BARTLETT

ENGINEERING CALCULATION

Calculation Number: ENG-005

Revision Number: 0

Calculation Title: Calculation of EF1 Building Surface Area Factors

Preparer: J. Bisson Date 10/23/2008

Reviewer: Bruce J. Vionne Date 10/23/08

Approval: [signature] Date 11-4-2008
Corporate Project Manager

Approval: [signature] Date: 10/29/08
Acting as the Director of Quality Assurance

Bartlett.
60 Industrial Park Road
Plymouth, MA 02360

1.0 PURPOSE

The purpose of this calculation is to develop area factors (AFs) for use with the building surface derived concentration guideline levels (DCGLs) developed for the Detroit Edison Company's (DTE) Enrico Fermi (EF) 1 nuclear power site. This calculation is part of the scope of work defined in DTE Contract No. 4400001090.

2.0 APPLICABILITY

This calculation addresses only the development of building surface AFs for the EF 1 site.

3.0 REFERENCES

3.1 Bartlett Engineering Procedure ENG-AP-02, *Verification of Software Operability*

3.2 *User's Manual for RESRAD-Build Version 3.0*, June 2003 (ANL/EAD/03-1)

3.3 Bartlett Engineering Calculation ENG-001, *Sensitivity Analyses to Support EF1 Building Surface DCGLs*

3.4 Bartlett Engineering Calculation ENG-003, *Calculation of EF1 Building Surface DCGLs*

3.5 NUREG-1757, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Rev.1 , August 2000

3.6 NUREG/CR-5512, *Residual Radioactive Contamination from Decommissioning*

- Volume 1: *Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*, Oct. 1992 (PNL-7994)
- Volume 3: *Parameter Analysis, Draft Report for Comment*, Oct. 1999 (SAND99-2148)

3.7 NUREG/CR-6697, *Development of Probabilistic RESRAD 6.0 and RESRAD-Build 3.0 Computer Codes*, Nov. 2000 (ANL/EAD/TM-98)

3.8 NUREG/CR-6755, *Technical Basis for Calculating Radiation Doses for the Building Occupancy Scenario Using the Probabilistic RESRAD-Build 3.0 Code*, Feb. 2002 (ANL/EAD/TM/02-1)

3.9 NUREG-1727, *NMSS Decommissioning Standard Review Plan*, Sept. 2000

3.10 Federal Guidance Report (FGR) 11, *Limiting Values of Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, EPA, 1988

3.11 Federal Guidance Report (FGR) 12, *External Exposure to Radionuclides in Air, Water, and Soil*, EPA, 1993

4.0 METHOD OF CALCULATION

The operability of the RESRAD-Build code was verified on each computer used for code executions in accordance with Bartlett Engineering procedure ENG-AP-02, Verification of Software Operability [ref. 3.1]. The RESRAD-Build user's manual [ref. 3.2] provided guidance for code operation.

Version 3.4 of the RESRAD-Build code was used to perform a parameter sensitivity analysis [ref. 3.3] and to calculate building surface DCGL values [ref 3.4]. To maintain consistency with the approached used in those calculations, RESRAD-Build version 3.4 was also used in the development of area factors for use with the EF1 DCGLS.

Area factors permit assessments of small areas of elevated activity. By definition, an AF is the magnitude by which the residual radioactivity in a small area of elevated activity can exceed the $DCGL_w$ while maintaining compliance with the release criterion [ref. 3.5]. Typically, a $DCGL_w$ value is adjusted by an area factor that is appropriate for the given area of elevated contamination. The resulting adjusted DCGL value is referred to as $DCGL_{EMC}$, where EMC stands for elevated measurement comparison. $DCGL_{EMC}$ values are obtained from the following relationship:

$DCGL_w * AF = DCGL_{EMC}$ [equation 8-1 from ref. 3.5]

where the AF value is specific for the area of the elevated contamination.

The model used for AFs is similar to that used in the development of building surface $DCGL_w$ values. However, only one source is modeled, instead of the six sources considered in calculating the building surface $DCGL_w$ values. The receptor is located at the source midpoint at a distance of 1 meter. All other input parameters and assumed active exposure pathways are the same as those in the building surface DCGL calculation [ref. 3.4].

Elevated measurement comparisons (i.e., assessments of residual activity greater than the DCGL value) are likely to occur only in Class 1 areas. Greater than DCGL measurements in a Class 2 area would result in re-classification of the entire area (or a portion of the area) to Class 1. Accordingly, the recommended limit to the size of a Class 1 structure, $100m^2$ [ref. 3.5], was set as the upper bound for sizes used to develop AFs. AF based on twelve area sizes were calculated: $100m^2$, $50m^2$, $25m^2$, $15m^2$, $10m^2$, $8m^2$, $6m^2$, $5m^2$, $4m^2$, $3m^2$, $2m^2$, $1m^2$.

Three hundred RESRAD-Build version 3.4 code runs were performed; one for each area size and each of the 25 radionuclides-of-concern for the EF1 site. The development of AFs followed the steps outlined below.

1. RESRAD-Build calculations of the doses associated with each area size for each radionuclide.

2. Calculation of the relative fractions of the doses for the various area sizes to the doses associated with an area of $100m^2$.

3. Derive AF values by taking the reciprocal of the relative dose fractions.

4. Generation of tables and graphs to present AF values.

5.0 ASSUMPTIONS AND INPUT

5.1 Assumptions

5.1.1 With the exception of the number of sources and area size input, all assumptions regarding input parameters and active exposure pathways were the same as those used in the sensitivity analysis [ref. 3.3] and in the DCGL calculations [ref. 3.4].

5.1.2 Radionuclides-of-concern for the Fermi 1 site: Ag-108m, Am241, C-14, Mn-54, Co-60, Cm-242, Cm-243, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Fe-55, H-3, Na-22, Nb-94, Ni-59, Ni-63, Pu-238, Pu239, Pu-240, Pu-241, Sb-125, Sr-90, and Tc-99.

5.1.3 The areas used to develop AF values are bounded by the recommended maximum size for a Class 1 structure, 100 m^2 [ref 3.5]. Area sizes assumed in this calculation are m^2) are 100 m^2, 50 m^2, 25 m^2, 15 m^2, 10 m^2, 8 m^2, 6 m^2, 5 m^2, 4 m^2, 3 m^2, 2 m^2, and 1 m^2.

5.1.4 The receptor dose point was assumed at 1m above the center of the various area sources, which were located at the center of the room and directly under the receptor.

5.2 Input

5.2.1 Values used as input for the RESRAD-Build parameters were the same as those used in the calculation of the EF1 building surface DCGLs [ref. 3.4]. Table 1 summarizes the input values for all input parameters.

5.2.2 As in the calculation of building surface DCGLs [ref. 3.4], 25th or 75th percentile values from Bartlett Engineering Calculation ENG-001 [ref. 3.3] were used as input for the sensitive parameters (i.e., deposition velocity, resuspension rate, and time for source removal).

5.2.3 The location of the receptor was the center of the floor. The dose point was set at a height of 1m. On the x, y, and z-axes, the locations were 5.97m, 13.23m, 1.0m, respectively, which is the same location used in the calculation of the building surface DCGLs [ref. 3.4] and in the sensitivity analysis [ref. 3.3]. The various sized sources were automatically placed under the receptor when the area input value was entered.

6.0 CALCULATIONS AND RESULTS

6.1 Using the assumptions described in section 5.0 and the input values shown in Table 1, RESRAD-Build code executions were made for each radionuclide-of-concern and various source areas. The sizes for the various area sources were $100m^2$, $50m^2$, $25m^2$, $15m^2$, $10m^2$, $8m^2$, $6m^2$, $5m^2$, $4m^2$, $3m^2$, $2m^2$, and $1m^2$.

6.2 Table 2 summarizes the RESRAD-Build dose results for the various area sizes by radionuclide. Table 2A provides a cross reference for the RESRAD-Build files.

6.3 Table 3 shows the dose fractions for each area relative to the dose for a 100-m^2 area. The relative dose fractions were calculated as follows:

Relative dose fraction = $dose_x/dose_{100}$

where, $dose_x$ = dose for area size of interest ($100m^2$, $50m^2$, $25m^2$, $15m^2$, $10m^2$, $8m^2$, $6m^2$, $5m^2$, $4m^2$, $3m^2$, $2m^2$, and $1m^2$), and

$dose_{100}$ = dose associated with 100 m^2

6.4 Table 4 present the AF values by radionuclide. These values were determined by taking the reciprocals of the relative doses in Table 3.

6.5 For the ease of displaying the AFs, the radionuclides were categorized as gamma-emitters, beta-emitters, and alpha-emitters. Table 5 presents AFs for the gamma-emitting radionuclides, Table 6 presents AFs for beta-emitting radionuclides, and Table 7 presents AFs for alpha-emitters.

6.6 Figures 1, 2, and 3, respectively, graphically display the data in Tables 5, 6, and 7.

Table 1: Input Parameter Values for Building Surface AFs

Parameter	Type[a]	Nuclide	Treatment[b]	Value/Distribution	Value Reference Source
Exposure Duration (d)	B	All	D	365	NUREG/CR-5512, Vol.3,section 5.2.1
Indoor Fraction	B	All	D	0.267	NUREG/CR-5512, Vol.3,section 5.2.2.9
Evaluation Time (y)	P	All		1	Use of 1y provides doses at t=0y and t=1y.
Number of Rooms	P	All	D	1	NUREG/CR-5512
Deposition Velocity (m/s)	P	Cm-242 Pu-241 All Others	D D D	1.5179E-05 1.5179E-05 4.78217E-04	25th percentile value 25th percentile value 75th percentile value
Resuspension Rate (s^{-1})	P	Cm-242 Pu-241 All Others	D D D	4.87543E-07 4.87543E-07 6.70403E-10	75th percentile value 75th percentile value 25th percentile value
Air Exchange Rate for Room (h^{-1})	B	All	D	1.52	NUREG/CR-6697, Att. C, sec. 7.4 and NUREG/CR-6755, sec. 3.2
Room Area (m^2)	P	All	D	315.97	Site-specific data
Room Height (m)	P	All	D	3.66	Site-specific data
Time Fraction	B	All	D	1	NUREG/CR-5512
Inhalation Rate (m^3/d)	M	All	D	45.6	Inhalation rate for moderate to heavy activities - NUREG/CR-6697, Attachment C, section 5.1; NUREG/CR-5512, vol. 3, section 5.3.4
Indirect Ingestion Rate (m^2/h)	B	All	D	0.00011	NUREG/CR6755, A.3.3, Table A.12
Receptor Location	B	All	D	5.97, 13.23, 1	NUREG/CR-5512; site-specific room dimensions
Shielding Thickness (cm)	P	All	D	0	Site-specific model-no shielding assumed
Shielding Density (g/cm^3)	P	All	D	2.4	RESRAD-Build default value for concrete – not used in DCGL calculations
Shielding Material	P	All	D	concrete	Default input – not used in DCGL calculations
Number of Sources	P	All		1	Various size floor area sources
External Dose Conversion Factor, (mrem/y per pCi/cm^2)	M	All	D	RESRAD-Build default	FGR12
Air Submersion Dose Conversion Factor, (mrem/y per pCi/m^3)	M	All	D	RESRAD-Build default	FGR12
Inhalation Dose Conversion Factor, (mrem/pCi)	M	All	D	RESRAD-Build default	FGR11
Ingestionl Dose Conversion Factor, (mrem/pCi)	M	All	D	RESRAD-Build default	FGR11
Source 1, Floor					
Type	P	All		area	NUREG/CR-5512
Direction	P	All		Z	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All	D	5.97, 13.23, 0	Site-Specific Modeling
Source length X-axis (m)	P	All	D	11.94	Not used in calculations
Source length Y-axis (m)	P	All	D	26.47	Not used in calculations
Area (m^2)	P	All	D	100, 50, 25, 15, 10, 8, 6, 5, 4, 3, 2, 1	Recommended size for Class 1 structure [ref. 3.5] used as upper limit for area source size
Air Fraction	B	H-3 All others	D	1.0 0.07	NUREG/CR-6697, Att. C Section 8.6
Direct Ingestion (h^{-1})	B	All	D	1.2E-7	NUREG/CR6755, A.3.3
Removable Fraction	P	All	D	0.1	NUREG-1727, Table C.7.1; NUREG/CR-6755, section 3.5

Parameter	Type[a]	Nuclide	Treatment[b]	Value/Distribution	Value Reference Source
Time for Source Removal (d)	P	Ag-108m	D	52,695.2	75th percentile value
		Am-241	D	18,249.3	25Th percentile value
		C-14	D	52,695.2	75Th percentile value
		Co-60	D	52,695.2	75Th percentile value
		Cm-242	D	18,249.3	25Th percentile value
		Cm-243	D	18,249.3	25Th percentile value
		Cs-134	D	52,695.2	75Th percentile value
		Cs-137	D	52,695.2	75Th percentile value
		Eu-152	D	52,695.2	75Th percentile value
		Eu-154	D	52,695.2	75Th percentile value
		Eu-155	D	52,695.2	75Th percentile value
		Fe-55	D	52,695.2	75Th percentile value
		H-3	D	18,249.3	25Th percentile value
		Mn-54	D	52,695.2	75Th percentile value
		Na_22	D	52,695.2	75Th percentile value
		Nb-94	D	52,695.2	75Th percentile value
		Ni-59	D	18,249.3	25Th percentile value
		Ni-63	D	18,249.3	25Th percentile value
		Pu-238	D	18,249.3	25Th percentile value
		Pu-239	D	18,249.3	25Th percentile value
		Pu-240	D	18,249.3	25Th percentile value
		Pu-241	D	18,249.3	25Th percentile value
		Sb-125	D	52,695.2	75Th percentile value
		Sr-90	D	52,695.2	75Th percentile value
		Tc-99	D	52,695.2	75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All	D	1.0	-

[a] P = physical, B = behavioral, M = metabolic; (see NUREG/CR-6697, Attachment B, Table 4.)
[b] D = deterministic

Table 2: RESRAD-Build Results

Area (m^2)	Annual Dose (mrem) from 1 pCi/m^2: Ag-108m	Am-241	C-14	Cm-242	Cm-243	Co-60	Cs-134	Cs-137	Eu-152	Eu-154	Eu-155	Fe-55	H-3
1	1.31E-06	1.58E-07	7.69E-11	1.99E-09	1.85E-07	1.79E-06	1.06E-06	4.51E-07	8.89E-07	9.42E-07	4.69E-08	1.50E-11	2.11E-12
2	2.34E-06	3.09E-07	1.50E-10	3.98E-09	3.47E-07	3.18E-06	1.89E-06	8.04E-07	1.59E-06	1.68E-06	8.37E-08	3.00E-11	4.21E-12
3	3.18E-06	4.55E-07	2.21E-10	5.97E-09	4.95E-07	4.33E-06	2.57E-06	1.09E-06	2.16E-06	2.28E-06	1.14E-07	4.51E-11	6.32E-12
4	3.89E-06	5.98E-07	2.90E-10	7.96E-09	6.32E-07	5.31E-06	3.15E-06	1.34E-06	2.64E-06	2.80E-06	1.40E-07	6.01E-11	8.43E-12
5	4.51E-06	7.38E-07	3.58E-10	9.95E-09	7.63E-07	6.15E-06	3.65E-06	1.56E-06	3.06E-06	3.24E-06	1.62E-07	7.51E-11	1.05E-11
6	5.06E-06	8.76E-07	4.25E-10	1.19E-08	8.87E-07	6.90E-06	4.09E-06	1.74E-06	3.44E-06	3.64E-06	1.82E-07	9.01E-11	1.26E-11
8	6.00E-06	1.15E-06	5.57E-10	1.59E-08	1.12E-06	8.18E-06	4.85E-06	2.07E-06	4.07E-06	4.31E-06	2.17E-07	1.20E-10	1.69E-11
10	6.78E-06	1.42E-06	6.87E-10	1.99E-08	1.35E-06	9.24E-06	5.49E-06	2.34E-06	4.61E-06	4.88E-06	2.45E-07	1.50E-10	2.11E-11
15	8.31E-06	2.08E-06	1.01E-09	2.98E-08	1.87E-06	1.13E-05	6.73E-06	2.87E-06	5.64E-06	5.98E-06	3.02E-07	2.25E-10	3.16E-11
25	1.04E-05	3.37E-06	1.63E-09	4.96E-08	2.85E-06	1.42E-05	8.42E-06	3.60E-06	7.06E-06	7.47E-06	3.79E-07	3.76E-10	5.27E-11
50	1.34E-05	6.55E-06	3.17E-09	9.92E-08	5.11E-06	1.83E-05	1.09E-05	4.66E-06	9.11E-06	9.64E-06	4.95E-07	7.51E-10	1.05E-10
100	1.65E-05	1.28E-05	6.20E-09	1.98E-07	9.41E-06	2.26E-05	1.35E-05	5.81E-06	1.13E-05	1.19E-05	6.20E-07	1.50E-09	2.11E-10

Area (m^2)	Annual Dose (mrem) from 1 pCi/m^2: Mn-54	Na-22	Nb-94	Ni-59	Ni-63	Pu-238	Pu-239	Pu-240	Pu-241	Sb-125	Sr-90	Tc-99
1	4.58E-07	1.52E-06	1.26E-06	6.29E-12	1.69E-11	1.09E-07	1.23E-07	1.24E-07	2.31E-09	3.22E-07	8.83E-09	1.04E-10
2	8.17E-07	2.71E-06	2.24E-06	1.26E-11	3.37E-11	2.17E-07	2.46E-07	2.47E-07	4.61E-09	5.75E-07	1.67E-08	1.94E-10
3	1.11E-06	3.68E-06	3.05E-06	1.89E-11	5.06E-11	3.25E-07	3.69E-07	3.70E-07	6.90E-09	7.82E-07	2.39E-08	2.76E-10
4	1.36E-06	4.51E-06	3.74E-06	2.52E-11	6.75E-11	4.33E-07	4.91E-07	4.92E-07	9.19E-09	9.58E-07	3.06E-08	3.52E-10
5	1.58E-06	5.23E-06	4.34E-06	3.15E-11	8.44E-11	5.41E-07	6.13E-07	6.15E-07	1.15E-08	1.11E-06	3.71E-08	4.23E-10
6	1.77E-06	5.87E-06	4.68E-06	3.78E-11	1.01E-10	6.48E-07	7.35E-07	7.37E-07	1.38E-08	1.25E-06	4.32E-08	4.91E-10
8	2.10E-06	6.96E-06	5.76E-06	5.04E-11	1.35E-10	8.63E-07	9.79E-07	9.82E-07	1.83E-08	1.48E-06	5.50E-08	6.20E-10
10	2.37E-06	7.86E-06	6.52E-06	6.29E-11	1.69E-10	1.08E-06	1.22E-06	1.23E-06	2.29E-08	1.67E-06	6.63E-08	7.41E-10
15	2.91E-06	9.63E-06	7.98E-06	9.44E-11	2.53E-10	1.61E-06	1.83E-06	1.84E-06	3.43E-08	2.05E-06	9.30E-08	1.02E-09
25	3.63E-06	1.20E-05	9.98E-06	1.57E-10	4.22E-10	2.68E-06	3.05E-06	3.05E-06	5.71E-08	2.56E-06	1.43E-07	1.54E-09
50	4.68E-06	1.55E-05	1.29E-05	3.15E-10	8.44E-10	5.35E-06	6.09E-06	6.10E-06	1.14E-07	3.30E-06	2.60E-07	2.74E-09
100	5.78E-06	1.92E-05	1.59E-05	6.29E-10	1.69E-09	1.07E-05	1.22E-05	1.22E-05	2.28E-07	4.08E-06	4.85E-07	4.98E-09

Table 2A: Cross Reference for RESRAD-Build Files

Area (m^2)	RESRAD-Build report[a] file name: Ag-108m	Am-241	C-14	Cm-242	Cm-243	Co-60
1	RESRADB_Ag108m_AF1	RESRADB_Am241_AF1	RESRADB_C14_AF1	RESRADB_Cm242_AF1	RESRADB_Cm243_AF1	RESRADB_Co60_AF1
2	RESRADB_Ag108m_AF2	RESRADB_Am241_AF2	RESRADB_C14_AF2	RESRADB_Cm242_AF2	RESRADB_Cm243_AF2	RESRADB_Co60_AF2
3	RESRADB_Ag108m_AF3	RESRADB_Am241_AF3	RESRADB_C14_AF3	RESRADB_Cm242_AF3	RESRADB_Cm243_AF3	RESRADB_Co60_AF3
4	RESRADB_Ag108m_AF4	RESRADB_Am241_AF4	RESRADB_C14_AF4	RESRADB_Cm242_AF4	RESRADB_Cm243_AF4	RESRADB_Co60_AF4
5	RESRADB_Ag108m_AF5	RESRADB_Am241_AF5	RESRADB_C14_AF5	RESRADB_Cm242_AF5	RESRADB_Cm243_AF5	RESRADB_Co60_AF5
6	RESRADB_Ag108m_AF6	RESRADB_Am241_AF6	RESRADB_C14_AF6	RESRADB_Cm242_AF6	RESRADB_Cm243_AF6	RESRADB_Co60_AF6
8	RESRADB_Ag108m_AF8	RESRADB_Am241_AF8	RESRADB_C14_AF8	RESRADB_Cm242_AF8	RESRADB_Cm243_AF8	RESRADB_Co60_AF8
10	RESRADB_Ag108m_AF10	RESRADB_Am241_AF10	RESRADB_C14_AF10	RESRADB_Cm242_AF10	RESRADB_Cm243_AF10	RESRADB_Co60_AF10
15	RESRADB_Ag108m_AF15	RESRADB_Am241_AF15	RESRADB_C14_AF15	RESRADB_Cm242_AF15	RESRADB_Cm243_AF15	RESRADB_Co60_AF15
25	RESRADB_Ag108m_AF25	RESRADB_Am241_AF25	RESRADB_C14_AF25	RESRADB_Cm242_AF25	RESRADB_Cm243_AF25	RESRADB_Co60_AF25
50	RESRADB_Ag108m_AF50	RESRADB_Am241_AF50	RESRADB_C14_AF50	RESRADB_Cm242_AF50	RESRADB_Cm243_AF50	RESRADB_Co60_AF50
100	RESRADB_Ag108m_AF100	RESRADB_Am241_AF100	RESRADB_C14_AF100	RESRADB_Cm242_AF100	RESRADB_Cm243_AF100	RESRADB_Co60_AF100
Area (m^2)	RESRAD-Build file name: Cs-134	Cs-137	Eu-152	Eu-154	Eu-155	Fe-55
1	RESRADB_Cs134_AF1	RESRADB_Cs137_AF1	RESRADB_Eu152_AF1	RESRADB_Eu154_AF1	RESRADB_Eu155_AF1	RESRADB_Fe55_AF1
2	RESRADB_Cs134_AF2	RESRADB_Cs137_AF2	RESRADB_Eu152_AF2	RESRADB_Eu154_AF2	RESRADB_Eu155_AF2	RESRADB_Fe55_AF2
3	RESRADB_Cs134_AF3	RESRADB_Cs137_AF3	RESRADB_Eu152_AF3	RESRADB_Eu154_AF3	RESRADB_Eu155_AF3	RESRADB_Fe55_AF3
4	RESRADB_Cs134_AF4	RESRADB_Cs137_AF4	RESRADB_Eu152_AF4	RESRADB_Eu154_AF4	RESRADB_Eu155_AF4	RESRADB_Fe55_AF4
5	RESRADB_Cs134_AF5	RESRADB_Cs137_AF5	RESRADB_Eu152_AF5	RESRADB_Eu154_AF5	RESRADB_Eu155_AF5	RESRADB_Fe55_AF5
6	RESRADB_Cs134_AF6	RESRADB_Cs137_AF6	RESRADB_Eu152_AF6	RESRADB_Eu154_AF6	RESRADB_Eu155_AF6	RESRADB_Fe55_AF6
8	RESRADB_Cs134_AF8	RESRADB_Cs137_AF8	RESRADB_Eu152_AF8	RESRADB_Eu154_AF8	RESRADB_Eu155_AF8	RESRADB_Fe55_AF8
10	RESRADB_Cs134_AF10	RESRADB_Cs137_AF10	RESRADB_Eu152_AF10	RESRADB_Eu154_AF10	RESRADB_Eu155_AF10	RESRADB_Fe55_AF10
15	RESRADB_Cs134_AF15	RESRADB_Cs137_AF15	RESRADB_Eu152_AF15	RESRADB_Eu154_AF15	RESRADB_Eu155_AF15	RESRADB_Fe55_AF15
25	RESRADB_Cs134_AF25	RESRADB_Cs137_AF25	RESRADB_Eu152_AF25	RESRADB_Eu154_AF25	RESRADB_Eu155_AF25	RESRADB_Fe55_AF25
50	RESRADB_Cs134_AF50	RESRADB_Cs137_AF50	RESRADB_Eu152_AF50	RESRADB_Eu154_AF50	RESRADB_Eu155_AF50	RESRADB_Fe55_AF50
100	RESRADB_Cs134_AF100	RESRADB_Cs137_AF100	RESRADB_Eu152_AF100	RESRADB_Eu154_AF100	RESRADB_Eu155_AF100	RESRADB_Fe55_AF100

[a] All listed RESRAD-Build report files have the same extension: "rpt".

Table 2A: Cross Reference for RESRAD-Build Files
(continued)

Area (m^2)	RESRAD-Build report[a] file name: H-3	Mn-54	Na-22	Nb-94	Ni-59	Ni-63
1	RESRADB_H3_AF1	RESRADB_Mn54_AF1	RESRADB_Na22_AF1	RESRADB_Nb94_AF1	RESRADB_Ni59_AF1	RESRADB_Ni63_AF1
2	RESRADB_H3_AF2	RESRADB_Mn54_AF2	RESRADB_Na22_AF2	RESRADB_Nb94_AF2	RESRADB_Ni59_AF2	RESRADB_Ni63_AF2
3	RESRADB_H3_AF3	RESRADB_Mn54_AF3	RESRADB_Na22_AF3	RESRADB_Nb94_AF3	RESRADB_Ni59_AF3	RESRADB_Ni63_AF3
4	RESRADB_H3_AF4	RESRADB_Mn54_AF4	RESRADB_Na22_AF4	RESRADB_Nb94_AF4	RESRADB_Ni59_AF4	RESRADB_Ni63_AF4
5	RESRADB_H3_AF5	RESRADB_Mn54_AF5	RESRADB_Na22_AF5	RESRADB_Nb94_AF5	RESRADB_Ni59_AF5	RESRADB_Ni63_AF5
6	RESRADB_H3_AF6	RESRADB_Mn54_AF6	RESRADB_Na22_AF6	RESRADB_Nb94_AF6	RESRADB_Ni59_AF6	RESRADB_Ni63_AF6
8	RESRADB_H3_AF8	RESRADB_Mn54_AF8	RESRADB_Na22_AF8	RESRADB_Nb94_AF8	RESRADB_Ni59_AF8	RESRADB_Ni63_AF8
10	RESRADB_H3_AF10	RESRADB_Mn54_AF10	RESRADB_Na22_AF10	RESRADB_Nb94_AF10	RESRADB_Ni59_AF10	RESRADB_Ni63_AF10
15	RESRADB_H3_AF15	RESRADB_Mn54_AF15	RESRADB_Na22_AF15	RESRADB_Nb94_AF15	RESRADB_Ni59_AF15	RESRADB_Ni63_AF15
25	RESRADB_H3_AF25	RESRADB_Mn54_AF25	RESRADB_Na22_AF25	RESRADB_Nb94_AF25	RESRADB_Ni59_AF25	RESRADB_Ni63_AF25
50	RESRADB_H3_AF50	RESRADB_Mn54_AF50	RESRADB_Na22_AF50	RESRADB_Nb94_AF50	RESRADB_Ni59_AF50	RESRADB_Ni63_AF50
100	RESRADB_H3_AF100	RESRADB_Mn54_AF100	RESRADB_Na22_AF100	RESRADB_Nb94_AF100	RESRADB_Ni59_AF100	RESRADB_Ni63_AF100
Area (m^2)	RESRAD-Build file name: Pu-238	Pu-239	Pu-240	Pu-241	Sb-125	Sr-90
1	RESRADB_Pu238_AF1	RESRADB_Pu239_AF1	RESRADB_Pu240_AF1	RESRADB_Pu241_AF1	RESRADB_Sb125_AF1	RESRADB_Sr90_AF1
2	RESRADB_Pu238_AF2	RESRADB_Pu239_AF2	RESRADB_Pu240_AF2	RESRADB_Pu241_AF2	RESRADB_Sb125_AF2	RESRADB_Sr90_AF2
3	RESRADB_Pu238_AF3	RESRADB_Pu239_AF3	RESRADB_Pu240_AF3	RESRADB_Pu241_AF3	RESRADB_Sb125_AF3	RESRADB_Sr90_AF3
4	RESRADB_Pu238_AF4	RESRADB_Pu239_AF4	RESRADB_Pu240_AF4	RESRADB_Pu241_AF4	RESRADB_Sb125_AF4	RESRADB_Sr90_AF4
5	RESRADB_Pu238_AF5	RESRADB_Pu239_AF5	RESRADB_Pu240_AF5	RESRADB_Pu241_AF5	RESRADB_Sb125_AF5	RESRADB_Sr90_AF5
6	RESRADB_Pu238_AF6	RESRADB_Pu239_AF6	RESRADB_Pu240_AF6	RESRADB_Pu241_AF6	RESRADB_Sb125_AF6	RESRADB_Sr90_AF6
8	RESRADB_Pu238_AF8	RESRADB_Pu239_AF8	RESRADB_Pu240_AF8	RESRADB_Pu241_AF8	RESRADB_Sb125_AF8	RESRADB_Sr90_AF8
10	RESRADB_Pu238_AF10	RESRADB_Pu239_AF10	RESRADB_Pu240_AF10	RESRADB_Pu241_AF10	RESRADB_Sb125_AF10	RESRADB_Sr90_AF10
15	RESRADB_Pu238_AF15	RESRADB_Pu239_AF15	RESRADB_Pu240_AF15	RESRADB_Pu241_AF15	RESRADB_Sb125_AF15	RESRADB_Sr90_AF15
25	RESRADB_Pu238_AF25	RESRADB_Pu239_AF25	RESRADB_Pu240_AF25	RESRADB_Pu241_AF25	RESRADB_Sb125_AF25	RESRADB_Sr90_AF25
50	RESRADB_Pu238_AF50	RESRADB_Pu239_AF50	RESRADB_Pu240_AF50	RESRADB_Pu241_AF50	RESRADB_Sb125_AF50	RESRADB_Sr90_AF50
100	RESRADB_Pu238_AF100	RESRADB_Pu239_AF100	RESRADB_Pu240_AF100	RESRADB_Pu241_AF100	RESRADB_Sb125_AF100	RESRADB_Sr90_AF100

[a] All listed RESRAD-Build report files have the same extension: "rpt".

Table 2A: Cross Reference for RESRAD-Build Files
(continued)

Area (m^2)	RESRAD-Build report[a] file name: Tc-99
1	RESRADB_Tc99_AF1
2	RESRADB_Tc99_AF2
3	RESRADB_Tc99_AF3
4	RESRADB_Tc99_AF4
5	RESRADB_Tc99_AF5
6	RESRADB_Tc99_AF6
8	RESRADB_Tc99_AF8
10	RESRADB_Tc99_AF10
15	RESRADB_Tc99_AF15
25	RESRADB_Tc99_AF25
50	RESRADB_Tc99_AF50
100	RESRADB_Tc99_AF100

[a] All listed RESRAD-Build report files have the same extension: "rpt".

Table 3: Relative Dose Fractions by Radionuclide and Area Size

Area (m^2)	Dose fraction relative to dose from 100 m^2 area: Ag-108m	Am-241	C-14	Cm-242	Cm-243	Co-60	Cs-134	Cs-137	Eu-152	Eu-154	Eu-155	Fe-55	H-3
1	7.94E-02	1.23E-02	1.24E-02	1.01E-02	1.97E-02	7.92E-02	7.85E-02	7.76E-02	7.87E-02	7.92E-02	7.56E-02	1.00E-02	1.00E-02
2	1.42E-01	2.41E-02	2.42E-02	2.01E-02	3.69E-02	1.41E-01	1.40E-01	1.38E-01	1.41E-01	1.41E-01	1.35E-01	2.00E-02	2.00E-02
3	1.93E-01	3.55E-02	3.56E-02	3.02E-02	5.26E-02	1.92E-01	1.90E-01	1.88E-01	1.91E-01	1.92E-01	1.84E-01	3.01E-02	3.00E-02
4	2.36E-01	4.67E-02	4.68E-02	4.02E-02	6.72E-02	2.35E-01	2.33E-01	2.31E-01	2.34E-01	2.35E-01	2.26E-01	4.01E-02	4.00E-02
5	2.73E-01	5.77E-02	5.77E-02	5.03E-02	8.11E-02	2.72E-01	2.70E-01	2.69E-01	2.71E-01	2.72E-01	2.61E-01	5.01E-02	4.98E-02
6	3.07E-01	6.84E-02	6.85E-02	6.01E-02	9.43E-02	3.05E-01	3.03E-01	2.99E-01	3.04E-01	3.06E-01	2.94E-01	6.01E-02	5.97E-02
8	3.64E-01	8.98E-02	8.98E-02	8.03E-02	1.19E-01	3.62E-01	3.59E-01	3.56E-01	3.60E-01	3.62E-01	3.50E-01	8.00E-02	8.01E-02
10	4.11E-01	1.11E-01	1.11E-01	1.01E-01	1.43E-01	4.09E-01	4.07E-01	4.03E-01	4.08E-01	4.10E-01	3.95E-01	1.00E-01	1.00E-01
15	5.04E-01	1.63E-01	1.63E-01	1.51E-01	1.99E-01	5.00E-01	4.99E-01	4.94E-01	4.99E-01	5.03E-01	4.87E-01	1.50E-01	1.50E-01
25	6.30E-01	2.63E-01	2.63E-01	2.51E-01	3.03E-01	6.28E-01	6.24E-01	6.20E-01	6.25E-01	6.28E-01	6.11E-01	2.51E-01	2.50E-01
50	8.12E-01	5.12E-01	5.11E-01	5.01E-01	5.43E-01	8.10E-01	8.07E-01	8.02E-01	8.06E-01	8.10E-01	7.98E-01	5.01E-01	4.98E-01
100	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Area (m^2)	Dose fraction relative to dose from 100 m^2 area: Mn-54	Na-22	Nb-94	Ni-59	Ni-63	Pu-238	Pu-239	Pu-240	Pu-241	Sb-125	Sr-90	Tc-99
1	7.92E-02	7.92E-02	7.92E-02	1.00E-02	1.00E-02	1.02E-02	1.01E-02	1.02E-02	1.01E-02	7.89E-02	1.82E-02	2.09E-02
2	1.41E-01	1.41E-01	1.41E-01	2.00E-02	1.99E-02	2.03E-02	2.02E-02	2.02E-02	2.02E-02	1.41E-01	3.44E-02	3.90E-02
3	1.92E-01	1.92E-01	1.92E-01	3.00E-02	2.99E-02	3.04E-02	3.02E-02	3.03E-02	3.03E-02	1.92E-01	4.93E-02	5.54E-02
4	2.35E-01	2.35E-01	2.35E-01	4.01E-02	3.99E-02	4.05E-02	4.02E-02	4.03E-02	4.03E-02	2.35E-01	6.31E-02	7.07E-02
5	2.73E-01	2.72E-01	2.73E-01	5.01E-02	4.99E-02	5.06E-02	5.02E-02	5.04E-02	5.04E-02	2.72E-01	7.65E-02	8.49E-02
6	3.06E-01	3.06E-01	2.94E-01	6.01E-02	5.98E-02	6.06E-02	6.02E-02	6.04E-02	6.05E-02	3.06E-01	8.91E-02	9.86E-02
8	3.63E-01	3.63E-01	3.62E-01	8.01E-02	7.99E-02	8.07E-02	8.02E-02	8.05E-02	8.03E-02	3.63E-01	1.13E-01	1.24E-01
10	4.10E-01	4.09E-01	4.10E-01	1.00E-01	1.00E-01	1.01E-01	1.00E-01	1.01E-01	1.00E-01	4.09E-01	1.37E-01	1.49E-01
15	5.03E-01	5.02E-01	5.02E-01	1.50E-01	1.50E-01	1.50E-01	1.50E-01	1.51E-01	1.50E-01	5.02E-01	1.92E-01	2.05E-01
25	6.28E-01	6.25E-01	6.28E-01	2.50E-01	2.50E-01	2.50E-01	2.50E-01	2.50E-01	2.50E-01	6.27E-01	2.95E-01	3.09E-01
50	8.10E-01	8.07E-01	8.11E-01	5.01E-01	4.99E-01	5.00E-01	4.99E-01	5.00E-01	5.00E-01	8.09E-01	5.36E-01	5.50E-01
100	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Table 4: Building Surface Area Factors by Radionuclide and Area Size

Area (m^2)	AF Value: Ag-108m	Am-241	C-14	Cm-242	Cm-243	Co-60	Cs-134	Cs-137	Eu-152	Eu-154	Eu-155	Fe-55	H-3
1	1.3E+01	8.1E+01	8.1E+01	9.9E+01	5.1E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.0E+02	1.0E+02
2	7.1E+00	4.1E+01	4.1E+01	5.0E+01	2.7E+01	7.1E+00	7.1E+00	7.2E+00	7.1E+00	7.1E+00	7.4E+00	5.0E+01	5.0E+01
3	5.2E+00	2.8E+01	2.8E+01	3.3E+01	1.9E+01	5.2E+00	5.3E+00	5.3E+00	5.2E+00	5.2E+00	5.4E+00	3.3E+01	3.3E+01
4	4.2E+00	2.1E+01	2.1E+01	2.5E+01	1.5E+01	4.3E+00	4.3E+00	4.3E+00	4.3E+00	4.3E+00	4.4E+00	2.5E+01	2.5E+01
5	3.7E+00	1.7E+01	1.7E+01	2.0E+01	1.2E+01	3.7E+00	3.7E+00	3.7E+00	3.7E+00	3.7E+00	3.8E+00	2.0E+01	2.0E+01
6	3.3E+00	1.5E+01	1.5E+01	1.7E+01	1.1E+01	3.3E+00	3.3E+00	3.3E+00	3.3E+00	3.3E+00	3.4E+00	1.7E+01	1.7E+01
8	2.8E+00	1.1E+01	1.1E+01	1.2E+01	8.4E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.9E+00	1.3E+01	1.2E+01
10	2.4E+00	9.0E+00	9.0E+00	9.9E+00	7.0E+00	2.4E+00	2.5E+00	2.5E+00	2.5E+00	2.4E+00	2.5E+00	1.0E+01	1.0E+01
15	2.0E+00	6.2E+00	6.1E+00	6.6E+00	5.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.1E+00	6.7E+00	6.7E+00
25	1.6E+00	3.8E+00	3.8E+00	4.0E+00	3.3E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	4.0E+00	4.0E+00
50	1.2E+00	2.0E+00	2.0E+00	2.0E+00	1.8E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00	1.3E+00	2.0E+00	2.0E+00
100	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Area (m^2)	AF Value: Mn-54	Na-22	Nb-94	Ni-59	Ni-63	Pu-238	Pu-239	Pu-240	Pu-241	Sb-125	Sr-90	Tc-99
1	1.3E+01	1.3E+01	1.3E+01	1.0E+02	1.0E+02	9.8E+01	9.9E+01	9.8E+01	9.9E+01	1.3E+01	5.5E+01	4.8E+01
2	7.1E+00	7.1E+00	7.1E+00	5.0E+01	5.0E+01	4.9E+01	5.0E+01	4.9E+01	4.9E+01	7.1E+00	2.9E+01	2.6E+01
3	5.2E+00	5.2E+00	5.2E+00	3.3E+01	3.3E+01	3.3E+01	3.3E+01	3.3E+01	3.3E+01	5.2E+00	2.0E+01	1.8E+01
4	4.3E+00	4.3E+00	4.3E+00	2.5E+01	2.5E+01	2.5E+01	2.5E+01	2.5E+01	2.5E+01	4.3E+00	1.6E+01	1.4E+01
5	3.7E+00	3.7E+00	3.7E+00	2.0E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01	3.7E+00	1.3E+01	1.2E+01
6	3.3E+00	3.3E+00	3.4E+00	1.7E+01	1.7E+01	1.7E+01	1.7E+01	1.7E+01	1.7E+01	3.3E+00	1.1E+01	1.0E+01
8	2.8E+00	2.8E+00	2.8E+00	1.2E+01	1.3E+01	1.2E+01	1.2E+01	1.2E+01	1.2E+01	2.8E+00	8.8E+00	8.0E+00
10	2.4E+00	2.4E+00	2.4E+00	1.0E+01	1.0E+01	9.9E+00	1.0E+01	9.9E+00	1.0E+01	2.4E+00	7.3E+00	6.7E+00
15	2.0E+00	2.0E+00	2.0E+00	6.7E+00	6.7E+00	6.6E+00	6.7E+00	6.6E+00	6.6E+00	2.0E+00	5.2E+00	4.9E+00
25	1.6E+00	1.6E+00	1.6E+00	4.0E+00	4.0E+00	4.0E+00	4.0E+00	4.0E+00	4.0E+00	1.6E+00	3.4E+00	3.2E+00
50	1.2E+00	1.2E+00	1.2E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	1.2E+00	1.9E+00	1.8E+00
100	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table 5: Building Surface Area Factors for Gamma-Emitting Radionuclides

Area (m^2)	AF for various source sizes by radionuclide:										
	Ag-108m	Co-60	Cs-134	Cs-137	Eu-152	Eu-154	Eu-155	Mn-54	Nb-94	Sb-125	Na-22
1	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01
2	7.1E+00	7.1E+00	7.1E+00	7.2E+00	7.1E+00	7.1E+00	7.4E+00	7.1E+00	7.1E+00	7.1E+00	7.1E+00
3	5.2E+00	5.2E+00	5.3E+00	5.3E+00	5.2E+00	5.2E+00	5.4E+00	5.2E+00	5.2E+00	5.2E+00	5.2E+00
4	4.2E+00	4.3E+00	4.3E+00	4.3E+00	4.3E+00	4.3E+00	4.4E+00	4.3E+00	4.3E+00	4.3E+00	4.3E+00
5	3.7E+00	3.7E+00	3.7E+00	3.7E+00	3.7E+00	3.7E+00	3.8E+00	3.7E+00	3.7E+00	3.7E+00	3.7E+00
6	3.3E+00	3.3E+00	3.3E+00	3.3E+00	3.3E+00	3.3E+00	3.4E+00	3.3E+00	3.4E+00	3.3E+00	3.3E+00
8	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.9E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00
10	2.4E+00	2.4E+00	2.5E+00	2.5E+00	2.5E+00	2.4E+00	2.5E+00	2.4E+00	2.4E+00	2.4E+00	2.4E+00
15	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.1E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00
25	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00
50	1.2E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00	1.3E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00
100	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table 6: Building Surface Area Factors for Beta-Emitting Radionuclides

Area (m^2)	C-14	Fe-55	H-3	Ni-59	Ni-63	Sr-90	Tc-99
1	8.1E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02	5.5E+01	4.8E+01
2	4.1E+01	5.0E+01	5.0E+01	5.0E+01	5.0E+01	2.9E+01	2.6E+01
3	2.8E+01	3.3E+01	3.3E+01	3.3E+01	3.3E+01	2.0E+01	1.8E+01
4	2.1E+01	2.5E+01	2.5E+01	2.5E+01	2.5E+01	1.6E+01	1.4E+01
5	1.7E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01	1.3E+01	1.2E+01
6	1.5E+01	1.7E+01	1.7E+01	1.7E+01	1.7E+01	1.1E+01	1.0E+01
8	1.1E+01	1.3E+01	1.2E+01	1.2E+01	1.3E+01	8.8E+00	8.0E+00
10	9.0E+00	1.0E+01	1.0E+01	1.0E+01	1.0E+01	7.3E+00	6.7E+00
15	6.1E+00	6.7E+00	6.7E+00	6.7E+00	6.7E+00	5.2E+00	4.9E+00
25	3.8E+00	4.0E+00	4.0E+00	4.0E+00	4.0E+00	3.4E+00	3.2E+00
50	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	1.9E+00	1.8E+00
100	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table 7: Building Surface Area Factors for Alpha-Emitting Radionuclides

Area (m^2)	Am-241	Cm-242	Cm-243	Pu-238	Pu-239	Pu-240	Pu-241
1	8.1E+01	9.9E+01	5.1E+01	9.8E+01	9.9E+01	9.8E+01	9.9E+01
2	4.1E+01	5.0E+01	2.7E+01	4.9E+01	5.0E+01	4.9E+01	4.9E+01
3	2.8E+01	3.3E+01	1.9E+01	3.3E+01	3.3E+01	3.3E+01	3.3E+01
4	2.1E+01	2.5E+01	1.5E+01	2.5E+01	2.5E+01	2.5E+01	2.5E+01
5	1.7E+01	2.0E+01	1.2E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01
6	1.5E+01	1.7E+01	1.1E+01	1.7E+01	1.7E+01	1.7E+01	1.7E+01
8	1.1E+01	1.2E+01	8.4E+00	1.2E+01	1.2E+01	1.2E+01	1.2E+01
10	9.0E+00	9.9E+00	7.0E+00	9.9E+00	1.0E+01	9.9E+00	1.0E+01
15	6.2E+00	6.6E+00	5.0E+00	6.6E+00	6.7E+00	6.6E+00	6.6E+00
25	3.8E+00	4.0E+00	3.3E+00	4.0E+00	4.0E+00	4.0E+00	4.0E+00
50	2.0E+00	2.0E+00	1.8E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00
100	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Figure 1: Building Surface Area Factors for Gamma-Emitting Radionuclides

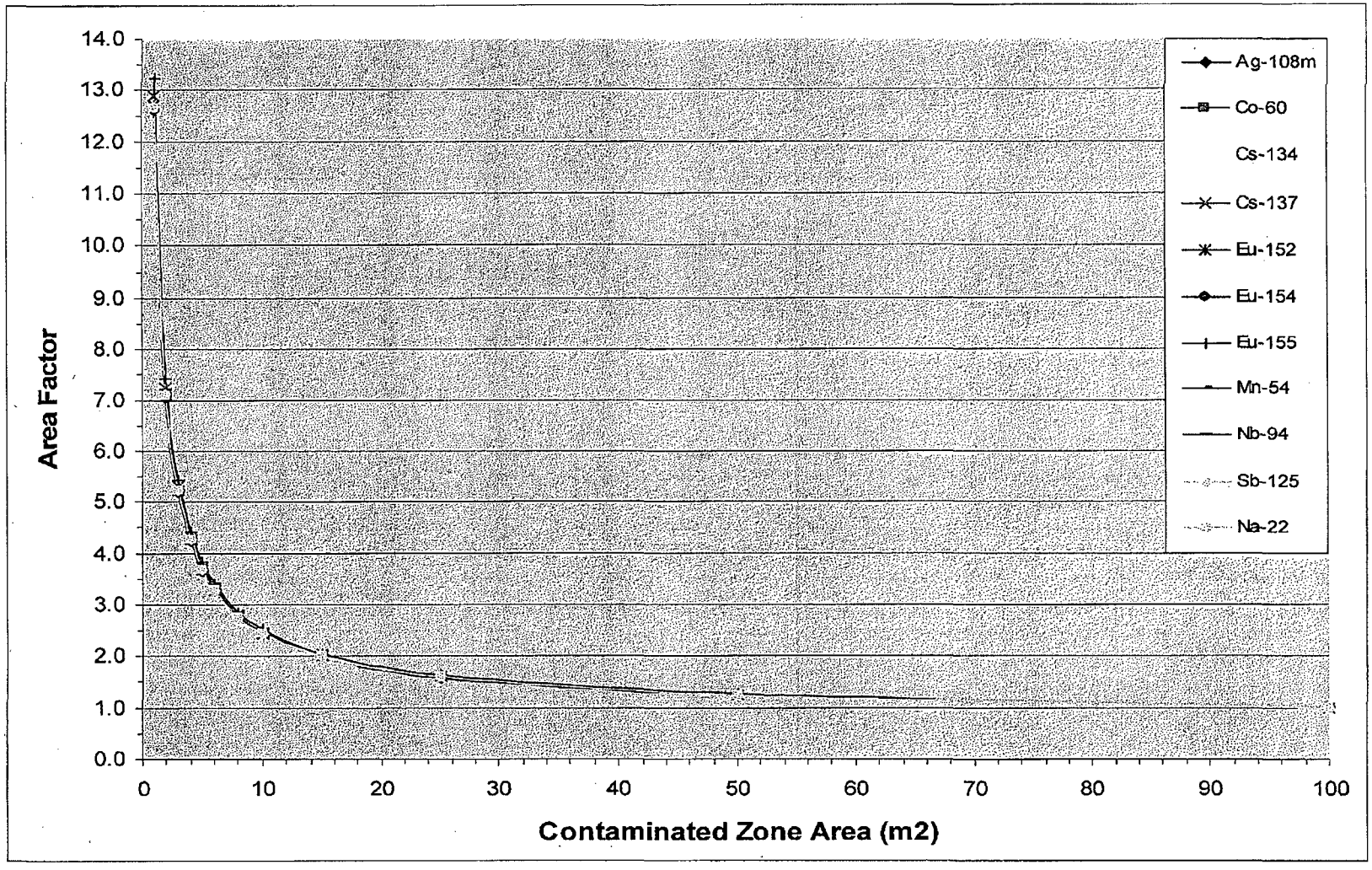

Figure 2: Building Surface Area Factors for Beta-Emitting Radionuclides

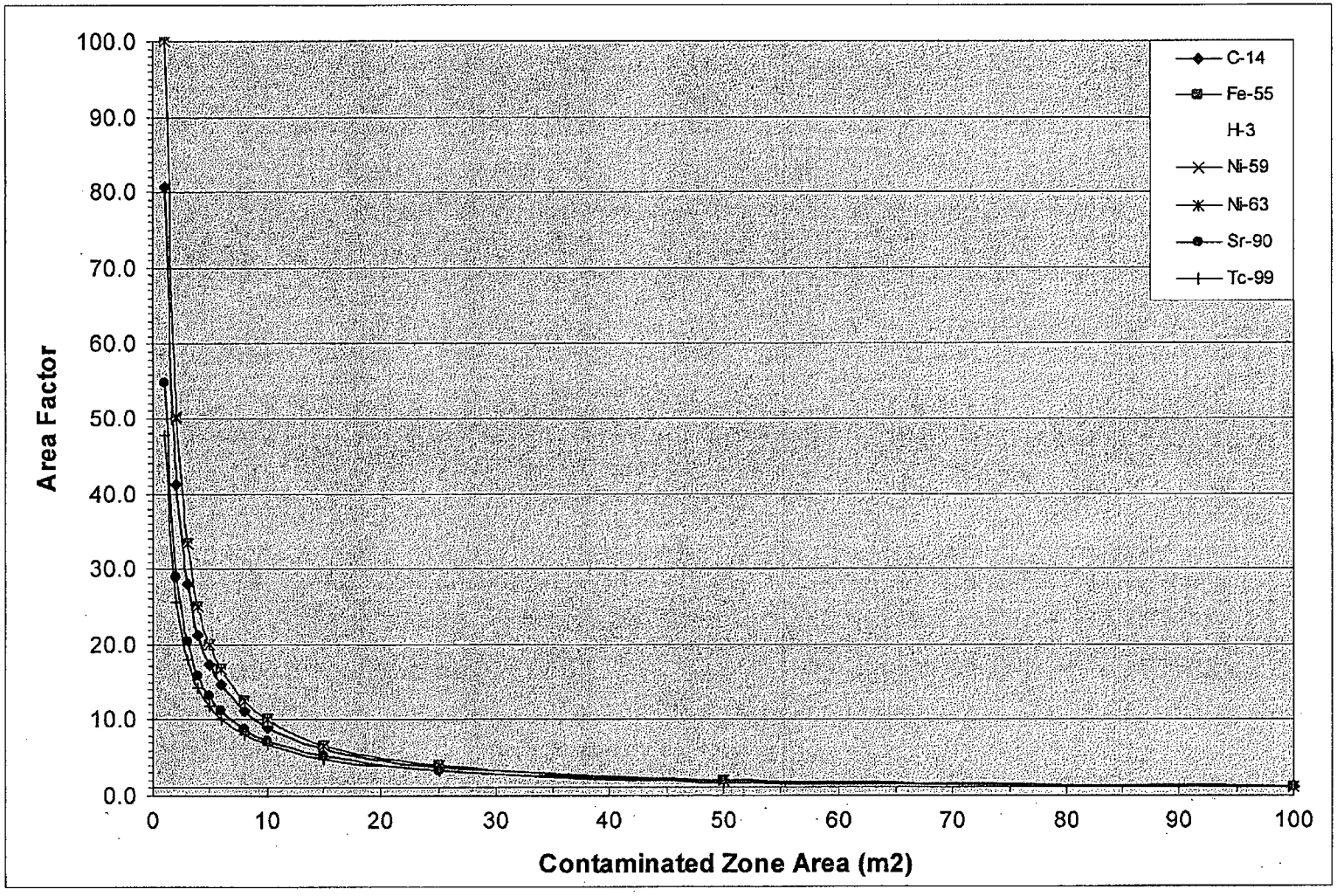
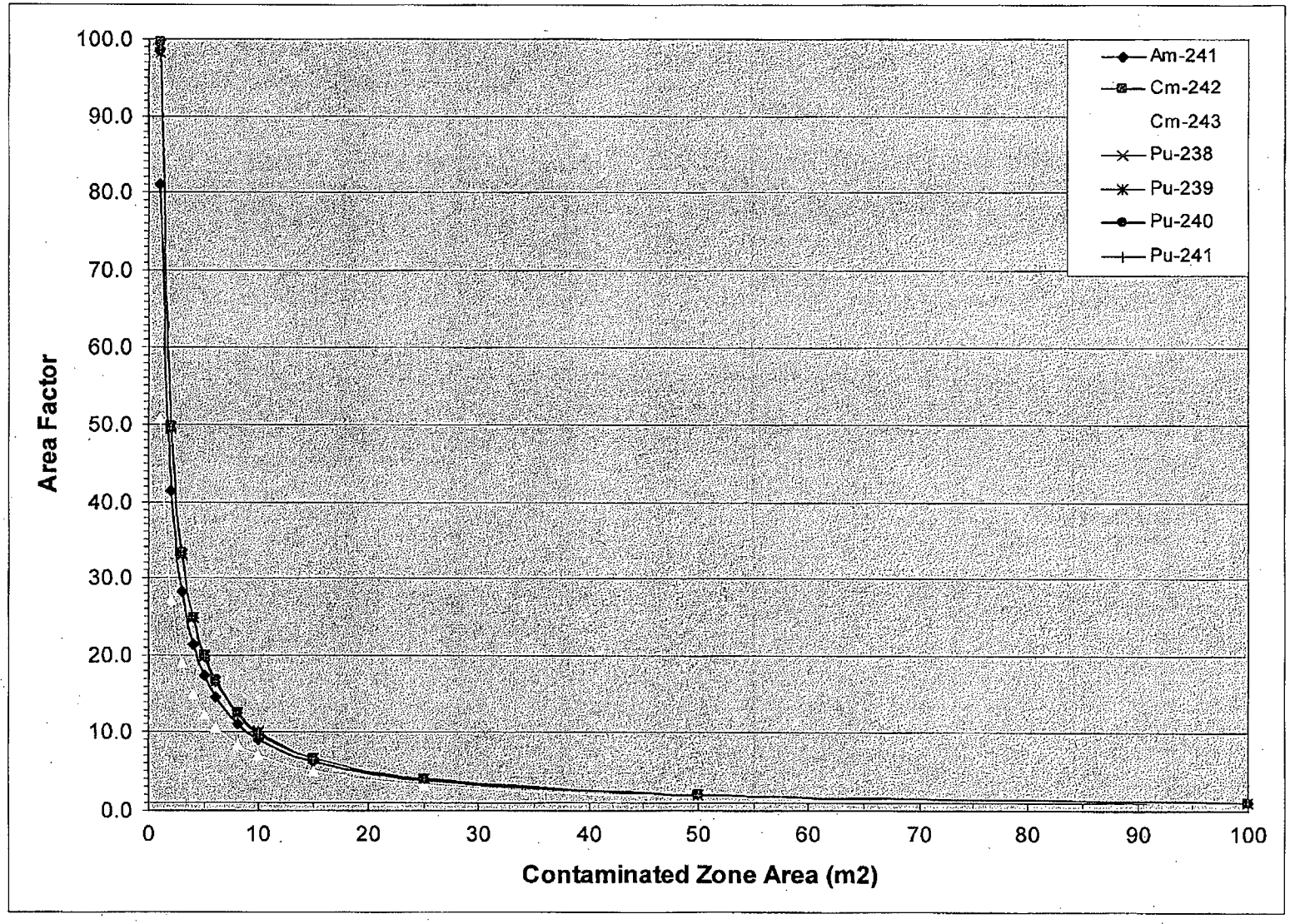
Figure 3: Building Surface Area Factors for Alpha-Emitting Radionuclides