Industrial Use Scenario with Open Drinking Water Pathway: An Assessment of Impact on BFM $DCGL_{w/f}$ Values

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Prepared by: _____
Joseph Bisson, Technical Consultant

Reviewed by: _____
William Parish, CHP, Sr. Health Physicist

Approved by: _____
Christopher C. Messier, Sr. Director of Engineering and Strategic Development

Radiation Safety & Control Services, Inc
93 Ledge Road,
Seabrook, NH 03874
1-800-525-8339
(603) 778-2871 (Outside USA)
www.radsafety.com

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1 Introduction

This report is an assessment of impact that an open drinking water exposure pathway under the Industrial Use (IU) scenario has on the DCGL values for concrete foundation walls and floors (i.e., $DCGL_{W/F}$ values).

The IU scenario with an open drinking water pathway is considered a "less likely but plausible" exposure scenario for the OCNGS site for the following reasons:

- The Lacey Ordinance #93-31, which requires the owner the site to connect to the town waterline and discontinue and disconnect any water service from a water well located on his or her property.
- The groundwater Classification Exception Area (CEA) delineated across a major portion of the site.

The open drinking water pathway for the IU scenario assumes that (i) Lacy Ordinance #93-31 and CEA delineation are ignored, (ii) untreated contaminated site groundwater (GW) is the sole source of drinking water available to the hypothetical receptor (a site industrial worker) while onsite, (iii) the GW used as drinking water is drawn from a well located at the downstream edge of the contamination zone (i.e., the point of highest groundwater contamination), (iv) the radioactive contamination levels in GW remain constant, and (v) the receptor ingests 478.5 liters of GW during an employment year.

The $DCGL_{W/F}$ values incorporate 3 sub-scenarios: instantaneous release (IR), drilling spoils (DS), and excavated concrete (EC). Details for these scenarios are found in TSD 24-063 [1].

RESRAD-Onsite v7.2 [2] was used to calculate probabilistic annual doses. The exposure pathways assumed open are:

- Direct external radiation exposure
- Inhalation exposure
- Aquatic food ingestion exposure
- Inadvertent ingestion of contaminated soil
- Ingestion of GW as the source of drinking water

The $DCGL_{W/F}$ values developed in this document correspond to the NRC dose criteria established in 10CFR20.1403 (i.e., 25 mrem/y). This calculation addresses only the development of BFM $DCGL_{W/F}$ values for the OCNGS site.

A site-specific suite of potential radionuclides-of-concern (ROCs) has been identified for the OCNGS site [3] and is listed in Table 1. RESRAD-Onsite 7.2 automatically accounts for progeny radionuclides with input for several of the ROCs. Progeny radionuclides are also listed in Table 1.

Table 1: Potential Radionuclides of Concern Identified for the OCNGS Site

ROC	Progeny	ROC	Progeny
Am-241	Np-237, Th-229, U-233	Nb-94	---
C-14	---	Ni-63	---
Cm-243	Ac-227, Am-243, Pa-231, Pu-239, U-235	Np-237	Th-229, U-233
Cm-244	Pu-240, Ra-228, Th-228, Th-232, U-236	Pu-238	Pb-210, Po-210, Ra-226, Th-230, U-234
Cs-137	---	Pu-239	Ac-227, Pa-231, U-235
Co-60	---	Pu-240	Ra-228, Th-228, Th-232, U-236
Eu-152	Gd-152	Pu-241	Am-241, Np-237, Th-229, U-233
Eu-154	---	Sb-125	Te-125m
Fe-55	---	Sr-90	---
H-3	---	Tc-99	---
Mn-54	---		

Each of the 3 sub-scenarios is described and evaluated separately in this calculation. Radionuclide-specific DCGL values are calculated for each scenario and combined to produce the final $DCGL_{W/F}$ values.

IR scenario: Calculations for $DCGL_{IR}$ values assumed the site modeling described in TSD 24-063. Except for the 25th or 75th percentile values for risk-sensitive parameters (documented in TSD 24-055 [4]) and the input required for the drinking water exposure pathway, input values for RESRAD-Onsite parameters are the same as those used in the probabilistic analysis.

DS and EC scenarios: Calculations for $DCGL_{DS}$ and $DCGL_{EC}$ values are based on contaminated volume/area calculations with application of peak of the means (POM) doses and DCGL values documented in TSD 24-063 and soil area factors (AFs) documented in ENG-OCS-009 [5].

2 Input and Calculations

Input for the well pumping rate was determined using the method found in NUREG/CR-7267 with consideration only to drinking water (annual volume obtained from NUREG/CR-7267 [6]).

GW Use Component	GW Use (m^3/y)
Household	NA
Livestock	NA
Irrigation Water	NA
Drinking Water	1.64
Total, m^3/y	1.64

2.1 $DCGL_{IR}$ Calculations

The IR scenario assumes a contaminated volume (CV) is created by an instantaneous release of radioactive contamination from sub-surface concrete surfaces to fill material immediately within 1m from the concrete surfaces. RESRAD-Onsite modeling assumes that the CV is a homogenous mixture, covered by 3ft (0.91m) of site soil, and extends to a depth of the Reactor Building foundation, 43ft (13.1m). Modeling places portions of the CV above and below the average groundwater table. The below-grade concrete structures are assumed not to impede groundwater flow. The conceptual configuration of the contaminated zone (CZ) created by the CV is shown in Figure 1.

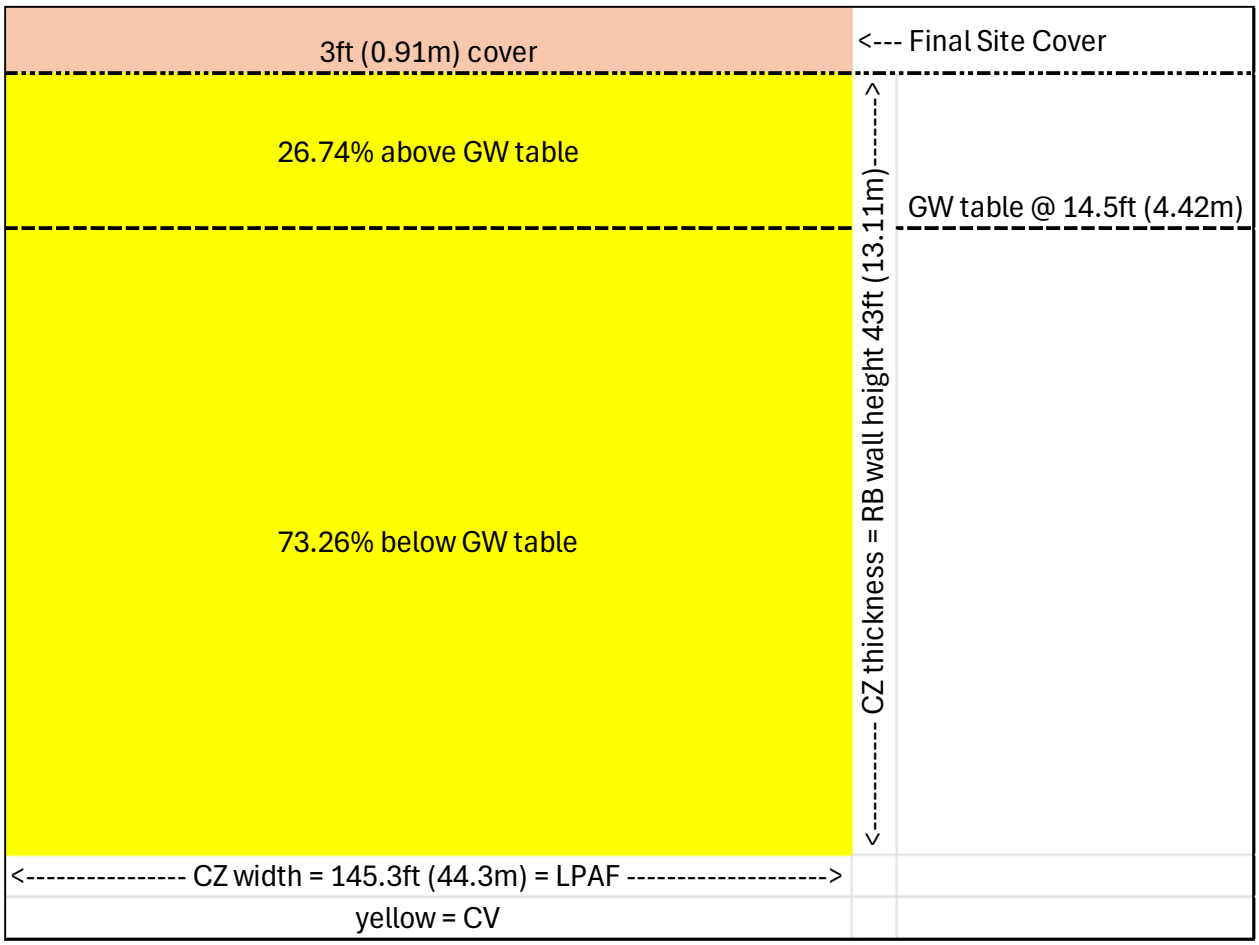

Figure 1 Conceptual Configuration of the CV

The probabilistic mode of the RESRAD-Onsite code was used to calculate ROC-specific "peak of the mean" (POM) doses associated with soil concentrations equal to 1 pCi/g. The POM doses were then used to develop $DCGL_{IR}$ values.

The value and basis for each RESRAD-Onsite parameter are provided in Table 2.

Table 2. Input Values for RESRAD-Onsite Parameters: IU BFM IR Scenario with Open Drinking Water Pathway

Table 2. Input Values for RESRAD-Onsite Parameters: IU BFM IR Scenario with Open Drinking Water Pathway										
Parameter (unit)	**Type**	**Priority**	**Treatment**	**Value/Distribution**	**Basis**	**Distribution's Statistical Parameters**				**Median/ Mean**
						1	**2**	**3**	**4**	
Soil Concentrations										
Basic radiation dose limit (mrem/y)	P	3	D	25	10 CFR 20.1402					
Initial principal radionuclide (pCi/g)	P	2	D	1	Unit Value					
Distribution coefficients (cm^3/g) for sand soil type assigned to CZ and SZ except as noted										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.44	1.1	0.001	0.999	1700
Am-241	P	1	D	2.69E+02	25th percentile value					
Am-243	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	6.91	1.95	0.001	0.999	1000
C-14	P	1	D	6.13E+00	25th percentile value					
Cm-243	P	1	D S	5.74E+02 (CZ) Truncated lognormal-n (SZ)	25th percentile value ANL/EVS/TM-14/4	8.13	2.64	0.001	0.999	3400
Cm-244	P	1	D S	5.74E+02 (CZ) Truncated lognormal-n (SZ)	25th percentile value ANL/EVS/TM-14/4	8.13	2.64	0.001	0.999	3400
Co-60	P	1	D	3.71E+01	25th percentile value					
Cs-137	P	1	D	1.58E+02	25th percentile value					
Eu-152	P	1	D	6.40E+01	25th percentile value					
Eu-154	P	1	D	6.40E+01	25th percentile value					
Fe-55	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	5.77	0	0.001	0.999	320
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.61	3.22	0.001	0.999	5
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.81	0.5	0.001	0.999	0.06
Mn-54	P	1	D	1.66E+02	25th percentile value					
Nb-94	P	1	D S	3.81E+03 (CZ) Truncated lognormal-n (SZ)	75th percentile value NUREG/CR-7267	7.31	1.39	0.001	0.999	1500
Ni-63	P	1	D	2.77E+01	25th percentile value					
Np-237	P	1	D	5.49E+00	25th percentile value					
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.6	1.1	0.001	0.999	2000
Pb-210	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	5.39	1.39	0.001	0.999	220
Po-210	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	4.61	1.79	0.001	0.999	100
Pu-238	P	1	D	1.56E+02	25th percentile value					
Pu-239	P	1	D	1.56E+02	25th percentile value					
Pu-240	P	1	D	1.56E+02	25th percentile value					
Pu-241	P	1	D	1.57E+02	25th percentile value					
Ra-226	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	8.04	2.08	0.001	0.999	3100
Ra-228	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	8.04	2.08	0.001	0.999	3100

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Parameter (unit)	**Type**	**Priority**	**Treatment**	**Value/Distribution**	**Basis**	**Distribution's Statistical Parameters**				**Median/ Mean**
						1	**2**	**3**	**4**	
Sb-125	P	1	D	5.07E+00 (CZ)	25th percentile value					
			S	Truncated lognormal-n (SZ)	ANL/EVS/TM-14/4	2.83	1.79	0.001	0.999	17
Sr-90	P	1	D	6.58E+00	25th percentile value					
Tc-99	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	-3.22	1.1	0.001	0.999	0.04
Te-125m	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.31	3.22	0.001	0.999	550
Th-228	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	6.55	2.4	0.001	0.999	700
Th-229	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	6.55	2.4	0.001	0.999	700
Th-230	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	6.55	2.4	0.001	0.999	700
Th-232	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	6.55	2.4	0.001	0.999	700
U-233	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	4.7	2.48	0.001	0.999	110
U-234	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	4.7	2.48	0.001	0.999	110
U-235	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	4.7	2.48	0.001	0.999	110
U-236	P	1	S	Truncated lognormal-n	ANL/EVS/TM-14/4	4.7	2.48	0.001	0.999	110
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	Ground water uncontaminated					
Calculation Times										
Time since placement of material (y)	P	3	D	0						
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default					
Contaminated Zone										
Area of contaminated zone (m^2)	P	2	D	1539.6	Based on contaminated volume and height of RB wall.					
Thickness of contaminated zone (m)	P	2	D	13.1	CZ thickness set to RB wall height.					
Length parallel to aquifer flow (m)	P	2	D	44.3	Set to diameter of CZ.					
Does the initial contamination penetrate the water table?				Yes	Based on site features and RB dimensions.					
Contaminated fraction below water table			D	.7326	Based on OCGS site data; average groundwater depths recorded for wells around the RB, TB, and ORB..					
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	0.91	3ft cover assumed.					

**Table 2. Input Values for RESRAD-Onsite Parameters:
IU BFM IR Scenario with Open Drinking Water Pathway**

Parameter (unit)	Type	Priority	Treatment	Value/Distribution	Basis	Distribution's Statistical Parameters				Median/ Mean
						1	2	3	4	
Cover density (g/cm^3)	P	2	D S	1.40E+00 (Co-60, Cs-137, Eu-152, Eu-154, Mn-54, Nb-94, Sb-125) Truncated Normal (all other ROCs)	25^{th} percentile value Site soil type = sand (OCNGS *Hydrogeologic Investigation Report*). Input for density of fill material = NUREG/CR-7267 density distribution for site soil type - **s**and.	1.5105	0.159	0.001	0.999	1.5105
Cover erosion rate (m/y)	P	2	D	6E-04	Assumed final site grade is level. Input for erosion rate = NUREG/CR-7267 erosion rate for site with shallow slope (i.e., relatively level)					
Density of contaminated zone (g/cm^3)	P	1	S	Truncated Normal	Site soil type = sand (OCNGS *Hydrogeologic Investigation Report*). Input for density of fill material = NUREG/CR-7267 density distribution for site soil type - **s**and.	1.5105	0.159	0.001	0.999	1.5105
Contaminated zone erosion rate (m/y)	P	2	D	6E-04	Assumed same as cover.					
Contaminated zone total porosity	P	2	S	Bounded Normal	NUREG/CR-7267 distribution for site soil type -**s**and	0.43	0.06	0.2446	0.6154	0.43
Contaminated zone field capacity	P	3	D	0.18	Value based on site-specific soil type (**s**and**)**; calculated using equation in NUREG/CR-7267					
Contaminated zone hydraulic conductivity (m/y)	P	2	D	2741	OCNGS *Hydrogeologic Investigation Report*					
Contaminated zone b parameter	P	2	S	Bounded Log Normal n	NUREG/CR-7267 distribution for site soil type - **s**and	- 0.0253	0.216	0.501	1.90	0.975
Humidity in air (g/m^3)	P	3	D	6.6	From *Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations*.					
Evapotranspiration coefficient	P	2	D S	5.62E-01 (Fe-55) Uniform (all other ROCs)	25^{th} percentile value NUREG/CR-7267 distribution	0.5	0.75	NR	NR	0.625
Average annual wind speed (m/s)	P	2	D	3.13	Internet search: https://www.windfinder.com/windstatistics/oyster_creek_barnegat_bay					

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Parameter (unit)	Type	Priority	Treatment	Value/Distribution	Basis	Distribution's Statistical Parameters				Median/ Mean
						1	2	3	4	
Precipitation (m/y)	P	2	D	1.4	*Annual Report on the Meteological Program at Oyster Creek Generating Station* – average annual precipitation for 2015 through 2020					
Irrigation (m/y)	B	3	S	Uniform	Distribution determined using methodology described in *Data Collection Handbook* and NUREG/CR-6697	0	0.08			0.04
Irrigation mode	B	3	D	Overhead	Overhead irrigation is common practice for crops in U.S.					
Runoff coefficient	P	2	D	0.2	Value determined using methodology described in *Data Collection Handbook* and NUREG/CR-7267					
Watershed area for nearby stream or pond (m^2)	P	3	D	1.01E+08	NJ-GeoWeb (NJDEP BGIS)					
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	1	S	Truncated Normal	NUREG/CR-7267 distribution for site soil type -**s**and	1.5105	0.159	0.001	0.999	1.5105
Saturated zone total porosity	P	1	S	Truncated Normal	NUREG/CR-7267 distribution for site soil type -**s**and	0.43	0.06	0.001	0.999	0.43
Saturated zone effective porosity	P	1	D	0.25	OCNGS *Hydrogeologic Investigation Report*					
Saturated zone field capacity	P	3	D	0.18	Value based on site-specific soil type **(s**and); calculated using equation in NUREG/CR-7267					
Saturated zone hydraulic conductivity (m/y)	P	1	D	2741	OCNGS *Hydrogeologic Investigation Report*					
Saturated zone hydraulic gradient	P	2	D	1.75E-02 (H-3, Nb-94, Tc-99)	25th percentile value					
			S	Uniform (all other ROCs)	OCNGS *Hydrogeologic Investigation Report*	0.01	0.04			0.025
Saturated zone b parameter	P	2	S	N/A	Input not required when CZ is in SZ					
Water table drop rate (m/y)	P	3	D	0	CZ in SZ					
Well pump intake depth (m below water table)	P	2	D	9.6	Input has no impact because drinking water exposure pathway is not an open pathway.					

Table 2. Input Values for RESRAD-Onsite Parameters: IU BFM IR Scenario with Open Drinking Water Pathway										
Parameter (unit)	**Type**	**Priority**	**Treatment**	**Value/Distribution**	**Basis**	**Distribution's Statistical Parameters**				**Median/ Mean**
						1	**2**	**3**	**4**	
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	ND model recommended for contaminant areas >1,000 m^2					
Well pumping rate (m^3/y)	P	2	S	1.64						
Unsaturated Zone Hydrological Data										
Unsaturated zones	P	3	D	0	See Figure 1 below					
Unsat. zone 1, thickness (m)	P	1	D	N/A	UZ strata set to 0; input for UZ parameters not used.					
Unsat. zone 1, soil density (g/cm^3)	P	2	S	N/A	UZ strata set to 0; input for UZ parameters not used.					
Unsat. zone 1, total porosity	P	2	S	N/A	UZ strata set to 0; input for UZ parameters not used.					
Unsat. zone 1, effective porosity	P	2	D	N/A	UZ strata set to 0; input for UZ parameters not used.					
Unsat. zone 1, field capacity	P	3	D	N/A	UZ strata set to 0; input for UZ parameters not used.					
Unsat. zone 1, hydraulic conductivity (m/y)	P	2	D	N/A	UZ strata set to 0; input for UZ parameters not used.					
Unsat. zone 1, soil-specific b parameter	P	2	S	N/A	UZ strata set to 0; input for UZ parameters not used.					
Occupancy										
Inhalation rate (m^3/y)	B	3	D	8400	NUREG/CR-7267					
Mass loading for inhalation (g/m^3)	P	2	S	Continuous linear	NUREG/CR-7267					2.3E-5
Exposure duration	B	3	D	30	RESRAD Default					
Indoor dust filtration factor	P	2	S	Uniform	NUREG/CR-7267	0.15	0.95			0.55
Shielding factor, external gamma	P	2	S	Bounded lognormal-n	NUREG/CR-7267	-1.3	0.59	0.044	1	0.2725
Fraction of time spent indoors	B	3	D	0.03	Fraction of calendar year assuming 1h/work day for daily work breaks					
Fraction of time spent outdoors	B	3	D	0.2	Fraction of calendar year assuming 7h/work day for outside tasks					
Shape factor flag, external gamma	P	3	D	Circular	Circular contaminated zone assumed					
Ingestion, Dietary										
Fruits, vegetables, grain consumption (kg/y)	B	2	D	N/A	Input not required - plant ingestion pathway inactive					
Leafy vegetable consumption (kg/y)	B	3	D	N/A	Input not required - plant ingestion pathway inactive					
Milk consumption (L/y)	B	2	D	N/A	Input not required - milk ingestion pathway inactive					
Meat and poultry consumption (kg/y)	B	3	D	N/A	Input not required - meat ingestion pathway inactive					
Fish consumption (kg/y)	B	3	D	20.6	NUREG/CR-5512, Vol. 3					
Other seafood consumption (kg/y)	B	3	D	0.9	RESRAD Default					

**Table 2. Input Values for RESRAD-Onsite Parameters:
IU BFM IR Scenario with Open Drinking Water Pathway**

Parameter (unit)	Type	Priority	Treatment	Value/Distribution	Basis	Distribution's Statistical Parameters				Median/ Mean
						1	2	3	4	
Soil ingestion rate (g/yr)	B	2	D	Triangular	NUREG/CR-7267	0	18.3	36.5		18.3
Drinking water intake (L/y)	B	2	D	478.5	NUREG/CR-5512					
Contamination fraction of drinking water	P	3	D	1.0	RESRAD default – all DW from GW					
Contamination fraction of household water	P	3		N/A	Input not required – water pathway inactive					
Contamination fraction of livestock water	P	3	D	N/A	Input not required – drinking water/ingestion pathways inactive					
Contamination fraction of irrigation water	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Contamination fraction of aquatic food	P	2	D S	6.10E-01 (All ROCs except the 5 ROCs listed for distribution below) Triangular (Co-60, Eu-152, Eu-154, Mn-54, Nb-94)	75th percentile value NUREG/CR-7267	0	0.39	1.0		0.39
Contamination fraction of plant food	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Contamination fraction of meat	P	3	D	N/A	Input not required – meat ingestion pathway inactive					
Contamination fraction of milk	P	3	D	N/A	Input not required – milk ingestion pathway inactive					
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/d)	M	3	D	N/A	Input not required – meat ingestion pathway inactive					
Livestock fodder intake for milk (kg/d)	M	3	D	N/A	Input not required – milk ingestion pathway inactive					
Livestock water intake for meat (L/d)	M	3	D	N/A	Input not required – water ingestion pathway inactive					
Livestock water intake for milk (L/d)	M	3	D	N/A	Input not required – milk ingestion pathway inactive					
Livestock soil intake (kg/d)	M	3	D	N/A	Input not required – meat ingestion pathway inactive					
Mass loading for foliar deposition (g/m^3)	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Depth of soil mixing layer (m)	P	2	S	Triangular	NUREG/CR-7267	0	0.15	0.6		0.23
Depth of roots (m)	P	1	S	N/A	Input not required – plant ingestion pathway inactive	0.3	4			1.85
Drinking water fraction from ground water	P	3	D	1.0	All DW from GW					
Household water fraction from ground water	P	3		N/A	Input not required – drinking water pathway inactive					
Livestock water fraction from ground water	P	3	D	N/A	Input not required – drinking water/meat ingestion pathways inactive					

Table 2. Input Values for RESRAD-Onsite Parameters: IU BFM IR Scenario with Open Drinking Water Pathway										
Parameter (unit)	**Type**	**Priority**	**Treatment**	**Value/Distribution**	**Basis**	**Distribution's Statistical Parameters**				**Median/ Mean**
						1	**2**	**3**	**4**	
Irrigation fraction from ground water	P	3	D	N/A	Input not required – drinking water pathway inactive					
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	S	N/A	Input not required – plant ingestion pathway inactive	0.56	0.48	0.001	0.999	1.75
Wet weight crop yield for Leafy (kg/m^2)	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	N/A	Input not required – meat ingestion pathway inactive					
Growing Season for Non-Leafy (y)	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Growing Season for Leafy (y)	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Growing Season for Fodder (y)	P	3	D	N/A	Input not required – meat ingestion pathway inactive					
Translocation Factor for Non-Leafy	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Translocation Factor for Leafy	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Translocation Factor for Fodder	P	3	D	N/A	Input not required – meat ingestion pathway inactive					
Weathering Removal Constant for Vegetation (1/y)	P	2	S	N/A	Input not required – plant ingestion pathway inactive	5.1	18	84		33
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Wet Foliar Interception Fraction for Leafy	P	2	S	N/A	Input not required – plant ingestion pathway inactive	0.06	0.67	0.95		0.58
Wet Foliar Interception Fraction for Fodder	P	3	D	N/A	Input not required – meat ingestion pathway inactive					
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Dry Foliar Interception Fraction for Leafy	P	3	D	N/A	Input not required – plant ingestion pathway inactive					
Dry Foliar Interception Fraction for Fodder	P	3	D	N/A	Input not required – meat ingestion pathway inactive					
Storage times of contaminated foodstuffs (days)										
Fruits, non-leafy vegetables, and grain	B	3	D	N/A	Input not required – plant ingestion pathway inactive					
Leafy vegetables	B	3	D	N/A	Input not required – plant ingestion pathway inactive					
Milk	B	3	D	N/A	Input not required – milk ingestion pathway inactive					
Meat and poultry	B	3	D	N/A	Input not required – meat ingestion pathway inactive					
Fish	B	3	D	7	RESRAD Default					
Crustacea and mollusks	B	3	D	7	RESRAD Default					
Well water	B	3	D	1	RESRAD default					

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IU BFM IR Scenario with Open Drinking Water Pathway**

Parameter (unit)	Type	Priority	Treatment	Value/Distribution	Basis	Distribution's Statistical Parameters				Median/ Mean
						1	2	3	4	
Surface water	B	3	D	N/A	Input not required drinking water pathway inactive					
Livestock fodder	B	3	D	N/A	Input not required – meat ingestion pathway inactive					
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	2.00E-05	RESRAD Default					
C-12 concentration in contaminated soil (g/g)	P	3	D	3.00E-02	RESRAD Default					
Fraction of vegetation carbon from soil	P	3	D	2.00E-02	RESRAD Default					
Fraction of vegetation carbon from air	P	3	D	9.80E-01	RESRAD Default					
C-14 evasion layer thickness in soil (m)	P	2	S	Triangular	NUREG/CR-7267	0.2	0.3	0.6		0.3
C-14 evasion flux rate from soil (1/s)	P	3	D	7.00E-07	RESRAD Default					
C-12 evasion flux rate from soil (1/s)	P	3	D	1.00E-10	RESRAD Default					
Fraction of grain in beef cattle feed	B	3	D	0.2500	NUREG/CR-7267					
Fraction of grain in milk cow feed	B	3	D	0.1000	NUREG/CR-7267					
Inhalation Dose Conversion Factors (mrem/pCi inhaled) from FGR11 (contained in RESRAD Dose Conversion Factor Library)										
Ingestion Dose Conversion Factors (mrem/pCi ingested) from FGR11 (contained in RESRAD Dose Conversion Factor Library)										
Plant Transfer Factors (pCi/g plant)/(pCi/g soil) Note: Plant ingestion pathway closed – input for plant transfer factors not required for Industrial Use dose calculations.										
Meat Transfer Factors (pCi/kg)/(pCi/d) Note: Meat ingestion pathway closed – input for meat transfer factors not required for Industrial Use dose calculations.										
Milk Transfer Factors (pCi/L)/(pCi/d) Note: Milk ingestion pathway closed – input for milk transfer factors not required for Industrial Use dose calculations.										
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.5E+01
Am-241	P	2	D	5.14E+02	75th percentile value					
Am-243	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4E+02
C-14	P	2	D	9.28E+05	75th percentile value					
Cm-243	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Cm-244	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Co-60	P	2	S	Lognormal-n	NUREG/CR-7267	4.3	0.9			7.4E+01
Cs-137	P	2	D	4.47E+03	75th percentile value					
Eu-152	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Eu-154	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Fe-55	P	2	D	5.90E+02	75th percentile value					
Gd-152	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
H-3	P	2	D	1.07E+00	75th percentile value					
Mn-54	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.9			2.4E+02

Table 2. Input Values for RESRAD-Onsite Parameters: IU BFM IR Scenario with Open Drinking Water Pathway										
Parameter (unit)	Type	Priority	Treatment	Value/Distribution	Basis	Distribution's Statistical Parameters				Median/ Mean
						1	2	3	4	
Nb-94	P	2	S	Lognormal-n	NUREG/CR-7267	5.7	1.1			3.0E+02
Ni-63	P	2	D	3.01E+01	75th percentile value					
Np-237	P	2	D	4.21E+01	75th percentile value					
Pa-231	P	2	S	Lognormal-n	NUREG/CR-7267	2.3	1.1			1.0E+01
Pb-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.5E+02
Po-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.6	1.5			3.7E+01
Pu-238	P	2	D	4.32E+04	75th percentile value					
Pu-239	P	2	D	4.32E+04	75th percentile value					
Pu-240	P	2	D	4.32E+04	75th percentile value					
Pu-241	P	2	D	4.32E+04	75th percentile value					
Ra-226	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Ra-228	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Sb-125	P	2	D	1.00E+02	75th percentile value					
Sr-90	P	2	D	7.71E+00	75th percentile value					
Tc-99	P	2	D	4.21E+01	75th percentile value					
Te-12m	P	2	S	Lognormal-n	NUREG/CR-7267	5.0	0.4			1.5E+02
Th-228	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-229	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-230	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
U-233	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-234	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-235	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-236	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
Bioaccumulation Factors for Crustacea/ Mollusks ((pCi/kg)/(pCi/L)) RESRAD default value for each radionuclide applied										
Graphics Parameters										
Number of points				32	RESRAD Default					
Spacing				Log	RESRAD Default					
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default					

In addition to the RESRAD-Onsite results, calculations of the ROC-specific $DCGL_{IR}$ values relied on 2 other calculations. The first is the calculation of the activity concentrations in fill material (pCi/g) that corresponded to surface activity concentrations equal to 1 pCi/m^2. This was accomplished using the following equation:

$$C_{fill} = A_s/((V_{fill} \times 1E6 \times D_{fill})) \quad \text{Eq. 1}$$

Where:

C_{fill} = activity concentration in the fill material (pCi/g) per surface area activity concentration = 1 pCi/m^2

A_s = unit surface area activity concentration assumed over 1 m^2 of concrete surface (1 pCi)

V_{fill} = unit volume of fill material (1 m^3)

1E6 = conversion factor (cm^3 per m^3)

D_{fill} = density of fill material (g/cm^3)

The mean value of the density distribution for sand (1.5105 g/cm^3) was applied for all ROCs.

C_{fill} = 1pCi/(1m^3 * 1E+06 cm^3/m^3 * 1.5101g/cm^3) = 6.62E-07 pCi/g per 1 pCi/m^2

The ROC-specific $DCGL_{IR}$ values are calculated using RESRAD-Onsite POM doses, 10CFR20.1402 dose criterion, and fill activity concentration, 6.62E-07 pCi/g per 1 pCi/m^2. This was accomplished using equation 2.

$$DCGL_{IR,ROC} = [25 \div (POM_{ROC} \times C_{fill})] \quad \text{Eq. 2}$$

Where:

$DCGL_{IR,ROC}$ = ROC-specific $DCGL_{IR}$ value (pCi/m^2)

25 = 10CFR20.1402 unrestricted release criterion (mrem/y)

POM_{ROC} = ROC-specific POM dose (mrem/y per 1 pCi/g) calculated using RESRAD-Onsite 7.2

C_{fill} = 6.62E-07 pCi/g per pCi/m^2

Table 3: RESRAD-Onsite Generated POM Doses and $DCGL_{IR}$ Values by ROC

ROC	POM dose (mrem/y)	$DCGL_{IR}$ (pCi/m^2)
Am-241	6.45E+00	5.85E+06
C-14	1.99E-01	1.90E+08
Cm-243	2.06E+00	1.83E+07
Cm-244	1.65E+00	2.29E+07
Co-60	3.19E-01	1.18E+08
Cs-137	1.49E-01	2.53E+08
Eu-152	4.68E-02	8.08E+08
Eu-154	6.80E-02	5.55E+08
Fe-55	7.97E-04	4.74E+10
H-3	4.36E-02	8.67E+08
Mn-54	5.46E-03	6.91E+09
Nb-94	3.11E-02	1.21E+09
Ni-63	9.69E-03	3.90E+09
Np-237	3.44E+02	1.10E+05
Pu-238	9.82E+00	3.85E+06
Pu-239	1.09E+01	3.45E+06
Pu-240	1.09E+01	3.45E+06
Pu-241	2.10E-01	1.80E+08
Sb-125	2.24E-01	1.69E+08
Sr-90	9.95E+00	3.80E+06
Tc-99	1.02E+00	3.71E+07

2.2 Drilling Spoils

Scenario description and assumptions are provided in TSD 24-063.

The volume of the drilling spoils was calculated using equation 3:

$$V_{ds} = \pi r^2 h \quad \text{Eq. 3}$$

where

V_{ds} = the volume of drilling spoils (m^3)

π = pi constant

r = radius of borehole (m)

h = drilling depth (m)

Input for volume and area calculations:

- The diameter of the bore hole = 8 inches (0.2032m).
- Radius of bore hole = 4 inches (0.1016m)
- Height of ORB wall = 14.4 ft (4.39m)
- Cover thickness = 3 ft (0.91m)
- Concrete depth to refusal = 1 inch (0.0254m)
- Density of fill material = 1.5105 g/cm^3 (assumed sand; mean density value for sand distribution)
- Thickness of CZ at the surface = 6 inches (0.1524m)

The area of the drilling spoils at the ground surface (A_{ds}) was calculated by dividing the volume of the drilling spoils by the assumed thickness of the spoils after spreading:

$$A_{ds} = V_{ds}/T_{ds} \quad \text{Eq. 4}$$

where

V_{ds} = the volume of drilling spoils (m^3)

T_{ds} = assumed thickness of the drilling spoils at the ground surface (m)

Assuming a drill column depth = 5.33m as the "h" term, the volume (V_{ds}) and area (A_{ds}) of the drilling spoils are:

$V_{ds} = \pi r^2 h = (3.1415927\ldots)(0.2032m/2)^2(5.33m) = 0.1728m^3$

$A_{ds} = (0.1728m^3)/(0.1524m) = 1.134\ m^2$

The area concentration activity of contamination on the concrete, C_c (pCi/m^2), required to produce a concentration in the drilling spoils equal to 1 pCi/g was determined using the following equation:

$$C_c = ((V_{ds})(1x10^6)(D_f)(C_{ds}))/\ \pi r^2 \quad \text{Eq. 5}$$

Where

C_c = area concentration activity of contamination on the concrete required to produce a concentration in the drilling spoils equal to 1 pCi/g

V_{ds} = the volume of drilling spoils (m^3)

$1x10^6$ = conversion for cm^3/m^3

D_f = density of fill material (g/cm^3), assumed sand as above

C_{ds} = unit concentration in drilling spoils (1 pCi/g)

π = pi constant

r = radius of borehole (m)

Using equation 5, the area concentration activity of contamination on the concrete, C_c (pCi/m^2), required to produce a concentration in the drilling spoils equal to 1 pCi/g:

$$C_c = ((V_{ds})(1x10^6)(D_f)(C_{ds}))/ \pi r^2$$

$$= ((0.1728m^3)(1x10^6\ cm^3/m^3)(1.5105\ g/cm^3)(1\ pCi/g))/((3.1415297\ldots)(0.1016\ m)^2)$$

$$= 8.05x10^6\ pCi/m^2 \text{ per } 1\ pCi/g$$

The drilling spoils ROC-specific DCGL values ($DCGL_{ds,ROC}$) were calculated as follows:

$$DCGL_{ds,ROC} = (25)(C_c)(AF_{dsA})/POM_{ROC} \qquad \text{Eq. 6}$$

where

25 = 10CFR20.1402 radiological criterion for unrestricted release (mrem/y)

C_c = area concentration activity of contamination on the concrete required to produce a concentration in the drilling spoils equal to 1 pCi/g, $8.05x10^6$ pCi/m^2

AF_{dsA} = the area factor applicable to A_{ds} (unitless) taken from Table 4 in ENG-OCS-009.

POM_{ROC} = the peak of the mean dose (mrem/y per pCi/g) taken from TSD 25-103 [7].

Table 4: POM Doses, Area Factors, and $DCGL_{ds}$ Values by ROC

ROC	POM Dose (mrem/y per pCi/g)	AF_{1m}	$DCGL_{DS}$ (pCi/m^2)
Am-241	3.42E-02	12	7.06E+10
C-14	1.23E-02	585	9.56E+12
Cm-243	1.38E-01	9	1.31E+10
Cm-244	1.37E-02	16	2.35E+11
Co-60	3.15E+00	9	5.75E+08
Cs-137	6.99E-01	9	2.59E+09
Eu-152	1.42E+00	9	1.28E+09
Eu-154	1.53E+00	9	1.18E+09
Fe-55	2.98E-06	278	1.88E+16
H-3	7.94E-03	45	1.14E+12
Mn-54	7.34E-01	9	2.47E+09

ROC	POM Dose (mrem/y per pCi/g)	AF_{1m}	$DCGL_{DS}$ (pCi/m²)
Nb-94	2.01E+00	9	9.02E+08
Ni-63	4.56E-06	176	7.77E+15
Np-237	6.08E+00	9	2.98E+08
Pu-238	2.20E-02	16	1.46E+11
Pu-239	1.40E-01	21	3.02E+10
Pu-240	1.16E-01	21	3.64E+10
Pu-241	1.00E-03	24	4.82E+12
Sb-125	4.50E-01	9	4.03E+09
Sr-90	1.13E-02	11	1.97E+11
Tc-99	3.98E-01	27	1.37E+10

2.3 Excavated Concrete

Scenario description and assumptions are provided in TSD 24-063.

The volume of excavated concrete is calculated using the following equation:

V_{ec} = (4-wall total length)(average depth to groundwater-3ft)(wall thickness) Eq. 7

The Turbine Building (TB) was selected as the most conservative input for the CZ area calculation (TSD 24-063).

Turbine Building:

4-wall total length = 893 ft

Wall thickness = 3.0 ft

Wall height = (14.5 ft – 3 ft) = 11.5 ft

V_{ec} = (893ft)(3.0ft)(11.5ft) = 30,811 ft^3 (value rounded) = **872 m^3**(value rounded)

The area of the CZ with a thickness of 1 m was calculated using the following equation:

$A_{cz} = V_{ec}/T_{cz}$ Eq. 8

Where

A_{cz} = the area of the CZ (m^2)

V_{ec} = the volume of excavated concrete (m^3)

T_{cz} = assumed thickness of the CZ (1m)

Area of the CZ using the TB value for V_{ec} : $A_{cz} = V_{ec}/h$ = 872 m^3/1m = 872 m^2

The concentration activity in the excavated concrete (pCi/g) resulting from area contamination on the concrete equal to 1 pCi/m^2 was determined using the following equation:

$C_{ec} = (A_c)/((t_w)(30.48)(W_{UA})(1x10^4)(D_c))$ Eq. 9

Where

C_{ec} = unit concentration in the excavated concrete (pCi/g per 1 pCi/m^2)

A_c = unit activity over 1 m^2 of concrete surface (1 pCi)

t_w = wall thickness (ft)

30.48 = conversion for cm/ft

W_{UA} = unit area of concrete wall (1 m^2)

$1x10^4$ = conversion for cm^2/m^2

D_c = assumed density of concrete, 2.3 g/cm^2, which is the mid-point of the density range in the 1970 edition of the *Radiological Health Handbook*

The calculated value for C_{ec} is:

$$C_{ec} = (A_c)/((t_w)(30.48)(W_{UA})(1x10^4)(D_c))$$

$$= (1\ pCi)/((3ft)(30.48)(1m^2)(1x10^4)(2.3\ g/cm^3))$$

$$= 4.75x10^{-7}\ pCi/g\ per\ 1\ pCi/m^2$$

The excavated concrete ROC-specific DCGL values are calculated using Equation 10:

$$DCGL_{ec,ROC} = (DCGL_{soil,ROC})(AF_{cz,ROC})/C_{ec} \qquad \text{Eq. 10}$$

Where

$DCGL_{ec,ROC}$ = ROC-specific $DCGL_{ec}$ (pCi/m^2)

$DCGL_{soil,ROC}$ = ROC-specific DCGL (pCi/g) (from TSD 25-103)

$AF_{cz,ROC}$ = the ROC-specific area factor applicable to A_{cz} (unitless) (from ENG-OCS-009)

C_{ec} = unit concentration in the excavated concrete (pCi/g per 1 pCi/m^2)

The AF for a CZ area = 872 m^2 falls between values listed for CZ areas equal to 500 m^2 to 1000 m^2 (Table 4 in ENG-OCS-009). Except for C-14 and Tc-99, the AF value = 1 for all other ROCs for a 1000 m^2 CZ area. Rather than applying interpolated AF values, an AF value of 1 was applied to all ROCs to increase conservatism in the $DCGL_{EC}$ values. The application of an AF = 1 allows re-writing equation 10:

$$DCGL_{ec,ROC} = (DCGL_{soil,ROC})/C_{ec}$$

Values for $DCGL_{soil,ROC}$ in Table 4 were taken from TSD 25-103.

Table 5: $DCGL_{EC}$ Values by ROC

ROC	$DCGL_{soil}$ (pCi/g)	$DCGL_{ec}$ (pCi/m^2)
Am-241	7.30E+02	1.54E+09
C-14	2.03E+03	4.27E+09
Cm-243	1.81E+02	3.81E+08
Cm-244	1.82E+03	3.83E+09
Co-60	7.94E+00	1.67E+07
Cs-137	3.58E+01	7.53E+07
Eu-152	1.76E+01	3.70E+07
Eu-154	1.63E+01	3.43E+07
Fe-55	8.39E+06	1.76E+13
H-3	3.15E+03	6.62E+09
Mn-54	3.41E+01	7.17E+07
Nb-94	1.25E+01	2.63E+07
Ni-63	5.48E+06	1.15E+13
Np-237	4.11E+00	8.64E+06
Pu-238	1.14E+03	2.40E+09
Pu-239	1.79E+02	3.76E+08
Pu-240	2.16E+02	4.54E+08
Pu-241	2.49E+04	5.24E+10
Sb-125	5.56E+01	1.17E+08
Sr-90	2.22E+03	4.67E+09
Tc-99	6.29E+01	1.32E+08

2.4 Calculation of $DCGL_{W/F}$ Values

$DCGL_{W/F}$ values in column 5 of Table 6 were calculated using the following equation:

$$DCGL_{W/F} = 1/((1/DCGL_{IR})+(1/DCGL_{DS})+(1/DCGL_{EC})) \quad \text{Eq. 11}$$

Table 6: $DCGL_{W/F}$ Values by ROC

ROC	$DCGL_{IR}$ (pCi/m^2)	$DCGL_{DS}$ (pCi/m^2)	$DCGL_{EC}$ (pCi/m^2)	$DCGL_{W/F}$ (pCi/m^2)
Am-241	5.85E+06	7.06E+10	1.54E+09	**5.83E+06**
C-14	1.90E+08	9.56E+12	4.27E+09	**1.82E+08**
Cm-243	1.83E+07	1.31E+10	3.81E+08	**1.74E+07**
Cm-244	2.29E+07	2.35E+11	3.83E+09	**2.27E+07**
Co-60	1.18E+08	5.75E+08	1.67E+07	**1.43E+07**
Cs-137	2.53E+08	2.59E+09	7.53E+07	**5.68E+07**
Eu-152	8.08E+08	1.28E+09	3.70E+07	**3.44E+07**
Eu-154	5.55E+08	1.18E+09	3.43E+07	**3.14E+07**
Fe-55	4.74E+10	1.88E+16	1.76E+13	**4.72E+10**
H-3	8.67E+08	1.14E+12	6.62E+09	**7.66E+08**
Mn-54	6.91E+09	2.47E+09	7.17E+07	**6.90E+07**
Nb-94	1.21E+09	9.02E+08	2.63E+07	**2.50E+07**
Ni-63	3.90E+09	7.77E+15	1.15E+13	**3.89E+09**
Np-237	1.10E+05	2.98E+08	8.64E+06	**1.08E+05**
Pu-238	3.85E+06	1.46E+11	2.40E+09	**3.84E+06**
Pu-239	3.45E+06	3.02E+10	3.76E+08	**3.42E+06**
Pu-240	3.45E+06	3.64E+10	4.54E+08	**3.43E+06**
Pu-241	1.80E+08	4.82E+12	5.24E+10	**1.79E+08**
Sb-125	1.69E+08	4.03E+09	1.17E+08	**6.79E+07**
Sr-90	3.80E+06	1.97E+11	4.67E+09	**3.79E+06**
Tc-99	3.71E+07	1.37E+10	1.32E+08	**2.89E+07**

An open DW pathway lowers the $DCGL_{W/F}$ values for all ROCs as shown in Table 7.

Table 7. $DCGL_{W/F}$ Values Without and With an Open DW Pathway

ROC	IU $DCGL_{W/F}$ Value (pCi/g)	
	Without DW Pathway	With DW Pathway
Am-241	1.42E+09	5.83E+06
C-14	6.22E+08	1.82E+08
Cm-243	3.69E+08	1.74E+07
Cm-244	3.63E+09	2.27E+07
Co-60	1.62E+07	1.43E+07
Cs-137	7.31E+07	5.67E+07
Eu-152	3.60E+07	3.45E+07
Eu-154	3.33E+07	3.15E+07
Fe-55	1.64E+13	4.72E+10
H-3	1.05E+11	7.66E+08
Mn-54	6.97E+07	6.90E+07
Nb-94	2.49E+07	2.49E+07
Ni-63	1.54E+13	3.89E+09
Np-237	1.15E+08	1.08E+05
Pu-238	2.09E+08	3.84E+06
Pu-239	1.54E+08	3.42E+06
Pu-240	1.52E+08	3.43E+06
Pu-241	9.45E+09	1.79E+08
Sb-125	1.14E+08	6.78E+07
Sr-90	8.62E+09	3.79E+06
Tc-99	2.82E+10	2.89E+07

3 References

1. TSD 24-063, *Basement Fill Model: Calculation of DCGLW/F Values Assuming Industrial Use Exposure Pathways*
2. ANL/EVS/TM-18/1, *RESRAD-Onsite 7.2 User's Guide*, April 2018
3. TSD 25-032, *Radionuclides of Concern in Support of the Oyster Creek Station License Termination Plan*, Revision 0
4. TSD 24-055, *Basement Fill Model: Probabilistic Analysis for the Instantaneous Release Scenario Assuming Industrial Use Exposure Pathways.*
5. ENG-OCS-009, *Area Factors for Soil – Industrial Use Scenario*
6. NUREG/CR-7267, *Default Parameter Values and Distribution in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes, February 2020*
7. TSD 25-103, *Industrial Use Scenario with Open Drinking Water Pathway: An Assessment of Impact on DCGL Values for Surface Soil*, Sept. 26, 2025

Pages from the RESRAD-Onsite reports showing the POM dose values for the Instantaneous Release Scenario by radionuclide:

Am-241

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  18:03  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Am241 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\AM241\BFM-IU_AM241_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                          Years                mrem/yr
          1           0.000E+00             6.453E+00
```

C-14

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  12:45  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_C14_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\C14\BFM-IU_C14_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                          Years                mrem/yr
          1           0.000E+00             1.987E-01
```

CM-243

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  13:45  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_Cm243_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\CM243\BFM-IU_CM243_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                          Years                mrem/yr
          1           0.000E+00             2.064E+00
```

Cm-244

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  20:35  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_Cm244_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\CM244\BFM-IU_IR_CM244_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                          Years                mrem/yr
          1           0.000E+00             1.650E+00
```

Co-60

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  11:06  Page  20
 Probabilistic results summary : OCS BFM_Industrial Use_IR_Co60_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\CO60\BFM-IU_CO60_DCGL_DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                          Years                mrem/yr
          1           0.000E+00             3.194E-01
```

Cs-137

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  12:57  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_Cs137_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\CS137\BFM-IU_CS137_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                          Years                mrem/yr
          1           0.000E+00             1.491E-01
```

Eu-152

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  11:33  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_Eu152_DCGL_DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\EU152\BFM-IU_EU152_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                          Years                mrem/yr
          1           0.000E+00             4.675E-02
```

Eu-154

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  13:10  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_Eu154_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\EU154\BFM-IU_EU154_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              6.798E-02
```

Fe-55

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  16:54  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_Fe55_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\FE55\BFM-IU_FE55_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              7.974E-04
```

H-3

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  07:03  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_H3_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\H3\BFM-IU_IR_H3_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              4.358E-02
```

Mn-54

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  10:13  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_Mn54_DCGL DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\MN54\BFM-IU_IR_MN54_DCG DWL.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              5.464E-03
```

Nb-94

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  10:21  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Nb94 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\NB94\BFM-IU_IR_DCGL_NB94 DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           1.000E+03              3.114E-02
```

Ni-63

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  10:28  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Ni63 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\NI63\BFM-IU_IT_NI63_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              9.693E-03
```

Np-237

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  13:25  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Np237 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\NP237\BFM-IU_NP237.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              3.443E+02
```

Pu-238

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  07:08  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Pu238 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\PU238\BFM-IU_IR_PU238_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              9.818E+00
```

Pu-239

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  12:05  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Pu239 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\PU239\BFM-IUIR__DCGL_PU239 DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           1.000E+00              1.094E+01
```

Pu-240

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  13:14  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Pu240 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\PU240\BFM-IU_IR_DCGL_PU240 DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           1.000E+00              1.094E+01
```

Pu-241

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/19/2025  17:21  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Pu241
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\PU241\BFM-IU_DCGL_PU241 DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           1.000E+00              2.103E-01
```

Sb-125

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  10:36  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Sb125 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\SB125\BFM-IU_IR_DCGLSB125 DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              2.240E-01
```

Sr-90

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  10:53  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Sr90 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\SR90\BFM-IU_IR_DCGL_SR90 DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              9.948E+00
```

Tc-99

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/20/2025  11:00  Page  20
 Probabilistic results summary : OCS BFM_IU_IR_DCGL_Tc99 DW
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES\BFM IR IU DW\TC99\BFM-IU_IR_TC99_DCGL DW.RAD
                  Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                         Years                 mrem/yr
          1           0.000E+00              1.017E+00
```