Effective". The choice of using values from the Effective column was based on the methodology used for AST calculations and section 4.1.2 of Regulator Guide 1.183 which states:

"The exposure-to-CEDE factor for inhalation of radioactive material should be derived from data provided in ICRP Publication 30, *Limits for Intakes of radionuclides by Workers* (Ref. 19). Table 2.1 of Federal Guidance Report 11, *Limiting values of Radionuclide Intake and Air Concentration and Dose Conversion factors for Inhalation, Submersion, and Ingestion* (Ref. 20), provides tables of conversion factors acceptable to the NRC staff. The factors in the column headed *Effective* yield doses corresponding to the CEDE."

Since only the Normalized ratios are used in the calculation, unit conversion is not required, however the international units of Sv/Bq were converted to Rem/Ci for ease of understanding.

Additional calculations were performed using the FGR 11 Table 2.1, column "Thyroid" Dose Conversion Factors for comparison purposes. The calculations were limited to the 60.0 uCi/gm DEI-131 values. The results of these calculations are included in the Results table at the end of this attachment.

- MicroShield Model:

  A generic approach was taken when constructing the MicroShield model since each sites' actual configuration is different. Even though the entire air space volume is available for dilution of the released radioactive isotopes, the radiation detectors located within the containment are not exposed to the entire volume. Therefore a cylindrical source representing the entire containment was not used. Instead, a "box" was constructed in the MicroShield model that approximates the size of the area that a detector would be exposed to. The box measured 30 feet in depth (distance from the mounted wall to the closest significant wall), 40 feet tall, and 40 feet wide. A dose receptor point, representing the detector, was placed on the outer edge of the wall halfway up and across the box. This best represents the location of a radiation detector within the containment mounted on a wall. No attempt was made to simulate shielding from components within the containment nor was any credit taken for backscatter from the surrounding walls or components. The box was then filled with the calculated isotopic concentrations to determine a dose rate at the given point.

Methodology:

MicroShield requires a given concentration in uCi/cc or uCi/gm for each isotope of interest. To obtain those concentrations requires converting the given I-131 Dose Equivalent concentration (0.35 uCi/cc and 60.0 uCi/cc) to their individual isotopes components. In this case an equivalent for I-131, I-132, I-133, I-134 and I-135. Noble Gas concentrations are independent of I-131 Dose Equivalent Concentrations and were calculated with a different methodology then Iodines.

Iodine Conversion Calculations

Normalized I-131 Equivalent Activity Distribution

A normalized I-131 equivalent activity distribution for each isotope was calculated using the relative mix of the isotopes of interest for each facility. These ratios vary from site to site and are listed on the individual spreadsheets. Copies of the source documents are contained within this calculation. The normalized value is calculated using the following equation:

$$\frac{DCF_{(i)}}{DCF_{(I-131)}} = NDCF_{(i)}$$

Where:

$DCF_{(i)}$ = Isotopes FGR-11 Dose Conversion Factor (See Assumptions for details)

$DCF_{(I-131)}$ = I-131 FGR-11 Dose Conversion Factor (See Assumptions for details)

$NDCF_{(i)}$ = The Isotopes ratio normalized to I-131.

Since only the normalized DCF values are used in the calculation, no unit conversion is necessary.

$$AD_{(i)} * NDCF_{(i)} = NC_{(i)}$$

Where:

$AD_{(i)}$ = Activity Distribution (See the included calculation data for individual sites distribution numbers)

$NC_{(i)}$ = Normalized I-131 Equivalent Activity Distribution

Calculate the Fraction of each normalized concentration

$$\frac{NC_{(i)}}{\sum NC_{(i)}} = f_{(i)}$$

Where:

$f_{(i)}$ = Fraction of each isotope's normalized activity distribution.

Calculate the Dose Equivalent I-131 activity (uCi/gm) for each Isotope

$$f_{(i)} * DE_{(I-131)} = DEI-131_{(i)}$$

Where:

$DE_{(I-131)}$ = 0.35 or 60.0 uCi/gm

$DEI\text{-}131_{(i)}$ = the Dose Equivalent I-131 activity (uCi/gm) for each isotope.

Calculate the Isotopic Concentration

$$\frac{DEI-131_{(i)}}{NDCF_{(i)}} = IC_{(i)}$$

Where:

$IC_{(i)}$ = Isotope's RCS Concentration (uCi/gm).

Calculate Total Isotopic RCS Activity for each isotope

$$IC_i * V_{(RCS)} = A_{(i)}$$

Where:

$V_{(RCS)}$ = RCS Liquid Volume

$A_{(i)}$ = Isotopes total activity (uCi) in the RCS

Calculate the Containment Airborne Concentration

$$\frac{A_i}{V_{(f)}} = AC_{(i)}$$

Where:

$V_{(f)}$ = Free-air space as defined in the assumptions

$AC_{(i)}$ = Isotopes concentration (uCi/cc) in the Containment free-air space.

Noble Gas Concentrations

Noble Gas calculations are independent of Dose Equivalent I-131 Values. As such, gas concentrations remain constant for either calculation being performed and are based on 1% failed fuel criteria obtained from the referenced document in the sites calculation.

Byron / Braidwood

Calculation Number BYR04-046 & BRW-04-0040-M Rev. 1, Attachment A, Page A-2 provides a Total RCS Activity in Curies. Page 12 of the calculation provides an RCS volume used for the calculation of 7,285 ft^3. Since the referenced calculation uses a different RCS volume than this calculation, the

isotopic concentration in uCi/gm needs to be corrected using the referenced volume.

Convert 7,285 ft^3 to gm.

$$\frac{7285 ft^3}{} * \frac{7.481 gal}{ft^3} * \frac{8.33 lb}{gal} * \frac{453.6 gm}{lb} = 2.06E+08 gm$$

Calculate uCi/gm for each Isotope.

$$\frac{Act(i)}{} * \frac{1E06 uCi}{Ci} * \frac{1}{2.06E+08 gm} = IC_{(i)}$$

Where:

Act(i) = The activity for each isotope as describe in calculation BYR04-046 & BRW-04-0040-M Rev. 1

2.06E+08 = RCS Volume used in calculation BYR04-046 & BRW-04-0040-M Rev. 1

Calculate Total Isotopic RCS Activity for each isotope

$$IC_i * V_{(RCS)} = A_{(i)}$$

Where:

$V_{(RCS)}$ = RCS Liquid Volume as defined in the CDAM documentation

$A_{(i)}$ = Isotopes total activity (uCi) in the RCS

Calculate the Containment Airborne Concentration

$$\frac{A_i}{V_{(f)}} = AC_{(i)}$$

Where;

$V_{(f)}$ = Free-air space as defined in the assumptions

$AC_{(i)}$ = Isotopes concentration (uCi/cc) in the Containment free-air space.

TMI

Calculation C-1101-900-E000-087 provided Noble Gas isotopic concentrations in uCi/gm and required no conversion.

Calculate Total Isotopic RCS Activity for each isotope

$$IC_i * V_{(RCS)} = A_{(i)}$$

Where:

$V_{(RCS)}$ = RCS Liquid Volume

$A_{(i)}$ = Isotopes total activity (uCi) in the RCS

Calculate the Containment Airborne Concentration

$$\frac{A_i}{V_{(f)}} = AC_{(i)}$$

Where:

$V_{(f)}$ = Free-air space as defined in the assumptions

$AC_{(i)}$ = Isotopes concentration (uCi/cc) in the Containment free-air space.

Calculation

The Containment Airborne Concentrations ($AC_{(i)}$) were entered into the Micro-Shield program for each RCS Dose Equivalent Iodine –131 value of interest (0.35 and 60.0 uCi/gm) and the Noble Gas concentrations.

Results:

The following table summarizes the results of each calculation by site.

Site	Calculated Dose Rate (0.35 uCi/gm) R/hr (FGR 11 Effective DCF)	Calculated Dose Rate (60.0 uCi/gm) R/hr (FGR 11 Effective DCF)	Calculated Dose Rate (60.0 uCi/gm) R/hr (FGR 11 Thyroid DCF)
Byron / Braidwood	3.3	30.0	30.7
TMI	7.4	26.0	26.3

Byron / Braidwood

Byron / Braidwood (Effective DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Containment Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.7420	3.29E+04	1.00E+00	7.42E-01	0.723	0.35	2.53E-01	2.53E-01	2.46E+08	6.23E+07	7.820E+10	7.96E-04
I-132	0.9790	3.81E+02	1.16E-02	1.13E-02	0.011		3.87E-03	3.34E-01		8.22E+07		1.05E-03
I-133	1.3500	5.85E+03	1.78E-01	2.40E-01	0.234		8.19E-02	4.61E-01		1.13E+08		1.45E-03
I-134	0.2430	1.31E+02	3.98E-03	9.68E-04	0.001		3.30E-04	8.29E-02		2.04E+07		2.61E-04
I-135	0.8420	1.23E+03	3.74E-02	3.15E-02	0.031		1.07E-02	2.87E-01		7.07E+07		9.04E-04
				1.03E+00	1.000		3.50E-01					4.46E-03
I-131	0.7420	3.29E+04	1.00E+00	7.42E-01	0.723	60.0	4.34E+01	4.34E+01		1.07E+10		1.37E-01
I-132	0.9790	3.81E+02	1.16E-02	1.13E-02	0.011		6.63E-01	5.73E+01		1.41E+10		1.80E-01
I-133	1.3500	5.85E+03	1.78E-01	2.40E-01	0.234		1.40E+01	7.90E+01		1.94E+10		2.48E-01
I-134	0.2430	1.31E+02	3.98E-03	9.68E-04	0.001		5.66E-02	1.42E+01		3.50E+09		4.47E-02
I-135	0.8420	1.23E+03	3.74E-02	3.15E-02	0.031		1.84E+00	4.92E+01		1.21E+10		1.55E-01
				1.03E+00	1.000		6.00E+01					7.65E-01

Isotope	RCS Activity (Ci)[1]	RCS Volume (gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Containment Concentration (uCi/cc)
	$Act_{(I)}$		IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
Kr-85m	3.713E+02	2.06E+08	1.80E+00	2.46E+08	4.43E+08	7.820E+10	5.67E-03
Kr-85	1.467E+03		7.12E+00		1.75E+09		2.24E-02
Kr-87	2.372E+02		1.15E+00		2.83E+08		3.62E-03
Kr-88	6.911E+02		3.35E+00		8.25E+08		1.06E-02
Xe-131m	6.829E+02		3.32E+00		8.16E+08		1.04E-02
Xe-133m	7.530E+02		3.66E+00		8.99E+08		1.15E-02
Xe-133	5.178E+04		2.51E+02		6.18E+10		7.91E-01
Xe-135m	1.007E+02		4.89E-01		1.20E+08		1.54E-03
Xe-135	1.593E+03		7.73E+00		1.90E+09		2.43E-02
Xe-138	1.368E+02		6.64E-01		1.63E+08		2.09E-03

[1] Obtained from Calc No. BYR04-046 & BRW-04-0040-M, Rev. 1, Attachment A, Page A-2 of A-8

Exelon Nuclear

ATTACHMENT 1
Design Analysis Cover Sheet

CC-AA-309-1001
Revision 1

Last Page No. 27

Analysis No.	BYR04-046 & BRW-04-0040-M	**Revision**	1
EC/ECR No.	Byron: 348720 Braidwood: 348697	**Revision**	0
Title:	Re-analysis of Main Steam Line Break (MSLB) Accident Using Alternative Source Terms		

Station(s)	Byron/Braidwood
Unit No.:	00 (Common)
Discipline	M
Description Code/ Keyword	R02
Safety Class	S
System Code	Varies
Structure	N/A

Component(s)	
N/A	

CONTROLLED DOCUMENT REFERENCES

Document No.	From/To	Document No.	From/To
UFSAR	From/To	P&ID M-96-03 BYR & M-96-03 BRW, "Diagram of Control Room HVAC System"	From
BYR04-047 & BRW-04-0041-M, "Re-analysis of Fuel Handling Accident (FHA) Using Alternative Source Terms"	From	BYR04-050 & BRW-04-0044-M, "Calculation of Alternative Source Term Onsite and Offsite Atmospheric Dispersion Coefficients"	From
TODI No. BYR-04-020, BRW-2004-0029	From		
TODI No. DIT-BRW-2004-0017	From		
VC-400, "Control Room Volume"	From		

Is this Design Analysis Safeguards? Yes ☐ No ☒

Does this Design Analysis Contain Unverified Assumptions? Yes ☐ No ☒ ATI/AR#

Is a Supplemental Review Required? Yes ☐ No ☒ If yes, complete Attachment 3

Preparer	Aleem E. Boatright (Print Name)	Aleem E. Boatright (Sign Name)	11/16/2004 (Date)
Reviewer	Paul Reichert (Print Name)	Paul Reichert (Sign Name)	11/16/2004 (Date)

Method of Review ☒ Detailed Review ☐ Alternate Calculations ☐ Testing

Review Notes:

Approver	Harold Rothstein (Print Name)	Harold Rothstein (Sign Name)	11/16/2004 (Date)
(For External Analyses Only) Exelon Reviewer	T. J. Meisz (Print Name)	T. J. Meisz (Sign Name)	11/24/04 (Date)
Approver	Wayne R Lewis (Print Name)	Wayne R Lewis (Sign Name)	11/29/04 (Date)

Description of Revision (list affected pages for partials): All pages affected. Revision to incorporate Independent Third Party Review and Technical Verification Team comments.

THIS DESIGN ANALYSIS SUPERCEDES: BYR97-332

χ/Q =1.95E-04 sec/m^3 (24-96 hours) (72-hr limiting CR Emergency Air Intake χ/Q)
χ/Q =1.67E-04 sec/m^3 (96-720 hours) (624-hr limiting CR Emergency Air Intake χ/Q)

The CR atmospheric relative concentrations used for broken steam line releases are as follows:

χ/Q =3.20E-03 sec/m^3 (0-0.5 hours) (2-hr limiting CR Fresh Air Intake χ/Q)
χ/Q =1.70E-02 sec/m^3 (0.5-2 hours) (2-hr limiting CR Emergency Air Intake χ/Q)
χ/Q =1.46E-02 sec/m^3 (2-8 hours) (6-hr limiting CR Emergency Air Intake χ/Q)
χ/Q =6.68E-03 sec/m^3 (8-24 hours) (16-hr limiting CR Emergency Air Intake χ/Q)
χ/Q =4.48E-03 sec/m^3 (24-96 hours) (72-hr limiting CR Emergency Air Intake χ/Q)
χ/Q =3.31E-03 sec/m^3 (96-720 hours) (624-hr limiting CR Emergency Air Intake χ/Q)

The EAB and LPZ PAVAN calculated χ/Q values input to RADTRAD were also taken from the results of the B/B Design Analyses BYR04-050 & BRW-04-0044-M (Ref. 11). The EAB and LPZ χ/Q's used are as follows:

EAB χ/Q =5.36E-04 sec/m^3 (0-2 hours) (8-hr EAB χ/Q)

LPZ χ/Q =9.32E-05 sec/m^3 (0-2 hours) (2-hr limiting LPZ χ/Q)
χ/Q =4.50E-05 sec/m^3 (2-8 hours) (8-hr limiting LPZ χ/Q)
χ/Q =3.12E-05 sec/m^3 (8-24 hours) (16-hr limiting LPZ χ/Q)
χ/Q =1.41E-05 sec/m^3 (24-96 hours) (72-hr limiting LPZ χ/Q)
χ/Q =4.54E-06 sec/m^3 (96-720 hours) (624-hr limiting LPZ χ/Q)

4.2. Plant Data

Note: All volumes and volumetric flow rates are shown here in ft^3 and cfm, and the method of conversion described in reference 1 and Section 2.4 of this analysis was used when needed.

- DBA Power Level (Ref. 5) 3658.3 MWth
- RCS Primary Coolant Volume (Ref. 5) 7285 ft^3
- Secondary Coolant Volume (3 Intact SGs Combined) (Ref. 5) 3592 ft^3
- Faulted SG Coolant Volume (Ref. 5) 2675 ft^3
- Containment Volume (Ref. 5) 2,850,000 ft^3
- Primary to Secondary Coolant Leak Rate (per Intact SG) (Ref. 5) 0.02914 cfm
- Faulted SG Primary to Secondary Coolant Leak Rate (Ref. 5) 0.06684 cfm
- Equilibrium Iodine Release Rates (Ref. 7)
  These values were derived from the 500 times rate, shown in reference 7, and are used to determine the DE I-131 spike specific activities.
  - I-131 0.416 Ci/min
  - I-132 1.754 Ci/min
  - I-133 0.924 Ci/min

	A	B	C	D	E	F	G
29							
30	**Concurrent Accident Initiated Iodine Spike (500 times Equlibrium Iodine Release Rate)**						
31							
32				**Old Methodology**			
33		**RCS**		**RCS**	**RCS**		
34		**Equilibrium**	**RCS**	**Total Activity**	**Specific Activity**	**Total**	**(pre-AST) Total**
35		**Release Rate**	**500x Rate**	**500x Rate**	**500x Rate 6 hrs**	**Core Activity**	**Core Activity**
36		**(Ci/min)**	**(Ci/min)**	**6 hrs (Ci)**	**(Ci/MW)**	**(Ci)**	**(Ci)**
37	I-131	0.4160	208	74880	2.0469E+01	9.58300E+07	9.74000E+07
38	I-132	1.7540	877	315720	8.6302E+01	1.38600E+08	1.40000E+08
39	I-133	0.9240	462	166320	4.5464E+01	1.98400E+08	1.97000E+08
40	I-134	0.9260	463	166680	4.5562E+01	2.20400E+08	2.17000E+08
41	I-135	0.8260	413	148680	4.0642E+01	1.85100E+08	1.85000E+08
42							
43							
44							
45		**RCS Activity**	**Activity**				
46		**(Ci)**	**(Ci/MW)**				
47	KR-85m	3.713E+02	1.0150E-01				
48	KR-85	1.467E+03	4.0101E-01				
49	KR-87	2.372E+02	6.4839E-02				
50	KR-88	6.911E+02	1.8891E-01				
51	XE-131m	6.829E+02	1.8667E-01				
52	XE-133m	7.530E+02	2.0583E-01				
53	XE-133	5.178E+04	1.4154E+01				
54	XE-135m	1.007E+02	2.7526E-02				
55	XE-135	1.593E+03	4.3545E-01				
56	XE-138	1.368E+02	3.7394E-02				

TABLE 15.0-10

IODINE ACTIVITY IN THE PRIMARY AND SECONDARY COOLANT

Primary Coolant

Isotope	Equilibrium Concentration (1.0 µCi/gm DE I-131) µCi/gm	Equilibrium Appearance Rate, Ci/min	Iodine Spike Appearance Rate, Ci/min	Pre-Existing Iodine Spike (60 µCi/gm DE I-131) µCi/gm
I-131	0.742	0.416	208	44.5
I-132	0.979	1.754	877	58.7
I-133	1.350	0.923	462	81.0
I-134	0.243	0.926	463	14.6
I-135	0.842	0.826	413	50.5

Secondary Coolant

Isotope	Equilibrium Concentraion (0.1 µCi/gm DE I-131) µCi/gm
I-131	0.0742
I-132	0.0979
I-133	0.1350
I-134	0.0243
I-135	0.0842

ATTACHMENT 1
METHODOLOGIES

7.2.2 System Volume Calculations and Corrections

A. Reactor Coolant System Volume

1) Normal RCS volumes are as follows:

- Braidwood:.....2.46E+08 ml (8680 Ft^3 per UFSAR Table 15.6-7)
- Byron: .....2.46E+08 ml (8680 Ft^3 per UFSAR Table 15.6-7)

2) Normal RCS volumes can be adjusted down to account for a loss of mass.

B. Containment Sump System Volume

1) Normal Sump volume is set at 0.

2) **IF** ECCS was used, **THEN**:

$$\textbf{Sump} = (\textbf{RCS}_{\textbf{Normal}} - \textbf{RCS}_{\textbf{Current}}) + \textbf{RWST} + \textbf{Accum} + \textbf{Other}$$

Where:

RCS_{Normal}: Normal default RCS volume from above.

$RCS_{Current}$: RCS volume at time of sample.

RWST: % RWST Used x Total RWST Volume

- Braidwood:.....1.35E+09 ml (4.75E+04 Ft^3 per USAR Table 15.6-7)
- Byron: ..... 1.35E+09 ml (4.75E+04 Ft^3 per USAR Table 15.6-7)

Accum: # Accumulators Used x Accumulator Volume

- Braidwood:..... Total 1.06E+08 ml (3740 Ft^3 per USAR Table 15.6-7) or 2.65E+07 ml per accumulator.
- Byron: ..... Total 1.06E+08 ml (3740 Ft^3 per USAR Table 15.6-7) or 2.65E+07 ml per accumulator.

Other: Volume from any other source(s) added to the RCS that reach the sump.

C. Containment Free Volume

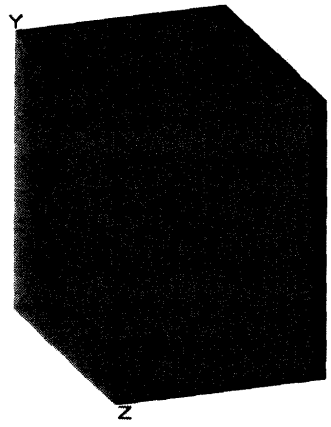
From Table 15.6-7 the Containment free volume is 2.76E+06 Ft^3
Using 28316.05 ml per cubic ft this equals 7.82E+10 ml

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: BB035UCI.MS5
Run Date: October 30, 2006
Run Time: 8:34:45 AM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: BY/BR 0.35 uCi/gm
Description: Containment High Rad Monitor WITH NOBLE GAS
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	914.4 cm	30 ft
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	917.448 cm 30 ft 1.2 in	609.6 cm 20 ft 0.0 in	609.6 cm 20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	4.80e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
I-131	1.0819e+000	4.0030e+010	7.9598e-004	2.9451e+001
I-132	1.4272e+000	5.2805e+010	1.0500e-003	3.8850e+001
I-133	1.9709e+000	7.2922e+010	1.4500e-003	5.3650e+001
I-134	3.5475e-001	1.3126e+010	2.6100e-004	9.6570e+000
I-135	1.2287e+000	4.5463e+010	9.0400e-004	3.3448e+001
Kr-85	3.0446e+001	1.1265e+012	2.2400e-002	8.2880e+002
Kr-85m	7.7067e+000	2.8515e+011	5.6700e-003	2.0979e+002
Kr-87	4.9203e+000	1.8205e+011	3.6200e-003	1.3394e+002
Kr-88	1.4408e+001	5.3308e+011	1.0600e-002	3.9220e+002
Xe-131m	1.4136e+001	5.2302e+011	1.0400e-002	3.8480e+002
Xe-133	1.0751e+003	3.9780e+013	7.9100e-001	2.9267e+004
Xe-133m	1.5631e+001	5.7834e+011	1.1500e-002	4.2550e+002
Xe-135	3.3029e+001	1.2221e+012	2.4300e-002	8.9910e+002
Xe-135m	2.0932e+000	7.7448e+010	1.5400e-003	5.6980e+001
Xe-138	2.8407e+000	1.0511e+011	2.0900e-003	7.7330e+001

Buildup
The material reference is : Source

Integration Parameters

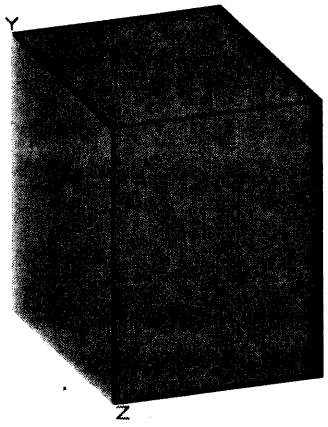
X Direction	10
Y Direction	20
Z Direction	20

Results

age : 2
OS File: BB035UCI.MS5
un Date: October 30, 2006
un Time: 8:34:45 AM
uration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.978e+13	1.507e+05	1.827e+05	1.493e+03	1.810e+03
0.08	1.460e+13	3.225e+05	3.786e+05	5.104e+02	5.991e+02
0.1	1.051e+09	2.919e+01	3.352e+01	4.466e-02	5.128e-02
0.15	2.528e+11	1.062e+04	1.187e+04	1.749e+01	1.954e+01
0.2	1.332e+12	7.505e+04	8.163e+04	1.325e+02	1.441e+02
0.3	8.097e+10	6.904e+03	7.357e+03	1.310e+01	1.396e+01
0.4	1.822e+11	2.084e+04	2.194e+04	4.060e+01	4.274e+01
0.5	1.548e+11	2.222e+04	2.321e+04	4.362e+01	4.557e+01
0.6	1.195e+11	2.067e+04	2.147e+04	4.034e+01	4.191e+01
0.8	1.763e+11	4.084e+04	4.211e+04	7.768e+01	8.010e+01
1.0	9.289e+10	2.701e+04	2.772e+04	4.979e+01	5.110e+01
1.5	1.378e+11	6.049e+04	6.168e+04	1.018e+02	1.038e+02
2.0	3.813e+11	2.240e+05	2.274e+05	3.464e+02	3.517e+02
3.0	2.957e+10	2.618e+04	2.647e+04	3.552e+01	3.592e+01
TOTALS:	3.732e+13	1.008e+06	1.114e+06	2.903e+03	3.340e+03

Case Title: BY/BR 60 uCi/gm
Description: Containment High Rad Monitor WITH NOBLE GAS
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	914.4 cm		30 ft
Width	1.2e+3 cm	40 ft	0.0 in
Height	1.2e+3 cm	40 ft	0.0 in

Dose Points

	X	Y	Z
# 1	917.448 cm	609.6 cm	609.6 cm
	30 ft 1.2 in	20 ft 0.0 in	20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	4.80e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	1.8621e+002	6.8898e+012	1.3700e-001	5.0690e+003
I-132	2.4466e+002	9.0523e+012	1.8000e-001	6.6600e+003
I-133	3.3708e+002	1.2472e+013	2.4800e-001	9.1760e+003
I-134	6.0757e+001	2.2480e+012	4.4700e-002	1.6539e+003
I-135	2.1068e+002	7.7951e+012	1.5500e-001	5.7350e+003
Kr-85	3.0446e+001	1.1265e+012	2.2400e-002	8.2880e+002
Kr-85m	7.7067e+000	2.8515e+011	5.6700e-003	2.0979e+002
Kr-87	4.9203e+000	1.8205e+011	3.6200e-003	1.3394e+002
Kr-88	1.4408e+001	5.3308e+011	1.0600e-002	3.9220e+002
Xe-131m	1.4136e+001	5.2302e+011	1.0400e-002	3.8480e+002
Xe-133	1.0751e+003	3.9780e+013	7.9100e-001	2.9267e+004
Xe-133m	1.5631e+001	5.7834e+011	1.1500e-002	4.2550e+002
Xe-135	3.3029e+001	1.2221e+012	2.4300e-002	8.9910e+002
Xe-135m	2.0932e+000	7.7448e+010	1.5400e-003	5.6980e+001
Xe-138	2.8407e+000	1.0511e+011	2.0900e-003	7.7330e+001

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

age : 2
DS File: BB60UCI.MS5
un Date: October 24, 2006
un Time: 1:38:58 PM
uration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	2.028e+13	1.545e+05	1.873e+05	1.531e+03	1.856e+03
0.08	1.478e+13	3.265e+05	3.833e+05	5.167e+02	6.065e+02
0.1	1.051e+09	2.919e+01	3.352e+01	4.466e-02	5.128e-02
0.15	3.817e+11	1.604e+04	1.791e+04	2.641e+01	2.949e+01
0.2	1.581e+12	8.910e+04	9.691e+04	1.573e+02	1.710e+02
0.3	1.115e+12	9.512e+04	1.014e+05	1.804e+02	1.923e+02
0.4	6.701e+12	7.664e+05	8.069e+05	1.493e+03	1.572e+03
0.5	1.419e+13	2.038e+06	2.129e+06	4.000e+03	4.178e+03
0.6	1.309e+13	2.263e+06	2.351e+06	4.417e+03	4.589e+03
0.8	1.433e+13	3.320e+06	3.423e+06	6.314e+03	6.510e+03
1.0	7.098e+12	2.064e+06	2.118e+06	3.804e+03	3.905e+03
1.5	6.330e+12	2.778e+06	2.832e+06	4.674e+03	4.766e+03
2.0	1.709e+12	1.004e+06	1.019e+06	1.552e+03	1.576e+03
3.0	2.957e+10	2.618e+04	2.647e+04	3.552e+01	3.592e+01
OTALS:	1.016e+14	1.494e+07	1.549e+07	2.870e+04	2.999e+04

Byron / Braidwood (Thyroid DCF)

Isotope	FSAR Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Containment Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.7420	1.08E+06	1.00E+00	7.42E-01	0.744	0.35	2.60E-01	2.60E-01	2.46E+08	6.41E+07	7.820E+10	8.19E-04
I-132	0.9790	6.44E+03	5.96E-03	5.83E-03	0.006		2.05E-03	3.44E-01		8.45E+07		1.08E-03
I-133	1.3500	1.80E+05	1.66E-01	2.25E-01	0.225		7.89E-02	4.74E-01		1.17E+08		1.49E-03
I-134	0.2430	1.07E+03	9.86E-04	2.40E-04	0.000		8.41E-05	8.53E-02		2.10E+07		2.68E-04
I-135	0.8420	3.13E+04	2.90E-02	2.44E-02	0.024		8.56E-03	2.96E-01		7.27E+07		9.30E-04
				9.97E-01	1.000		3.50E-01					4.59E-03
I-131	0.7420	1.08E+06	1.00E+00	7.42E-01	0.744	60.0	4.46E+01	4.46E+01		1.10E+10		1.40E-01
I-132	0.9790	6.44E+03	5.96E-03	5.83E-03	0.006		3.51E-01	5.89E+01		1.45E+10		1.85E-01
I-133	1.3500	1.80E+05	1.66E-01	2.25E-01	0.225		1.35E+01	8.12E+01		2.00E+10		2.56E-01
I-134	0.2430	1.07E+03	9.86E-04	2.40E-04	0.000		1.44E-02	1.46E+01		3.60E+09		4.60E-02
I-135	0.8420	3.13E+04	2.90E-02	2.44E-02	0.024		1.47E+00	5.07E+01		1.25E+10		1.59E-01
				9.97E-01	1.000		6.00E+01					7.87E-01

Isotope	RCS Activity (Ci)[1]	RCS Volume (gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Containment Concentration (uCi/cc)
	$Act_{(i)}$		IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
Kr-85m	3.713E+02	2.06E+08	1.80E+00	2.46E+08	4.43E+08	7.820E+10	5.67E-03
Kr-85	1.467E+03		7.12E+00		1.75E+09		2.24E-02
Kr-87	2.372E+02		1.15E+00		2.83E+08		3.62E-03
Kr-88	6.911E+02		3.35E+00		8.25E+08		1.06E-02
Xe-131m	6.829E+02		3.32E+00		8.16E+08		1.04E-02
Xe-133m	7.530E+02		3.66E+00		8.99E+08		1.15E-02
Xe-133	5.178E+04		2.51E+02		6.18E+10		7.91E-01
Xe-135m	1.007E+02		4.89E-01		1.20E+08		1.54E-03
Xe-135	1.593E+03		7.73E+00		1.90E+09		2.43E-02
Xe-138	1.368E+02		6.64E-01		1.63E+08		2.09E-03

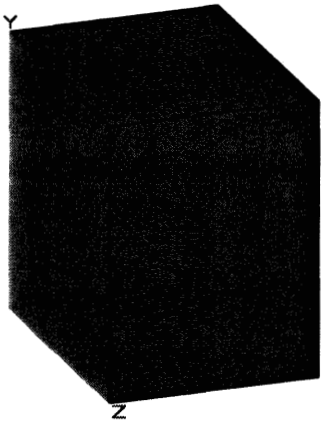
[1] Obtained from Calc No. BYR04-046 & BRW-04-0040-M, Rev. 1, Attachment A, Page A-2 of A-8

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: BB60UCII.MS5
Run Date: October 24, 2006
Run Time: 1:42:34 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: BY/BR 60 uCi/gm
Description: Containment High Rad Monitor WITH NOBLE GAS (Thyroid DCF)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	914.4 cm	30 ft
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	917.448 cm	609.6 cm	609.6 cm
	30 ft 1.2 in	20 ft 0.0 in	20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	4.80e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	1.9029e+002	7.0407e+012	1.4000e-001	5.1800e+003
I-132	2.5145e+002	9.3038e+012	1.8500e-001	6.8450e+003
I-133	3.4796e+002	1.2874e+013	2.5600e-001	9.4720e+003
I-134	6.2524e+001	2.3134e+012	4.6000e-002	1.7020e+003
I-135	2.1611e+002	7.9962e+012	1.5900e-001	5.8830e+003
Kr-85	3.0446e+001	1.1265e+012	2.2400e-002 ✓	8.2880e+002
Kr-85m	7.7067e+000	2.8515e+011	5.6700e-003 ✓	2.0979e+002
Kr-87	4.9203e+000	1.8205e+011	3.6200e-003 ✓	1.3394e+002
Kr-88	1.4408e+001	5.3308e+011	1.0600e-002 ✓	3.9220e+002
Xe-131m	1.4136e+001	5.2302e+011	1.0400e-002 ✓	3.8480e+002
Xe-133	1.0751e+003	3.9780e+013	7.9100e-001 ✓	2.9267e+004
Xe-133m	1.5631e+001	5.7834e+011	1.1500e-002 ✓	4.2550e+002
Xe-135	3.3029e+001	1.2221e+012	2.4300e-002 ✓	8.9910e+002
Xe-135m	2.0932e+000	7.7448e+010	1.5400e-003 ✓	5.6980e+001
Xe-138	2.8407e+000	1.0511e+011	2.0900e-003 ✓	7.7330e+001

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

MCNP File: BB60UCII.MS5
Run Date: October 24, 2006
Run Time: 1:42:34 PM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	2.029e+13	1.546e+05	1.874e+05	1.532e+03	1.857e+03
0.08	1.478e+13	3.266e+05	3.834e+05	5.168e+02	6.067e+02
0.1	1.051e+09	2.919e+01	3.352e+01	4.466e-02	5.128e-02
0.15	3.854e+11	1.619e+04	1.809e+04	2.667e+01	2.978e+01
0.2	1.587e+12	8.947e+04	9.731e+04	1.579e+02	1.718e+02
0.3	1.142e+12	9.734e+04	1.037e+05	1.846e+02	1.967e+02
0.4	6.851e+12	7.835e+05	8.249e+05	1.527e+03	1.607e+03
0.5	1.463e+13	2.101e+06	2.195e+06	4.124e+03	4.308e+03
0.6	1.345e+13	2.325e+06	2.416e+06	4.539e+03	4.716e+03
0.8	1.473e+13	3.413e+06	3.519e+06	6.492e+03	6.693e+03
1.0	7.290e+12	2.120e+06	2.176e+06	3.907e+03	4.010e+03
1.5	6.496e+12	2.851e+06	2.907e+06	4.797e+03	4.891e+03
2.0	1.744e+12	1.025e+06	1.041e+06	1.585e+03	1.609e+03
3.0	2.957e+10	2.618e+04	2.647e+04	3.552e+01	3.592e+01
TOTALS:	1.034e+14	1.533e+07	1.589e+07	2.942e+04	3.073e+04

Three Mile Island

TMI **(Effective DCF)**

Isotope	C-1101-900-E000-087 Table 21 Activity Distribution (uCi/gm)	FGR 11 Effective DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Containment Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.8320	3.29E+04	1.00E+00	8.32E-01	0.816	0.35	2.86E-01	2.86E-01	2.52E+08	7.20E+07	5.660E+10	1.27E-03
I-132	0.3030	3.81E+02	1.16E-02	3.51E-03	0.003		1.20E-03	1.04E-01		2.62E+07		4.63E-04
I-133	0.9370	5.85E+03	1.78E-01	1.67E-01	0.163		5.72E-02	3.22E-01		8.11E+07		1.43E-03
I-134	0.1100	1.31E+02	3.98E-03	4.38E-04	0.000		1.50E-04	3.78E-02		9.52E+06		1.68E-04
I-135	0.4490	1.23E+03	3.74E-02	1.68E-02	0.016		5.76E-03	1.54E-01		3.89E+07		6.86E-04
				1.02E+00	1.000		3.50E-01					4.02E-03
I-131	0.8320	3.29E+04	1.00E+00	8.32E-01	0.816	60.0	4.90E+01	4.90E+01		1.23E+10		2.18E-01
I-132	0.3030	3.81E+02	1.16E-02	3.51E-03	0.003		2.07E-01	1.78E+01		4.49E+09		7.94E-02
I-133	0.9370	5.85E+03	1.78E-01	1.67E-01	0.163		9.81E+00	5.52E+01		1.39E+10		2.46E-01
I-134	0.1100	1.31E+02	3.98E-03	4.38E-04	0.000		2.58E-02	6.47E+00		1.63E+09		2.88E-02
I-135	0.4490	1.23E+03	3.74E-02	1.68E-02	0.016		9.88E-01	2.64E+01		6.66E+09		1.18E-01
				1.02E+00	1.000		6.00E+01					6.90E-01

Isotope	C-1101-900-E000-087 Table 21 Noble Gas Activity (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Containment Concentration (uCi/cc)
	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
Kr-83m	5.45E-01	2.52E+08	1.37E+08	5.660E+10	2.43E-03
Kr-85m	2.43E+00		6.12E+08		1.08E-02
Kr-85	1.47E+01		3.71E+09		6.55E-02
Kr-87	1.34E+00		3.38E+08		5.97E-03
Kr-88	4.15E+00		1.05E+09		1.85E-02
Xe-131m	3.94E+00		9.93E+08		1.75E-02
Xe-133m	5.70E+00		1.44E+09		2.54E-02
Xe-133	4.19E+02		1.06E+11		1.87E+00
Xe-135m	4.85E-01		1.22E+08		2.16E-03
Xe-135	1.92E+01		4.83E+09		8.54E-02
Xe-138	6.99E-01		1.76E+08		3.11E-03

AmerGen **CALCULATION SHEET**
(Ref. EP-006T)

Subject: Post-LOCA EAB, LPZ, TSC, and CR Doses Using AST and RG 1.183 Requirements	Calculation No. C-1101-900-E000-087	Rev. No. 1	System Nos.	Sheet 49 of 860

Table 21

RCS Activity in Ci/MW_t For RADTRAD Nuclide File

Isotope	RCS Isotopic Activity μCi/g A	RCS Mass G B*	RCS Isotopic Activity Ci C=AxB/1E6	Core Thermal Power MW_t D	RCS Activity Ci/MW_t E=C/D
Kr-83m	0.545	2.99E+08	162.74	2619	.6214E-01
Kr-85m	2.43	2.99E+08	725.60	2619	.2771E+00
Kr-85	14.72	2.99E+08	4395.39	2619	.1678E+01
Kr-87	1.34	2.99E+08	400.12	2619	.1528E+00
Kr-88	4.15	2.99E+08	1239.19	2619	.4732E+00
Xe-131m	3.94	2.99E+08	1176.48	2619	.4492E+00
Xe-133m	5.7	2.99E+08	1702.02	2619	.6499E+00
Xe-133	419.4	2.99E+08	125232.84	2619	.4782E+02
Xe-135m	0.485	2.99E+08	144.82	2619	.5530E-01
Xe-135	19.17	2.99E+08	5724.16	2619	.2186E+01
Xe-138	0.699	2.99E+08	208.72	2619	.7970E-01
I-131	0.832	2.99E+08	248.48	2619	.9488E-01
I-132	0.303	2.99E+08	90.52	2619	.3456E-01
I-133	0.937	2.99E+08	279.82	2619	.1068E+00
I-134	0.110	2.99E+08	32.94	2619	.1258E-01
I-135	0.449	2.99E+08	134.03	2619	.5118E-01

* 10564.4 ft^3 x 7.481 gal/ft^3 x 8.33 lb/gal x 453.6 g/lb = 2.986E+08 g

ATTACHMENT 1
METHODOLOGIES

7.2.2 System Volume Calculations and Corrections

A. Reactor Coolant System Volume

1) Normal RCS volumes are as follows:

- TMI:..... 2.52E+08 ml (66,595 gallons per UFSAR)

2) Normal RCS volumes can be adjusted down to account for a loss of mass.

B. Containment Sump System Volume

1) Normal Sump volume is set at 0.

2) **IF** ECCS was used, **THEN**:

$$\text{Sump} = (\text{RCS}_{\text{Normal}} - \text{RCS}_{\text{Current}}) + \text{RWST} + \text{Accum} + \text{Other}$$

Where:

$\text{RCS}_{\text{Normal}}$: Normal default RCS volume from above.

$\text{RCS}_{\text{Current}}$: RCS volume at time of sample.

BWST: % RWST Used x Total RWST Volume

- 1.32E+09 ml (350,000 gals per USAR)

Core Flood Tanks: # Tanks Used x Tank Volume

- Total 5.32E+07 ml (14062 gals USAR)
  There are 2 Core Flood tanks (7031 gals each).

BAMT: 2.26E7 ml (798 Ft^3)

Other: Volume from any other source(s) added to the RCS that reach the sump.

C. Containment Free Volume

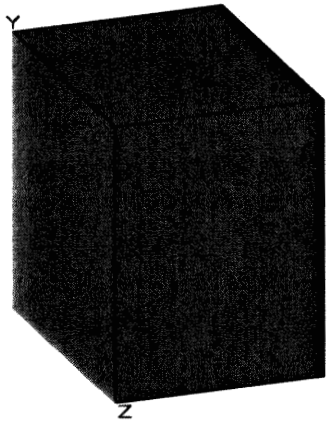
From Table 15.6-7 the Containment free volume is 2.00E+06 Ft^3
Using 28316.05 ml per cubic ft this equals 5.66E+10 ml

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: TM035-NG.MS5
Run Date: October 17, 2006
Run Time: 11:47:33 AM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: TMI 0.35 uCi/gm
Description: Containment High Rad Monitor WITH NOBLE GAS
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	914.4 cm	30 ft
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	917.448 cm	609.6 cm	609.6 cm
	30 ft 1.2 in	20 ft 0.0 in	20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	4.80e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	uCi/cm³	Bq/cm³
I-131	1.7262e+000	6.3869e+010	1.2700e-003	4.6990e+001
I-132	6.2931e-001	2.3285e+010	4.6300e-004	1.7131e+001
I-133	1.9437e+000	7.1916e+010	1.4300e-003	5.2910e+001
I-134	2.2835e-001	8.4488e+009	1.6800e-004	6.2160e+000
I-135	9.3242e-001	3.4499e+010	6.8600e-004	2.5382e+001
Kr-83m	3.3029e+000	1.2221e+011	2.4300e-003	8.9910e+001
Kr-85	8.9028e+001	3.2940e+012	6.5500e-002	2.4235e+003
Kr-85m	1.4679e+001	5.4314e+011	1.0800e-002	3.9960e+002
Kr-87	8.1145e+000	3.0024e+011	5.9700e-003	2.2089e+002
Kr-88	2.5145e+001	9.3038e+011	1.8500e-002	6.8450e+002
Xe-131m	2.3786e+001	8.8009e+011	1.7500e-002	6.4750e+002
Xe-133	2.5417e+003	9.4044e+013	1.8700e+000	6.9190e+004
Xe-133m	3.4524e+001	1.2774e+012	2.5400e-002	9.3980e+002
Xe-135	1.1608e+002	4.2948e+012	8.5400e-002	3.1598e+003
Xe-135m	2.9359e+000	1.0863e+011	2.1600e-003	7.9920e+001
Xe-138	4.2271e+000	1.5640e+011	3.1100e-003	1.1507e+002

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

DOS File: TM035-NG.MS5
Run Date: October 17, 2006
Run Time: 11:47:33 AM
Duration: 00:00:02

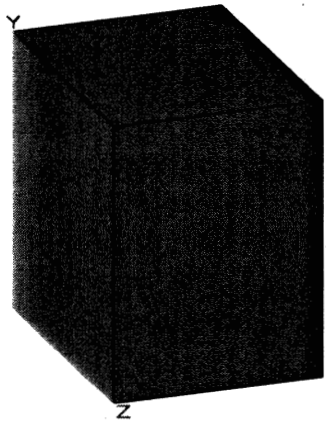
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	4.657e+13	3.547e+05	4.300e+05	3.516e+03	4.262e+03
0.08	3.452e+13	7.625e+05	8.951e+05	1.207e+03	1.416e+03
0.1	1.835e+09	5.095e+01	5.850e+01	7.794e-02	8.950e-02
0.15	4.788e+11	2.012e+04	2.247e+04	3.313e+01	3.700e+01
0.2	4.310e+12	2.429e+05	2.642e+05	4.288e+02	4.664e+02
0.3	1.349e+11	1.150e+04	1.226e+04	2.182e+01	2.325e+01
0.4	3.030e+11	3.465e+04	3.648e+04	6.751e+01	7.108e+01
0.5	1.834e+11	2.634e+04	2.751e+04	5.170e+01	5.401e+01
0.6	1.809e+11	3.128e+04	3.250e+04	6.105e+01	6.343e+01
0.8	2.073e+11	4.803e+04	4.953e+04	9.136e+01	9.420e+01
1.0	1.143e+11	3.324e+04	3.412e+04	6.127e+01	6.289e+01
1.5	2.014e+11	8.841e+04	9.014e+04	1.487e+02	1.517e+02
2.0	6.453e+11	3.791e+05	3.849e+05	5.862e+02	5.953e+02
3.0	4.916e+10	4.352e+04	4.401e+04	5.905e+01	5.971e+01
TOTALS:	8.790e+13	2.076e+06	2.323e+06	6.333e+03	7.357e+03

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: TM60-NG.MS5
Run Date: October 17, 2006
Run Time: 11:44:48 AM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: TMI 60 uCi/gm
Description: Containment High Rad Monitor WITH NOBLE GAS
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	914.4 cm	30 ft
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	917.448 cm	609.6 cm	609.6 cm
	30 ft 1.2 in	20 ft 0.0 in	20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	4.80e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	2.9631e+002	1.0963e+013	2.1800e-001	8.0661e+003
I-132	1.0792e+002	3.9931e+012	7.9400e-002	2.9378e+003
I-133	3.3437e+002	1.2372e+013	2.4600e-001	9.1020e+003
I-134	3.9145e+001	1.4484e+012	2.8800e-002	1.0656e+003
I-135	1.6039e+002	5.9343e+012	1.1800e-001	4.3660e+003
Kr-83m	3.3029e+000	1.2221e+011	2.4300e-003	8.9910e+001
Kr-85	8.9028e+001	3.2940e+012	6.5500e-002	2.4235e+003
Kr-85m	1.4679e+001	5.4314e+011	1.0800e-002	3.9960e+002
Kr-87	8.1145e+000	3.0024e+011	5.9700e-003	2.2089e+002
Kr-88	2.5145e+001	9.3038e+011	1.8500e-002	6.8450e+002
Xe-131m	2.3786e+001	8.8009e+011	1.7500e-002	6.4750e+002
Xe-133	2.5417e+003	9.4044e+013	1.8700e+000	6.9190e+004
Xe-133m	3.4524e+001	1.2774e+012	2.5400e-002	9.3980e+002
Xe-135	1.1608e+002	4.2948e+012	8.5400e-002	3.1598e+003
Xe-135m	2.9359e+000	1.0863e+011	2.1600e-003	7.9920e+001
Xe-138	4.2271e+000	1.5640e+011	3.1100e-003	1.1507e+002

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

DOS File: TM60-NG.MS5
Run Date: October 17, 2006
Run Time: 11:44:48 AM
Duration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	4.721e+13	3.596e+05	4.359e+05	3.564e+03	4.320e+03
0.08	3.480e+13	7.688e+05	9.025e+05	1.217e+03	1.428e+03
0.1	1.835e+09	5.095e+01	5.850e+01	7.794e-02	8.950e-02
0.15	5.575e+11	2.342e+04	2.616e+04	3.857e+01	4.308e+01
0.2	4.503e+12	2.538e+05	2.761e+05	4.480e+02	4.873e+02
0.3	1.237e+12	1.055e+05	1.124e+05	2.001e+02	2.132e+02
0.4	9.796e+12	1.120e+06	1.180e+06	2.183e+03	2.298e+03
0.5	1.271e+13	1.825e+06	1.906e+06	3.582e+03	3.742e+03
0.6	6.744e+12	1.166e+06	1.211e+06	2.276e+03	2.364e+03
0.8	8.113e+12	1.880e+06	1.938e+06	3.576e+03	3.687e+03
1.0	4.570e+12	1.329e+06	1.364e+06	2.450e+03	2.514e+03
1.5	4.507e+12	1.978e+06	2.017e+06	3.328e+03	3.393e+03
2.0	1.540e+12	9.049e+05	9.189e+05	1.399e+03	1.421e+03
3.0	4.916e+10	4.352e+04	4.401e+04	5.905e+01	5.971e+01
TOTALS:	1.363e+14	1.176e+07	1.233e+07	2.432e+04	2.597e+04

TMI (Thyroid DCF)

Isotope	C-1101-900-E000-087 Table 21 Activity Distribution (uCi/gm)	FGR 11 Thyroid DCF (Rem/Ci)	Normalized DCF	Normalized Activity Distribution (uCi/gm)	Isotopic Fraction	DE I-131 Conc (uCi/gm)	DE I-131 Conc. (uCi/gm)	Isotopic Concentration (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Containment Concentration (uCi/cc)
	AD	DCF	NDCF	NC	f	$DE_{(I-131)}$	DEI-131	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
I-131	0.8320	1.08E+06	1.00E+00	8.32E-01	0.830	0.35	2.90E-01	2.90E-01	2.52E+08	7.32E+07	5.660E+10	1.29E-03
I-132	0.3030	6.44E+03	5.96E-03	1.81E-03	0.002		6.30E-04	1.06E-01		2.66E+07		4.71E-04
I-133	0.9370	1.80E+05	1.66E-01	1.56E-01	0.156		5.44E-02	3.27E-01		8.24E+07		1.46E-03
I-134	0.1100	1.07E+03	9.86E-04	1.08E-04	0.000		3.79E-05	3.84E-02		9.67E+06		1.71E-04
I-135	0.4490	3.13E+04	2.90E-02	1.30E-02	0.013		4.54E-03	1.57E-01		3.95E+07		6.98E-04
				1.00E+00	1.000		3.50E-01					4.09E-03
I-131	0.8320	1.08E+06	1.00E+00	8.32E-01	0.830	60.0	4.98E+01	4.98E+01		1.25E+10		2.22E-01
I-132	0.3030	6.44E+03	5.96E-03	1.81E-03	0.002		1.08E-01	1.81E+01		4.57E+09		8.07E-02
I-133	0.9370	1.80E+05	1.66E-01	1.56E-01	0.156		9.33E+00	5.61E+01		1.41E+10		2.50E-01
I-134	0.1100	1.07E+03	9.86E-04	1.08E-04	0.000		6.49E-03	6.58E+00		1.66E+09		2.93E-02
I-135	0.4490	3.13E+04	2.90E-02	1.30E-02	0.013		7.78E-01	2.69E+01		6.77E+09		1.20E-01
				1.00E+00	1.000		6.00E+01					7.01E-01

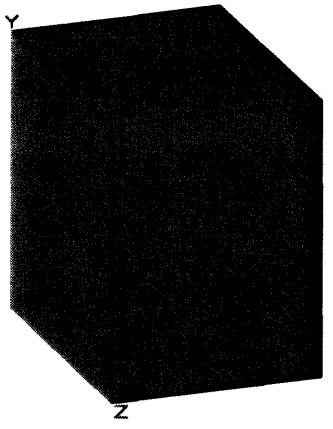
Isotope	C-1101-900-E000-087 Table 21 Noble Gas Activity (uCi/gm)	RCS Volume (gm)	Total Activity Released (uCi)	Free-Air Volume (cc)	Containment Concentration (uCi/cc)
	IC	$V_{(RCS)}$	A	$V_{(f)}$	AC
Kr-83m	5.45E-01	2.52E+08	1.37E+08	5.660E+10	2.43E-03
Kr-85m	2.43E+00		6.12E+08		1.08E-02
Kr-85	1.47E+01		3.71E+09		6.55E-02
Kr-87	1.34E+00		3.38E+08		5.97E-03
Kr-88	4.15E+00		1.05E+09		1.85E-02
Xe-131m	3.94E+00		9.93E+08		1.75E-02
Xe-133m	5.70E+00		1.44E+09		2.54E-02
Xe-133	4.19E+02		1.06E+11		1.87E+00
Xe-135m	4.85E-01		1.22E+08		2.16E-03
Xe-135	1.92E+01		4.83E+09		8.54E-02
Xe-138	6.99E-01		1.76E+08		3.11E-03

MicroShield v5.03 (5.03-00095)
PECO Energy

Page : 1
DOS File: TM60-NI.MS5
Run Date: October 24, 2006
Run Time: 1:33:50 PM
Duration: 00:00:02

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: TMI 60 uCi/gm
Description: Containment High Rad Monitor WITH NOBLE GAS (Thyroid DCF)
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	914.4 cm	30 ft
Width	1.2e+3 cm	40 ft 0.0 in
Height	1.2e+3 cm	40 ft 0.0 in

Dose Points

	X	Y	Z
# 1	917.448 cm	609.6 cm	609.6 cm
	30 ft 1.2 in	20 ft 0.0 in	20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	4.80e+04 ft³	Air	0.00122
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-131	3.0174e+002	1.1165e+013	2.2200e-001	8.2140e+003
I-132	1.0969e+002	4.0585e+012	8.0700e-002	2.9859e+003
I-133	3.3980e+002	1.2573e+013	2.5000e-001	9.2500e+003
I-134	3.9825e+001	1.4735e+012	2.9300e-002	1.0841e+003
I-135	1.6311e+002	6.0349e+012	1.2000e-001	4.4400e+003
Kr-83m	3.3029e+000	1.2221e+011	2.4300e-003	8.9910e+001
Kr-85	8.9028e+001	3.2940e+012	6.5500e-002	2.4235e+003
Kr-85m	1.4679e+001	5.4314e+011	1.0800e-002	3.9960e+002
Kr-87	8.1145e+000	3.0024e+011	5.9700e-003	2.2089e+002
Kr-88	2.5145e+001	9.3038e+011	1.8500e-002	6.8450e+002
Xe-131m	2.3786e+001	8.8009e+011	1.7500e-002	6.4750e+002
Xe-133	2.5417e+003	9.4044e+013	1.8700e+000	6.9190e+004
Xe-133m	3.4524e+001	1.2774e+012	2.5400e-002	9.3980e+002
Xe-135	1.1608e+002	4.2948e+012	8.5400e-002	3.1598e+003
Xe-135m	2.9359e+000	1.0863e+011	2.1600e-003	7.9920e+001
Xe-138	4.2271e+000	1.5640e+011	3.1100e-003	1.1507e+002

Buildup
The material reference is : Source

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

)OS File: TM60-NI.MS5
:un Date: October 24, 2006
:un Time: 1:33:50 PM
)uration: 00:00:02

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	4.722e+13	3.597e+05	4.360e+05	3.565e+03	4.321e+03
0.08	3.481e+13	7.689e+05	9.026e+05	1.217e+03	1.428e+03
0.1	1.835e+09	5.095e+01	5.850e+01	7.794e-02	8.950e-02
0.15	5.588e+11	2.348e+04	2.622e+04	3.866e+01	4.319e+01
0.2	4.507e+12	2.540e+05	2.763e+05	4.483e+02	4.876e+02
0.3	1.257e+12	1.072e+05	1.142e+05	2.033e+02	2.166e+02
0.4	9.970e+12	1.140e+06	1.200e+06	2.222e+03	2.339e+03
0.5	1.292e+13	1.854e+06	1.937e+06	3.640e+03	3.802e+03
0.6	6.854e+12	1.185e+06	1.231e+06	2.313e+03	2.403e+03
0.8	8.246e+12	1.911e+06	1.970e+06	3.635e+03	3.747e+03
1.0	4.646e+12	1.351e+06	1.387e+06	2.490e+03	2.556e+03
1.5	4.580e+12	2.010e+06	2.049e+06	3.382e+03	3.448e+03
2.0	1.556e+12	9.139e+05	9.280e+05	1.413e+03	1.435e+03
3.0	4.916e+10	4.352e+04	4.401e+04	5.905e+01	5.971e+01
TOTALS:	1.372e+14	1.192e+07	1.250e+07	2.463e+04	2.629e+04

Attachment 3
Additional Source Documents

FEDERAL GUIDANCE REPORT NO. 11

LIMITING VALUES OF RADIONUCLIDE INTAKE AND AIR CONCENTRATION AND DOSE CONVERSION FACTORS FOR INHALATION, SUBMERSION, AND INGESTION

Derived Guides for Control of Occupational Exposure and
Exposure-to-Dose Conversion Factors for General Application,
Based on the 1987 Federal Radiation Protection Guidance

Keith F. Eckerman, Anthony B. Wolbarst, and Allan C.B. Richardson

Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

Office of Radiation Programs
U.S. Environmental Protection Agency
Washington, DC 20460

1988

Second Printing, 1989
(with corrections)

Table 2.1. Inhalation, Cont'd.

Nuclide	Class/f_1	Committed Dose Equivalent per Unit Intake (Sv/Bq)							
		Gonad	Breast	Lung	R Marrow	B Surface	Thyroid	Remainder	Effective
Te-127	D 2 10^{-1}	6.63 10^{-12}	6.49 10^{-12}	2.77 10^{-10}	1.43 10^{-11}	1.44 10^{-11}	6.46 10^{-12}	9.74 10^{-11}	**6.74 10^{-11}**
	W 2 10^{-1}	2.02 10^{-12}	1.88 10^{-12}	4.27 10^{-10}	4.09 10^{-12}	4.09 10^{-12}	1.84 10^{-12}	1.11 10^{-10}	**8.60 10^{-11}**
Te-127m	D 2 10^{-1}	2.49 10^{-10}	2.43 10^{-10}	8.91 10^{-10}	1.37 10^{-8}	**5.24 10^{-8}**	2.39 10^{-10}	6.90 10^{-10}	3.64 10^{-9}
	W 2 10^{-1}	1.10 10^{-10}	1.10 10^{-10}	3.34 10^{-8}	5.36 10^{-9}	2.04 10^{-8}	9.66 10^{-11}	1.66 10^{-9}	**5.81 10^{-9}**
Te-129	D 2 10^{-1}	1.75 10^{-12}	1.68 10^{-12}	1.33 10^{-10}	1.97 10^{-12}	2.03 10^{-12}	1.63 10^{-12}	2.40 10^{-11}	**2.42 10^{-11}**
	W 2 10^{-1}	5.05 10^{-13}	5.39 10^{-13}	1.53 10^{-10}	6.19 10^{-13}	6.22 10^{-13}	5.09 10^{-13}	7.28 10^{-12}	**2.09 10^{-11}**
Te-129m	D 2 10^{-1}	4.12 10^{-10}	4.00 10^{-10}	2.16 10^{-9}	8.77 10^{-9}	2.01 10^{-8}	3.95 10^{-10}	1.47 10^{-9}	**2.53 10^{-9}**
	W 2 10^{-1}	1.78 10^{-10}	1.69 10^{-10}	4.03 10^{-8}	3.10 10^{-9}	7.05 10^{-9}	1.56 10^{-10}	3.27 10^{-9}	**6.47 10^{-9}**
Te-131	D 2 10^{-1}	6.14 10^{-12}	5.53 10^{-12}	2.54 10^{-10}	6.64 10^{-12}	6.21 10^{-12}	**2.63 10^{-9}**	5.42 10^{-11}	1.29 10^{-10}
	W 2 10^{-1}	2.17 10^{-12}	2.67 10^{-12}	2.99 10^{-10}	2.94 10^{-12}	2.61 10^{-12}	**2.66 10^{-9}**	2.21 10^{-11}	1.24 10^{-10}
Te-131m	D 2 10^{-1}	1.93 10^{-10}	1.15 10^{-10}	9.43 10^{-10}	2.39 10^{-10}	6.37 10^{-10}	**3.28 10^{-8}**	5.63 10^{-10}	1.38 10^{-9}
	W 2 10^{-1}	2.34 10^{-10}	9.25 10^{-11}	2.23 10^{-9}	1.41 10^{-10}	2.27 10^{-10}	**3.61 10^{-8}**	9.46 10^{-10}	1.73 10^{-9}
Te-132	D 2 10^{-1}	3.77 10^{-10}	3.52 10^{-10}	6.50 10^{-10}	4.95 10^{-10}	1.53 10^{-9}	**5.87 10^{-8}**	5.65 10^{-10}	2.26 10^{-9}
	W 2 10^{-1}	4.15 10^{-10}	3.63 10^{-10}	1.67 10^{-9}	4.27 10^{-10}	7.12 10^{-10}	**6.28 10^{-8}**	7.89 10^{-10}	2.55 10^{-9}
Te-133	D 2 10^{-1}	6.70 10^{-13}	8.48 10^{-13}	4.39 10^{-11}	8.39 10^{-13}	7.49 10^{-13}	**5.91 10^{-10}**	5.02 10^{-12}	2.49 10^{-11}
	W 2 10^{-1}	3.59 10^{-13}	6.05 10^{-13}	4.64 10^{-11}	5.83 10^{-13}	5.21 10^{-13}	**5.91 10^{-10}**	1.18 10^{-12}	2.39 10^{-11}
Te-133m	D 2 10^{-1}	8.97 10^{-12}	7.82 10^{-12}	1.82 10^{-10}	8.32 10^{-12}	6.94 10^{-12}	**2.61 10^{-9}**	4.14 10^{-11}	1.17 10^{-10}
	W 2 10^{-1}	3.39 10^{-12}	4.91 10^{-12}	2.06 10^{-10}	4.89 10^{-12}	4.13 10^{-12}	**2.63 10^{-9}**	1.43 10^{-11}	1.10 10^{-10}
Te-134	D 2 10^{-1}	9.00 10^{-12}	8.72 10^{-12}	6.02 10^{-11}	9.30 10^{-12}	8.58 10^{-12}	**5.54 10^{-10}**	1.88 10^{-11}	3.44 10^{-11}
	W 2 10^{-1}	7.90 10^{-12}	7.96 10^{-12}	6.60 10^{-11}	8.38 10^{-12}	7.78 10^{-12}	**5.56 10^{-10}**	1.09 10^{-11}	3.23 10^{-11}
Iodine									
I-120	D 1.0	1.07 10^{-11}	1.28 10^{-11}	4.33 10^{-10}	1.28 10^{-11}	1.17 10^{-11}	**1.55 10^{-9}**	5.02 10^{-11}	1.20 10^{-10}
I-120m	D 1.0	9.01 10^{-12}	1.23 10^{-11}	2.87 10^{-10}	1.22 10^{-11}	1.07 10^{-11}	5.84 10^{-10}	4.55 10^{-11}	**7.15 10^{-11}**
I-121	D 1.0	1.96 10^{-12}	3.53 10^{-12}	4.69 10^{-11}	3.44 10^{-12}	3.02 10^{-12}	**7.54 10^{-10}**	7.65 10^{-12}	3.21 10^{-11}
I-123	D 1.0	2.89 10^{-12}	4.87 10^{-12}	6.57 10^{-11}	5.97 10^{-12}	5.18 10^{-12}	**2.25 10^{-9}**	7.89 10^{-12}	8.01 10^{-11}
I-124	D 1.0	3.49 10^{-11}	1.15 10^{-10}	7.45 10^{-10}	8.63 10^{-11}	7.78 10^{-11}	**1.69 10^{-7}**	1.22 10^{-10}	5.23 10^{-9}
I-125	D 1.0	1.84 10^{-11}	9.25 10^{-11}	1.19 10^{-10}	4.41 10^{-11}	4.27 10^{-11}	**2.16 10^{-7}**	3.33 10^{-11}	6.53 10^{-9}
I-126	D 1.0	3.48 10^{-11}	1.37 10^{-10}	6.34 10^{-10}	9.84 10^{-11}	9.02 10^{-11}	**3.94 10^{-7}**	1.21 10^{-10}	1.20 10^{-8}
I-128	D 1.0	6.80 10^{-13}	7.15 10^{-13}	7.22 10^{-11}	7.17 10^{-13}	7.03 10^{-13}	5.34 10^{-11}	7.02 10^{-12}	**1.28 10^{-11}**
I-129	D 1.0	8.69 10^{-11}	2.09 10^{-10}	3.14 10^{-10}	1.40 10^{-10}	1.38 10^{-10}	**1.56 10^{-6}**	1.18 10^{-10}	4.69 10^{-8}
I-130	D 1.0	2.81 10^{-11}	4.87 10^{-11}	6.03 10^{-10}	4.55 10^{-11}	4.03 10^{-11}	**1.99 10^{-8}**	8.02 10^{-11}	7.14 10^{-10}
I-131	D 1.0	2.53 10^{-11}	7.88 10^{-11}	6.57 10^{-10}	6.26 10^{-11}	5.73 10^{-11}	**2.92 10^{-7}**	8.03 10^{-11}	8.89 10^{-9}
I-132	D 1.0	9.95 10^{-12}	1.41 10^{-11}	2.71 10^{-10}	1.40 10^{-11}	1.24 10^{-11}	**1.74 10^{-9}**	3.78 10^{-11}	1.03 10^{-10}
I-132m	D 1.0	6.48 10^{-12}	8.88 10^{-12}	1.77 10^{-10}	8.86 10^{-12}	7.95 10^{-12}	**1.65 10^{-9}**	2.01 10^{-11}	8.10 10^{-11}
I-133	D 1.0	1.95 10^{-11}	2.94 10^{-11}	8.20 10^{-10}	2.72 10^{-11}	2.52 10^{-11}	**4.86 10^{-8}**	5.00 10^{-11}	1.58 10^{-9}
I-134	D 1.0	4.25 10^{-12}	6.17 10^{-12}	1.43 10^{-10}	6.08 10^{-12}	5.31 10^{-12}	2.88 10^{-10}	2.27 10^{-11}	**3.55 10^{-11}**
I-135	D 1.0	1.70 10^{-11}	2.34 10^{-11}	4.41 10^{-10}	2.24 10^{-11}	2.01 10^{-11}	**8.46 10^{-9}**	4.70 10^{-11}	3.32 10^{-10}
Cesium									
Cs-125	D 1.0	1.46 10^{-12}	1.89 10^{-12}	6.36 10^{-11}	1.95 10^{-12}	1.76 10^{-12}	1.71 10^{-12}	8.46 10^{-12}	**1.12 10^{-11}**
Cs-127	D 1.0	7.12 10^{-12}	7.92 10^{-12}	5.98 10^{-11}	9.54 10^{-12}	8.40 10^{-12}	7.08 10^{-12}	1.38 10^{-11}	**1.59 10^{-11}**
Cs-129	D 1.0	3.04 10^{-11}	2.83 10^{-11}	1.08 10^{-10}	3.80 10^{-11}	3.40 10^{-11}	2.60 10^{-11}	3.93 10^{-11}	**4.29 10^{-11}**
Cs-130	D 1.0	7.83 10^{-13}	1.02 10^{-12}	4.82 10^{-11}	1.04 10^{-12}	9.41 10^{-13}	9.28 10^{-13}	5.84 10^{-12}	**8.07 10^{-12}**
Cs-131	D 1.0	3.77 10^{-11}	3.30 10^{-11}	7.29 10^{-11}	6.21 10^{-11}	5.58 10^{-11}	3.00 10^{-11}	3.95 10^{-11}	**4.50 10^{-11}**
Cs-132	D 1.0	3.20 10^{-10}	2.69 10^{-10}	4.20 10^{-10}	3.17 10^{-10}	2.87 10^{-10}	2.73 10^{-10}	3.54 10^{-10}	**3.32 10^{-10}**
Cs-134	D 1.0	1.30 10^{-8}	1.08 10^{-8}	1.18 10^{-8}	1.18 10^{-8}	1.10 10^{-8}	1.11 10^{-8}	1.39 10^{-8}	**1.25 10^{-8}**
Cs-134m	D 1.0	3.61 10^{-12}	3.39 10^{-12}	6.40 10^{-11}	3.76 10^{-12}	3.55 10^{-12}	3.34 10^{-12}	6.90 10^{-12}	**1.18 10^{-11}**

Dose Conversion Factors **(Effective DCF)**

This table converts FGR 11 Dose Conversion factors from Sv/Bq to Rem/Ci as used in the calculation. Though the ratios remain the same, the conversion was done for ease of understanding the units.

Isotope	FGR 11 Table 2.1 Inhalation DCF Column Effective (Sv/Bq)	(Bq/Ci)	(Rem/Sv)	(Rem/Ci)
I-131	8.89E-09	3.70E+10	100	3.29E+04
I-132	1.03E-10			3.81E+02
I-133	1.58E-09			5.85E+03
I-134	3.55E-11			1.31E+02
I-135	3.32E-10			1.23E+03

$$\left(\frac{Sv}{Bq}\right)_i * \frac{Bq}{Ci} * \frac{\mathrm{Re}\,m}{Sv} = \left(\frac{\mathrm{Re}\,m}{Ci}\right)_i$$

Dose Conversion Factors **(Thyroid DCF)**

This table converts FGR 11 Dose Conversion factors from Sv/Bq to Rem/Ci as used in the calculation. Though the ratios remain the same, the conversion was done for ease of understanding the units.

Isotope	FGR 11 Table 2.1 Inhalation DCF Column Thyroid (Sv/Bq)	(Bq/Ci)	(Rem/Sv)	(Rem/Ci)
I-131	2.92E-07	3.70E+10	100	1.08E+06
I-132	1.74E-09			6.44E+03
I-133	4.86E-08			1.80E+05
I-134	2.88E-10			1.07E+03
I-135	8.46E-09			3.13E+04

$$\left(\frac{Sv}{Bq}\right)_i * \frac{Bq}{Ci} * \frac{\mathrm{Re}\,m}{Sv} = \left(\frac{\mathrm{Re}\,m}{Ci}\right)_i$$

U.S. NUCLEAR REGULATORY COMMISSION

July 2000

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 1.183

(Draft was issued as DG-1081)

ALTERNATIVE RADIOLOGICAL SOURCE TERMS FOR EVALUATING DESIGN BASIS ACCIDENTS AT NUCLEAR POWER REACTORS

Regulatory guides are issued to describe and make available to the public such information as methods acceptable to the NRC staff for implementing specific parts of the NRC's regulations, techniques used by the staff in evaluating specific problems or postulated accidents, and data needed by the NRC staff in its review of applications for permits and licenses. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public. Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience. Written comments may be submitted to the Rules and Directives Branch, ADM, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

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3.6 Fuel Damage in Non-LOCA DBAs

The amount of fuel damage caused by non-LOCA design basis events should be analyzed to determine, for the case resulting in the highest radioactivity release, the fraction of the fuel that reaches or exceeds the initiation temperature of fuel melt and the fraction of fuel elements for which the fuel clad is breached. Although the NRC staff has traditionally relied upon the departure from nucleate boiling ratio (DNBR) as a fuel damage criterion, licensees may propose other methods to the NRC staff, such as those based upon enthalpy deposition, for estimating fuel damage for the purpose of establishing radioactivity releases.

The amount of fuel damage caused by a FHA is addressed in Appendix B of this guide.

4. DOSE CALCULATIONAL METHODOLOGY

The NRC staff has determined that there is an implied synergy between the ASTs and total effective dose equivalent (TEDE) criteria, and between the TID-14844 source terms and the whole body and thyroid dose criteria, and therefore, they do not expect to allow the TEDE criteria to be used with TID-14844 calculated results. The guidance of this section applies to all dose calculations performed with an AST pursuant to 10 CFR 50.67. Certain selective implementations may not require dose calculations as described in Regulatory Position 1.3 of this guide.

4.1 Offsite Dose Consequences

The following assumptions should be used in determining the TEDE for persons located at or beyond the boundary of the exclusion area (EAB):

4.1.1 The dose calculations should determine the TEDE. TEDE is the sum of the committed effective dose equivalent (CEDE) from inhalation and the deep dose equivalent (DDE) from external exposure. The calculation of these two components of the TEDE should consider all radionuclides, including progeny from the decay of parent radionuclides, that are significant with regard to dose consequences and the released radioactivity.[13]

4.1.2 The exposure-to-CEDE factors for inhalation of radioactive material should be derived from the data provided in ICRP Publication 30, "Limits for Intakes of Radionuclides by Workers" (Ref. 19). Table 2.1 of Federal Guidance Report 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" (Ref. 20), provides tables of conversion factors acceptable to the NRC staff. The factors in the column headed "effective" yield doses corresponding to the CEDE.

4.1.3 For the first 8 hours, the breathing rate of persons offsite should be assumed to be 3.5×10^{-4} cubic meters per second. From 8 to 24 hours following the accident, the breathing rate should be assumed to be 1.8×10^{-4} cubic meters per second. After that and until the end of the accident, the rate should be assumed to be 2.3×10^{-4} cubic meters per second.

[13] The prior practice of basing inhalation exposure on only radioiodine and not including radioiodine in external exposure calculations is not consistent with the definition of TEDE and the characteristics of the revised source term.