Relocation Impacts of an H-Separations Coil and Tube Failure

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DOE Contract No. **DE-AC09-96SR18500**

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Keywords: Relocation
Emergency Planning

Retention: Lifetime

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June 1999

Classification

UNCLASSIFIED

DOES NOT CONTAIN
UNCLASSIFIED CONTROLLED
NUCLEAR INFORMATION

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PROJECT: N/A

DOCUMENT: WSRC-TR-99-00104

TITLE: Relocation Impacts of an H-Separations Coil and
Tube Failure (U)

REVISION NUMBER: 1

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Abstract

The relocation impacts of an accidental release, scenario 1-RD-2.35, are evaluated for H-Separations. The extent of the area potentially contaminated to a level that would result in doses exceeding the relocation protective action guide (PAG) is calculated. The maximum calculated distance downwind from the accident at which the relocation PAG is exceeded is also determined. The consequences of the release are evaluated using the HOTSPOT model and an EXCEL spreadsheet.

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Introduction

The relocation impacts of an accidental release, scenario 1-RD-2.35, are evaluated for H-Separations. The sizes of the area requiring the protective action of relocation, as well as the maximum distances out to which protective action would be recommended, are calculated.

Approach

The methodology for determining the areas potentially requiring relocation is outlined below.

1. Determine the source terms (radionuclide-specific respirable and total airborne releases).
2. Determine the relocation Protective Action Guides (PAGs) for the radionuclides in the source terms in accordance with EPA (1992).
3. Calculate the doses (from inhalation and ground shine) associated with a unit deposition of (respirable) particulates. The inhalation source term is derived from the respirable airborne release. The ground shine source term is derived from the total (nonrespirable plus respirable) airborne release.
4. Sum the doses resulting from the unit deposition. Divide the relocation PAG by the sum of the doses to obtain the Derived Response Level (DRL) for relocation.
5. Run the dispersion/deposition model HOTSPOT (Homann 1994) to determine areas impacted.

Background

The area affected is considered to be that area in which the deposition due to an accidental release could cause the projected dose to an individual in that area to exceed the PAG. The Environmental Protection Agency (EPA) presents the rationale for its relocation PAG in its *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* (EPA 1992, section 4.2.1, p. 4-4 and Appendix E). The objectives of the relocation PAG are to keep the dose in any year after the first year following the accident from exceeding 500 mrem (5 mSv), and to keep the cumulative dose over 50 years (including the first year) from exceeding 5,000 mrem (50 mSv). For the reactor accidents addressed in EPA (1992), the PAG is 2,000 mrem (20 mSv) projected dose*. Additionally, it specifies that at 50 times the numerical value of the PAG, relocation to limit beta exposure to skin would be warranted.

For fission product releases, relocation decisions are based on whole body irradiation (or effective dose equivalent); preferential irradiation of single tissues is not anticipated to be limiting. However, the radiological hazards associated with many radionuclides (such as plutonium and other actinides) differ significantly from those of the fission product mix considered in EPA (1992). Guidance from the ICRP gives dose limits to single tissues, based on

* The projected sum of effective dose equivalent from external gamma radiation and committed effective dose equivalent from inhalation of resuspended materials, from exposure or intake during the first year.

non-stochastic effects that are a factor of ten greater than the effective dose limit based on stochastic effects (ICRP 1977). In general, the radiation associated with the decay of fission products is very penetrating and presents an external hazard (i.e., a person need only be exposed to the radioactive material to receive a dose; the material does not have to be ingested or inhaled) or a whole body irradiation hazard (material inside the body irradiates many tissues as it decays). The radiation associated with the decay of many actinides is not very penetrating and, therefore, only presents a significant radiological hazard when the material is taken into the body, either by inhalation or ingestion. Even then, specific organs are more limiting based on the radiosensitivity of the organ and the distribution of the radionuclides in the body. For the inhalation and ingestion pathways the dose to bone surfaces is more limiting than the effective dose for many actinides.

In order to facilitate comparisons between measured quantities and projected doses, it is often convenient to express a projected dose in terms of a measurable quantity. The value of a measurable quantity that corresponds to a dose value of interest (such as a PAG) is referred to as a derived response level (DRL). Spreadsheet calculations were performed to determine the relocation DRLs for the nuclide mix of interest. These DRLs were then used in conjunction with the HOTSPOT computer model to determine the size or extent of the area affected.

Analysis

Source term

For H-Separations, the postulated source term for the Coil & Tube Release Scenario, 1-RD-2.35, is evaluated. Respirable releases are the same as total releases for each radionuclide since the respirable fraction (RF) is 1.0 (S-CLC-G-00004, Sheet 6, section 3.2). S-CLC-G-00004 contains the source term calculations used ultimately in the *Interim Emergency Preparedness Hazards Assessment for H Area Separations*, S-EHA-H-00004 (Burns and Clifton 1998). The source terms are listed in Table 1.

Table 1. H-Separations airborne source term, 1-RD-2.35

Nuclide	Airborne Release (Ci)
Am-241	6.57E-01
Pu-238	1.62E+00
Pu-239	4.23E-03
Pu-240	2.43E-01
Pu-241	3.26E+01
Pu-242	1.54E-02
Total	3.51E+01

Reference: Source_terms_reloc.xls, Worksheet "Relo_H", column C.

Protective action guides

For evaluating the size of the area affected by potential accidents, relocation PAGs were used. Consideration was given to both effective dose and dose to bone surfaces. Since dose limits to single tissues, based on non-stochastic effects, are a factor of ten greater than the effective dose limit based on stochastic effects (ICRP 1977); the limit used for single tissues (e.g., bone

surfaces) was ten times that used for effective dose. These PAG values were used for evaluating the size of the area in which relocation may be warranted as a consequence of potential accidents.

For releases consisting primarily of long-lived radionuclides, the relocation PAG level of 2,000 mrem (20 mSv) in the first year may not, by itself, provide the intended level of long-term protection. The relocation PAG is intended to prevent doses exceeding 500 mrem (5 mSv) in any year after the first year following the accident, or 5,000 mrem (50 mSv) over the fifty years immediately following the accident. The relocation PAG values for projected doses that were considered for this work are presented in Table 2.

Table 2. PAG values used in this analysis

PAG	Timeframe
2,000 mrem (20 mSv) effective dose, or 20,000 mrem (200 mSv) committed dose equivalent to a single tissue or organ	the first year following an accident
500 mrem (5 mSv) effective dose, or 5,000 mrem (50 mSv) committed dose equivalent to a single tissue or organ	any year after the first year following an accident
5,000 mrem (50 mSv) effective dose, or 50,000 mrem (500 mSv) committed dose equivalent to a single tissue or organ	the 50 years (including the first year) following an accident

The effective dose is the “projected sum of effective dose equivalent from external gamma radiation and committed effective dose equivalent from inhalation of resuspended materials, from exposure or intake during the” time period of interest (EPA 1992). Similarly, the dose to an individual organ should consider both the committed dose from any intake plus any external contribution to dose, if significant.

Determination of the DRL

The respirable fraction (RF) is equal to unity for the release considered here, so the respirable release is equal to the total release. The first step in determining the DRL is to assume a unit deposition ($1 \mu\text{Ci}/\text{m}^2$) of the nuclide mix of interest, and that all radionuclides in the mix deposit similarly. In this case, the relative concentrations of the deposited material will be the same as that released.

The deposited activity can be apportioned to the individual nuclides based on the activity fraction (the ratio of the individual nuclide activity to the total activity) of the material released. That is: where

$$dep_i = dep_{Total} \left(\frac{A_i}{A_{Total}} \right)$$

dep_i = the deposition concentration of the i^{th} nuclide in $\mu\text{Ci}/\text{m}^2$

dep_{Total} = the total deposition concentration ($1 \mu\text{Ci}/\text{m}^2$)

A_i = the activity of the i^{th} nuclide (Ci)

A_{Total} = the total activity released (Ci)

The quantities of the individual radionuclides present for this unit deposition are given in Table 3. Attachment A presents applicable spreadsheet calculations.

Table 3. Areal concentrations for a unit deposition

Nuclide	Areal concentration ($\mu\text{Ci m}^{-2}$) per 1 $\mu\text{Ci m}^{-2}$ deposition of mix
Am-241	1.87E-02
Pu-238	4.61E-02
Pu-239	1.20E-04
Pu-240	6.92E-03
Pu-241	9.28E-01
Pu-242	4.38E-04

Reference: Source_terms_reloc.xls, Worksheet "Relo_H", column D

Inhalation dose conversion factors (DCFs) are from Federal Guidance Report 11 (EPA 1988). The lung clearance class for each nuclide was chosen to maximize the effective dose. For most nuclides this also maximized the bone surface DCF. External exposure DCFs are from DOE/EH-0070 (1988). To simplify calculations, and due to the anticipated small contribution of the external dose relative to the internal doses, the external contribution to the bone surface dose was approximated by the external contribution to the effective dose. For this nuclide mix and exposure scenario, this approximation did not introduce any appreciable error.

The amount of deposition for each nuclide determined above is used to calculate the dose contributed by that nuclide for both the external gamma exposure and inhalation of resuspended material pathways for both effective and organ doses. These internal and external components are then summed over the nuclides present and combined to give the effective dose and the organ dose equivalent due to a unit deposition of material. These calculations consider weathering and are performed for three time periods. Specifically, the cases considered were those indicated in Table 2 above with the dose in "any year after the first year following an accident" being represented by the dose in the second year following an accident. Weathering is modeled using the method presented in EPA (1992) where the weathering factor (WF) is defined as

$$WF = \frac{0.63}{\lambda_1 + \lambda_2} (1 - e^{-(\lambda_1 + \lambda_2)t}) + \frac{0.37}{\lambda_1 + \lambda_3} (1 - e^{-(\lambda_1 + \lambda_3)t})$$

where

- t = time during which radionuclides are inhaled (or exposure occurs),
- λ_1 = radioactive decay constant,
- λ_2 = assumed weathering decay constant for 63 percent of the deposited activity, taken as 1.13 per year, and
- λ_3 = assumed weathering decay constant for 37 percent of the deposited activity, taken as 7.48E-3 per year.

This weathering factor is used as the time period over which exposure occurs.

For a deposition of 1 $\mu\text{Ci m}^{-2}$ of the 1-RD-2.35 mix and a fifty-year exposure period, the inhalation dose (CEDE) is 4,950 mrem, the committed dose to bone surfaces (BS dose) is 89,500 mrem, and the external exposure is 0.9 mrem. Adding the external and internal doses gives 4,950 mrem effective dose and 89,500 mrem to bone surfaces for a deposition of 1 $\mu\text{Ci m}^{-2}$ of activity.

The DRLs may now be determined by dividing the PAGs by their corresponding dose per unit deposition. The DRLs associated with the effective and bone surface doses are much more limiting than those associated with the skin dose and are presented in Table 4. "Bone-surface dose" is the CDE to the bone surfaces. The DRLs calculated using the dose due to fifty years of exposure are the most limiting. Therefore, the DRLs presented for further analysis are those associated with effective and bone surface doses for fifty years of exposure. Details of the spreadsheet calculations are in Attachment A.

Table 4. PAGs and DRLs

PAG (mrem)	Description	DRL ($\mu\text{Ci m}^{-2}$)	DRL Formula
2000	Effective dose, first year, no weathering	5.1	$\text{DRL} = \text{PAG}/(\text{CEDE} + \text{External})$
20000	Bone-surface dose, first year, no weathering	2.8	$\text{DRL} = \text{PAG}/(\text{BS Dose} + \text{External})$
2000	Effective dose, first year, with weathering	6.9	$\text{DRL} = \text{PAG}/(\text{CEDE} + \text{External})$
20000	Bone-surface dose, first year, with weathering	3.8	$\text{DRL} = \text{PAG}/(\text{BS Dose} + \text{External})$
500	Effective dose, second year, with weathering	2.7	$\text{DRL} = \text{PAG}/(\text{CEDE} + \text{External})$
5000	Bone-surface dose, second year, with weathering	1.5	$\text{DRL} = \text{PAG}/(\text{BS Dose} + \text{External})$
5000	Effective dose, fifty years, with weathering	1.0	$\text{DRL} = \text{PAG}/(\text{CEDE} + \text{External})$
50000	Bone-surface dose, fifty years, with weathering	0.56	$\text{DRL} = \text{PAG}/(\text{BS Dose} + \text{External})$

Reference: Source_terms_reloc.xls_50yr, Worksheet "Relo_H DRLs Summary".

Determination of range and area of consequences

The HOTSPOT computer code was selected to evaluate the consequences of particulate releases (WSRC-TR-98-00392). In the following calculations, a source term equal to the total activity (35.1 Ci) is used, and the range and area affected for different meteorological parameters and DRLs are found. Pasquill-Briggs dispersion parameters are used.

HOTSPOT Parameters used for the H-Area Coil and Tube release are listed in Table 5.

Table 5. HOTSPOT Parameters used for the H-Separations Coil & Tube release (1-RD-2.35)

Parameter	Average Meteorology	95% Adverse Meteorology
Release height	Ground	Ground
Wind speed	2.5 m/s	1.7 m/s
Surface roughness	100 cm	100 cm
Stability class	C	E
Deposition velocity	0.1/1/10 cm/sec	0.1/1/10 cm/sec
Release duration	120 min	120 min
Inversion layer	500 m	200 m

Meteorological data are consistent with the HSEP IEPHA, Rev. 1 (S-EHA-H-00004 *Interim Emergency Preparedness Hazards Assessment for H Area Separations*, Appendix B, Calculation

5, Sheet 1), which references *Consequence Assessment for Emergency Preparedness Hazards Assessments*, TP-95-002, Revision 3, January 21, 1997.

Results

Tables 6 through 9 present results obtained for an H-Separations Coil and Tube Failure accident using the HOTSPOT computer code. The plots from which these data were obtained are included in Attachments B through G. For the average meteorology case, Tables 6 and 7 present the ranges and areas, respectively. Tables 8 and 9 contain results for runs made using adverse meteorological data.

Table 6. Ranges (in km) until deposition less than relocation DRL, average meteorology, H-Separations, 1-RD-2.35

Basis for DRL	DRL ($\mu\text{Ci m}^{-2}$)	Deposition Velocity		
		0.1 cm s ⁻¹	1 cm s ⁻¹	10 cm s ⁻¹
Effective dose	1.0E+00	0.25	0.82	1.8
Bone Surface Dose	5.6E-01	0.34	1.1	3.5

Table 7. Areas (in km²) with deposition above relocation DRL, average meteorology, H-Separations, 1-RD-2.35

Basis for DRL	DRL ($\mu\text{Ci m}^{-2}$)	Deposition Velocity		
		0.1 cm s ⁻¹	1 cm s ⁻¹	10 cm s ⁻¹
Effective dose	1.0E+00	1.7E-02	1.7E-01	8.2E-01
Bone Surface Dose	5.6E-01	3.0E-02	3.0E-01	1.9E-00

Table 8. Ranges (in km) until deposition less than relocation DRL, 95% adverse meteorology, H-Separations, 1-RD-2.35

Basis for DRL	DRL ($\mu\text{Ci m}^{-2}$)	Deposition Velocity		
		0.1 cm s ⁻¹	1 cm s ⁻¹	10 cm s ⁻¹
Effective dose	1.0E+00	0.9	3.5	2.4
Bone Surface Dose	5.6E-01	1.3	5.5	3.3

Table 9. Areas (in km²) with deposition above relocation DRL, 95% adverse meteorology, H-Separations, 1-RD-2.35

Basis for DRL	DRL ($\mu\text{Ci m}^{-2}$)	Deposition Velocity		
		0.1 cm s ⁻¹	1 cm s ⁻¹	10 cm s ⁻¹
Effective dose	1.0E+00	9.1E-02	1.1E+00	6.4E-01
Bone Surface Dose	5.6E-01	1.8E-01	2.4E+00	1.1E+00

Conclusion

Since the site boundary is over 11 km from H-area, no relocation protective actions are likely to be recommended for this scenario.

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Attachments

Attachment A

Spreadsheet calculations

Attachment B

HOTSPOT results - average meteorology, 0.1 cm s^{-1}

Attachment C

HOTSPOT results - average meteorology, 1.0 cm s^{-1}

Attachment D

HOTSPOT results - average meteorology, 10 cm s^{-1}

Attachment E

HOTSPOT results - adverse meteorology, 0.1 cm s^{-1}

Attachment F

HOTSPOT results - adverse meteorology, 1.0 cm s^{-1}

Attachment G

HOTSPOT results - adverse meteorology, 10 cm s^{-1}

Attachment A

Spreadsheet calculations

	A	B	C	D	E	F	G	H	J
3								CEDE	CDE B.S.
4								Inhalation	Inhalation
5							Class	DCF	DCF
6					DCF External			FGR-11	FGR-11
7					Effective Skin	(D,W,Y)		Sv/Bq	Sv/Bq
8	Element	At. No.	Half-life	units	mrem/yr	per mrem/yr	per uCi/m ²		
9									
10	Am	241	458 y		2.99E+00	6.39E+00	W# BS	1.20E-04	2.17E-03
11	Am	243	7.95E+03 y		6.61E+00	1.06E+01	W#	1.19E-04	2.17E-03
12	Ba	133	10.5 y		4.19E+01	5.82E+01	D	2.11E-09	9.51E-09
13	Ce	144	284 d		2.16E+00	2.86E+00	Y	1.01E-07	4.72E-09
14	Cf	249	360 y		3.52E+01	4.76E+01	W#	1.56E-04	3.32E-03
15	Cf	252	2.646 y		6.34E-02	4.66E-01	Y *	4.24E-05	1.37E-04
16	Cm	244	17.6 y		8.29E-02	6.56E-01	W#	6.70E-05	1.17E-03
17	Cm	246	5.50E+03 y		7.34E-02	5.84E-01	W#	1.22E-04	2.22E-03
18	Co	60	5.26 y		2.27E+02	3.05E+02	Y	5.91E-08	1.35E-08
19	Cs	137	30 y		0.00E+00	2.81E+01	D	8.63E-09	7.94E-09
20	H	3	12.3 y		0.00E+00	0.00E+00	V*	1.73E-11	1.73E-11
21	Np	237	2.14E+06 y		3.24E+00	7.54E+00	W#	1.46E-04	3.27E-03
22	Pm	147	2.62 y		4.10E-04	4.96E-04	Y *	1.06E-08	2.01E-08
23	Pu	238	86.4 y		8.58E-02	7.17E-01	W#	1.06E-04	1.90E-03
24	Pu	239	24390 y		3.78E-02	2.80E-01	W#	1.16E-04	2.11E-03
25	Pu	239/241							
26	Pu	240	6580 y		8.20E-02	6.83E-01	W#	1.16E-04	2.11E-03
27	Pu	241	13.2 y		0.00E+00	0.00E+00	W#	2.23E-06	4.20E-05
28	Pu	242	3.79E+05 y		6.82E-02	5.67E-01	W#	1.11E-04	2.01E-03
29	Sr	90	28.1 y		0.00E+00	1.73E+01	Y *	3.51E-07	7.09E-08
30	Tc	99	2.12E+05 y		6.26E-05	7.73E-05	W	2.25E-09	3.99E-11
31	Th	232	1.40E+10 y		6.66E-02	4.85E-01	W	4.43E-04	1.11E-02
32	Tl	204	3.8 y		1.30E-01	1.35E+02	D	6.50E-10	4.15E-10
33	U	235	7.10E+08 y		1.71E+01	2.27E+01	Y *	3.32E-05	1.05E-06
34	U	238	4.51E+09 y		6.46E-02	5.30E-01	Y *	3.20E-05	1.01E-06
35									
36	Ba	137m	2.552 m		6.11E+01	1.91E+02			
37	Y	90	64.1 h		0.00E+00	1.03E+03			
38	Pr	144	17.28 m		2.98E+00	1.49E+03	* = Different limiting organ for		
39	Pa	233	27 d		2.36E+01	3.28E+01	different solubility class		
40	Th	234	24.1 d		1.01E+00	1.77E+00			
41	Pa	234	6.7 h		1.96E+02	4.04E+02			
42	Np	239	2.355 d		1.92E+01	2.98E+01			
43	Th	231	25.52 h		1.91E+00	6.42E+00			
44	Ra	228	5.75 y		6.67E-08	8.02E-07			
45	Ac	228	6.13 h		9.10E+01	5.03E+02			

	A	B	C	D	E	F	G	H	I	J	K	L
1	Relocation calculation for H-Separations accident.											
2	Calculation of DCF for dose from resuspended deposited radionuclides (EPA PAG manual 1991, section 7.3.2, p. 7-15)											
3	1.00E-06 Resuspension factor (1/m)						2000 PAG -- Effective Dose (mrem)					
4	1.05E+04 BreathRate (m^3/yr)						20000 PAG -- Organ-specific Dose (mrem)					
5	3.70E+04 CF (Bq/microCi)						100000 PAG -- Skin (mrem)					
6	1.00E+05 CF (mrem/Sv)											
7	1.00E+00 microCi/m^2						PAG = Protective Action Guide					
8	1.00E+00 Exposure period (1 year)											

	B	C	D	E	F	G	H	I	J	P	Q	R
					CEDE	External EDE						
9	Nuclide	Release (Ci)	Activity fraction		(mrem per uCi/m^2)	(mrem per uCi/m^2)			Skin Dose (mrem per uCi/m^2)	BS Dose (mrem per uCi/m^2)		
10	Am-241	6.57E-01	1.87E-02		8.72E+01	5.59E-02			1.19E-01	1.58E+03		
11	Am-243	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
12	Ba-133	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
13	Ce-144	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
14	Cf-249	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
15	Cf-252	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
16	Cm-244	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
17	Cm-246	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
18	Co-60	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
19	Cs-137	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
20	H-3	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
21	Np-237	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
22	Pm-147	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
23	Pu-238	1.62E+00	4.61E-02		1.90E+02	3.96E-03			3.31E-02	3.40E+03		
24	Pu-239	4.23E-03	1.20E-04		5.42E-01	4.55E-06			3.37E-05	9.87E+00		
25	Pu-239/241	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
26	Pu-240	2.43E-01	6.92E-03		3.12E+01	5.67E-04			4.72E-03	5.67E+02		
27	Pu-241	3.26E+01	9.28E-01		8.04E+01	0.00E+00			0.00E+00	1.51E+03		
28	Pu-242	1.54E-02	4.38E-04		1.89E+00	2.99E-05			2.48E-04	3.42E+01		
29	Sr-90	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
30	Tc-99	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
31	Th-232	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
32	Tl-204	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
33	U-235	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
34	U-238	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00		
35												
36	Ba-137m	0.00E+00	0.00E+00									
37	Y-90	0.00E+00	0.00E+00									
38												
39	Total	3.51E+01	1.00E+00		3.91E+02	6.05E-02			1.58E-01	7.10E+03		

	B	C	D	E	F
9	Nuclide	Release (Ci)	Activity fraction	CEDE (mrem per uCi/m ²)	
10	Am-241	=Relocation!Y10	=C10/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D10*Relocation!H10	
11	Am-243	=Relocation!Y11	=C11/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D11*Relocation!H11	
12	Ba-133	=Relocation!Y12	=C12/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D12*Relocation!H12	
13	Ce-144	=Relocation!Y13	=C13/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D13*Relocation!H13	
14	Cf-249	=Relocation!Y14	=C14/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D14*Relocation!H14	
15	Cf-252	=Relocation!Y15	=C15/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D15*Relocation!H15	
16	Cm-244	=Relocation!Y16	=C16/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D16*Relocation!H16	
17	Cm-246	=Relocation!Y17	=C17/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D17*Relocation!H17	
18	Co-60	=Relocation!Y18	=C18/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D18*Relocation!H18	
19	Cs-137	=Relocation!Y19	=C19/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D19*Relocation!H19	
20	H-3	=Relocation!Y20	=C20/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D20*Relocation!H20	
21	Np-237	=Relocation!Y21	=C21/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D21*Relocation!H21	
22	Pm-147	=Relocation!Y22	=C22/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D22*Relocation!H22	
23	Pu-238	=Relocation!Y23	=C23/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D23*Relocation!H23	
24	Pu-239	=Relocation!Y24	=C24/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D24*Relocation!H24	
25	Pu-239/241	=Relocation!Y25	=C25/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D25*Relocation!H25	
26	Pu-240	=Relocation!Y26	=C26/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D26*Relocation!H26	
27	Pu-241	=Relocation!Y27	=C27/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D27*Relocation!H27	
28	Pu-242	=Relocation!Y28	=C28/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D28*Relocation!H28	
29	Sr-90	=Relocation!Y29	=C29/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D29*Relocation!H29	
30	Tc-99	=Relocation!Y30	=C30/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D30*Relocation!H30	
31	Th-232	=Relocation!Y31	=C31/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D31*Relocation!H31	
32	Tl-204	=Relocation!Y32	=C32/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D32*Relocation!H32	
33	U-235	=Relocation!Y33	=C33/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D33*Relocation!H33	
34	U-238	=Relocation!Y34	=C34/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$B\$8*D34*Relocation!H34	
35					
36	Ba-137m	=Relocation!Y36	=C36/\$C\$39		
37	Y-90	=Relocation!Y37	=C37/\$C\$39		
38					
39	Total	=SUM(C10:C38)	=SUM(D10:D38)	=SUM(F10:F38)	

	G	H	I	J
9	External EDE (mrem per uCi/m ²)	Skin Dose (mrem per uCi/m ²)	BS Dose (mrem per uCi/m ²)	
10	=B\$7*B\$8*D10*Relocation!E10	=B\$7*B\$8*D10*Relocation!\$F10	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D10*Relocation!\$J10	
11	=B\$7*B\$8*D11*Relocation!E11	=B\$7*B\$8*D11*Relocation!\$F11	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D11*Relocation!\$J11	
12	=B\$7*B\$8*D12*Relocation!E12	=B\$7*B\$8*D12*Relocation!\$F12	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D12*Relocation!\$J12	
13	=B\$7*B\$8*D13*Relocation!E13	=B\$7*B\$8*D13*Relocation!\$F13	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D13*Relocation!\$J13	
14	=B\$7*B\$8*D14*Relocation!E14	=B\$7*B\$8*D14*Relocation!\$F14	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D14*Relocation!\$J14	
15	=B\$7*B\$8*D15*Relocation!E15	=B\$7*B\$8*D15*Relocation!\$F15	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D15*Relocation!\$J15	
16	=B\$7*B\$8*D16*Relocation!E16	=B\$7*B\$8*D16*Relocation!\$F16	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D16*Relocation!\$J16	
17	=B\$7*B\$8*D17*Relocation!E17	=B\$7*B\$8*D17*Relocation!\$F17	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D17*Relocation!\$J17	
18	=B\$7*B\$8*D18*Relocation!E18	=B\$7*B\$8*D18*Relocation!\$F18	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D18*Relocation!\$J18	
19	=B\$7*B\$8*D19*Relocation!E19	=B\$7*B\$8*D19*Relocation!\$F19	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D19*Relocation!\$J19	
20	=B\$7*B\$8*D20*Relocation!E20	=B\$7*B\$8*D20*Relocation!\$F20	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D20*Relocation!\$J20	
21	=B\$7*B\$8*D21*Relocation!E21	=B\$7*B\$8*D21*Relocation!\$F21	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D21*Relocation!\$J21	
22	=B\$7*B\$8*D22*Relocation!E22	=B\$7*B\$8*D22*Relocation!\$F22	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D22*Relocation!\$J22	
23	=B\$7*B\$8*D23*Relocation!E23	=B\$7*B\$8*D23*Relocation!\$F23	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D23*Relocation!\$J23	
24	=B\$7*B\$8*D24*Relocation!E24	=B\$7*B\$8*D24*Relocation!\$F24	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D24*Relocation!\$J24	
25	=B\$7*B\$8*D25*Relocation!E25	=B\$7*B\$8*D25*Relocation!\$F25	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D25*Relocation!\$J25	
26	=B\$7*B\$8*D26*Relocation!E26	=B\$7*B\$8*D26*Relocation!\$F26	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D26*Relocation!\$J26	
27	=B\$7*B\$8*D27*Relocation!E27	=B\$7*B\$8*D27*Relocation!\$F27	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D27*Relocation!\$J27	
28	=B\$7*B\$8*D28*Relocation!E28	=B\$7*B\$8*D28*Relocation!\$F28	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D28*Relocation!\$J28	
29	=B\$7*B\$8*D29*Relocation!E29	=B\$7*B\$8*D29*Relocation!\$F29	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D29*Relocation!\$J29	
30	=B\$7*B\$8*D30*Relocation!E30	=B\$7*B\$8*D30*Relocation!\$F30	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D30*Relocation!\$J30	
31	=B\$7*B\$8*D31*Relocation!E31	=B\$7*B\$8*D31*Relocation!\$F31	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D31*Relocation!\$J31	
32	=B\$7*B\$8*D32*Relocation!E32	=B\$7*B\$8*D32*Relocation!\$F32	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D32*Relocation!\$J32	
33	=B\$7*B\$8*D33*Relocation!E33	=B\$7*B\$8*D33*Relocation!\$F33	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D33*Relocation!\$J33	
34	=B\$7*B\$8*D34*Relocation!E34	=B\$7*B\$8*D34*Relocation!\$F34	=B\$7*B\$3*B\$4*B\$5*B\$6*B\$8*D34*Relocation!\$J34	
35				
36				
37				
38				
39	=SUM(G10:G38)	=SUM(I10:I38)	=SUM(J10:J38)	

	E	F	G
44	5.11E+00	DRL (uCi/m^2) -- PAG/(CEDE+External)	
45	2.82E+00	DRL (uCi/m^2) -- PAG/(BS Dose + External)	
46	6.35E+05	DRL (uCi/m^2) -- PAG/(Skin Dose)	
47			

	E	F	G
44	=G3/(F39+G39)	DRL (uCi/m^2) -- PAG/(CEDE+External)	
45	=G4/(J39+G39)	DRL (uCi/m^2) -- PAG/(BS Dose + External)	
46	=G5/I39	DRL (uCi/m^2) -- PAG/(Skin Dose)	
47			

	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Relocation calculation for H-Separations accident.													
2	Calculation of DCF for dose from resuspended deposited radionuclides (EPA PAG manual 1991, section 7.3.2, p. 7-15)													
3	1.00E-06	Resuspension factor (1/m)			2000	Protective Action Guide (PAG) -- Effective Dose (mrem)								
4	1.05E+04	BreathRate (m ³ /yr)			20000	PAG -- Organ-specific Dose (mrem)								
5	3.70E+04	CF (Bq/microCi)			100000	PAG -- Skin (mrem)				Lambda 2 (1/yr)		Time (years) for length of exposure		
6	1.00E+05	CF (mrem/Sv)								1.13		1	2	50
7	1.00E+00	microCi/m ²				PAG = Protective Action Guide				Lambda 3 (1/yr)				
8	1.00E+00	Exposure period (1 year)								7.48E-03				

	B	C	D	E	F	G	H	I	J	K	L	M
					CEDE	External EDE		Skin Dose	BS Dose			Weathering
9	Nuclide	Release (Ci)	Activity fraction		(mrem per uCi/m^2)	(mrem per uCi/m^2)		(mrem per uCi/m^2)	(mrem per uCi/m^2)	Halflife (years)	Lambda1	Factor (1 year)
10	Am-241	6.57E-01	1.87E-02		6.50E+01	4.17E-02		8.91E-02	1.18E+03	458	0.001513	7.455E-01
11	Am-243	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	7950	8.72E-05	7.460E-01
12	Ba-133	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	10.5	0.066	7.242E-01
13	Ce-144	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.778082	0.890651	5.146E-01
14	Cf-249	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	360	0.001925	7.454E-01
15	Cf-252	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2.646	0.261905	6.644E-01
16	Cm-244	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	17.6	0.039375	7.329E-01
17	Cm-246	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	5500	0.000126	7.460E-01
18	Co-60	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	5.26	0.131749	7.033E-01
19	Cs-137	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	30	0.0231	7.383E-01
20	H-3	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	12.3	0.056341	7.273E-01
21	Np-237	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2140000	3.24E-07	7.460E-01
22	Pm-147	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2.62	0.264504	6.637E-01
23	Pu-238	1.62E+00	4.61E-02		1.41E+02	2.94E-03		2.46E-02	2.53E+03	86.4	0.008021	7.433E-01
24	Pu-239	4.23E-03	1.20E-04		4.05E-01	3.39E-06		2.51E-05	7.36E+00	24390	2.84E-05	7.460E-01
25	Pu-239/241	0.00E+00	0.00E+00									
26	Pu-240	2.43E-01	6.92E-03		2.32E+01	4.23E-04		3.52E-03	4.23E+02	6580	0.000105	7.460E-01
27	Pu-241	3.26E+01	9.28E-01		5.86E+01	0.00E+00		0.00E+00	1.10E+03	13.2	0.0525	7.286E-01
28	Pu-242	1.54E-02	4.38E-04		1.41E+00	2.23E-05		1.85E-04	2.55E+01	379000	1.83E-06	7.460E-01
29	Sr-90	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	28.1	0.024662	7.378E-01
30	Tc-99	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	212000	3.27E-06	7.460E-01
31	Th-232	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	1.4E+10	4.95E-11	7.460E-01
32	Tl-204	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	3.8	0.182368	6.878E-01
33	U-235	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	7.1E+08	9.76E-10	7.460E-01
34	U-238	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	4.51E+09	1.54E-10	7.460E-01
35												
36	Ba-137m	0.00E+00	0.00E+00							4.86E-06	142727.6	7.006E-06
37	Y-90	0.00E+00	0.00E+00							0.007317	94.7064	1.048E-02
38												
39	Total	3.51E+01	1.00E+00		2.90E+02	4.51E-02		1.17E-01	5.26E+03			

	B	C	D	F	G	I
9	Nuclide	Release (Ci)	Activity fraction	CEDE (mrem per uCi/m ²)	External EDE (mrem per uCi/m ²)	Skin Dose (mrem per uCi/m ²)
10	Am-241	=Relocation!Y10	=C10/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D10*Relocation!H10*M10	=\$B\$7*\$D10*Relocation!E10*M10	=\$B\$7*\$D10*Relocation!F10*M10
11	Am-243	=Relocation!Y11	=C11/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D11*Relocation!H11*M11	=\$B\$7*\$D11*Relocation!E11*M11	=\$B\$7*\$D11*Relocation!F11*M11
12	Ba-133	=Relocation!Y12	=C12/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D12*Relocation!H12*M12	=\$B\$7*\$D12*Relocation!E12*M12	=\$B\$7*\$D12*Relocation!F12*M12
13	Ce-144	=Relocation!Y13	=C13/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D13*Relocation!H13*M13	=\$B\$7*\$D13*Relocation!E13*M13	=\$B\$7*\$D13*Relocation!F13*M13
14	Cf-249	=Relocation!Y14	=C14/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D14*Relocation!H14*M14	=\$B\$7*\$D14*Relocation!E14*M14	=\$B\$7*\$D14*Relocation!F14*M14
15	Cf-252	=Relocation!Y15	=C15/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D15*Relocation!H15*M15	=\$B\$7*\$D15*Relocation!E15*M15	=\$B\$7*\$D15*Relocation!F15*M15
16	Cm-244	=Relocation!Y16	=C16/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D16*Relocation!H16*M16	=\$B\$7*\$D16*Relocation!E16*M16	=\$B\$7*\$D16*Relocation!F16*M16
17	Cm-246	=Relocation!Y17	=C17/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D17*Relocation!H17*M17	=\$B\$7*\$D17*Relocation!E17*M17	=\$B\$7*\$D17*Relocation!F17*M17
18	Co-60	=Relocation!Y18	=C18/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D18*Relocation!H18*M18	=\$B\$7*\$D18*Relocation!E18*M18	=\$B\$7*\$D18*Relocation!F18*M18
19	Cs-137	=Relocation!Y19	=C19/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D19*Relocation!H19*M19	=\$B\$7*\$D19*Relocation!E19*M19	=\$B\$7*\$D19*Relocation!F19*M19
20	H-3	=Relocation!Y20	=C20/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D20*Relocation!H20*M20	=\$B\$7*\$D20*Relocation!E20*M20	=\$B\$7*\$D20*Relocation!F20*M20
21	Np-237	=Relocation!Y21	=C21/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D21*Relocation!H21*M21	=\$B\$7*\$D21*Relocation!E21*M21	=\$B\$7*\$D21*Relocation!F21*M21
22	Pm-147	=Relocation!Y22	=C22/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D22*Relocation!H22*M22	=\$B\$7*\$D22*Relocation!E22*M22	=\$B\$7*\$D22*Relocation!F22*M22
23	Pu-238	=Relocation!Y23	=C23/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D23*Relocation!H23*M23	=\$B\$7*\$D23*Relocation!E23*M23	=\$B\$7*\$D23*Relocation!F23*M23
24	Pu-239	=Relocation!Y24	=C24/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D24*Relocation!H24*M24	=\$B\$7*\$D24*Relocation!E24*M24	=\$B\$7*\$D24*Relocation!F24*M24
25	Pu-239/241	=Relocation!Y25	=C25/\$C\$39			
26	Pu-240	=Relocation!Y26	=C26/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D26*Relocation!H26*M26	=\$B\$7*\$D26*Relocation!E26*M26	=\$B\$7*\$D26*Relocation!F26*M26
27	Pu-241	=Relocation!Y27	=C27/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D27*Relocation!H27*M27	=\$B\$7*\$D27*Relocation!E27*M27	=\$B\$7*\$D27*Relocation!F27*M27
28	Pu-242	=Relocation!Y28	=C28/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D28*Relocation!H28*M28	=\$B\$7*\$D28*Relocation!E28*M28	=\$B\$7*\$D28*Relocation!F28*M28
29	Sr-90	=Relocation!Y29	=C29/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D29*Relocation!H29*M29	=\$B\$7*\$D29*Relocation!E29*M29	=\$B\$7*\$D29*Relocation!F29*M29
30	Tc-99	=Relocation!Y30	=C30/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D30*Relocation!H30*M30	=\$B\$7*\$D30*Relocation!E30*M30	=\$B\$7*\$D30*Relocation!F30*M30
31	Th-232	=Relocation!Y31	=C31/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D31*Relocation!H31*M31	=\$B\$7*\$D31*Relocation!E31*M31	=\$B\$7*\$D31*Relocation!F31*M31
32	Tl-204	=Relocation!Y32	=C32/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D32*Relocation!H32*M32	=\$B\$7*\$D32*Relocation!E32*M32	=\$B\$7*\$D32*Relocation!F32*M32
33	U-235	=Relocation!Y33	=C33/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D33*Relocation!H33*M33	=\$B\$7*\$D33*Relocation!E33*M33	=\$B\$7*\$D33*Relocation!F33*M33
34	U-238	=Relocation!Y34	=C34/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D34*Relocation!H34*M34	=\$B\$7*\$D34*Relocation!E34*M34	=\$B\$7*\$D34*Relocation!F34*M34
35						
36	Ba-137m	=Relocation!Y36	=C36/\$C\$39			
37	Y-90	=Relocation!Y37	=C37/\$C\$39			
38						
39	Total	=SUM(C10:C38)	=SUM(D10:D38)	=SUM(F10:F38)	=SUM(G10:G38)	=SUM(I10:I38)

	J	K	L	M
9	BS Dose (mrem per uCi/m ²)	Half-life (years)	Lambda1	Weathering Factor (1 year)
10	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$10*Relocation!\$J\$10*M10	=T_halfIC2	=0.693/K10	=(0.63/(\$L10+\$K\$6)*(1-EXP(-(\$L10+\$K\$6)))+(0.37/(\$L10+\$K\$8))*(1-EXP(-(\$L10+\$K\$8)*\$M\$6)))
11	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$11*Relocation!\$J\$11*M11	=T_halfIC3	=0.693/K11	=(0.63/(\$L11+\$K\$6)*(1-EXP(-(\$L11+\$K\$6)))+(0.37/(\$L11+\$K\$8))*(1-EXP(-(\$L11+\$K\$8)*\$M\$6)))
12	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$12*Relocation!\$J\$12*M12	=T_halfIC4	=0.693/K12	=(0.63/(\$L12+\$K\$6)*(1-EXP(-(\$L12+\$K\$6)))+(0.37/(\$L12+\$K\$8))*(1-EXP(-(\$L12+\$K\$8)*\$M\$6)))
13	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$13*Relocation!\$J\$13*M13	=T_halfIC5	=0.693/K13	=(0.63/(\$L13+\$K\$6)*(1-EXP(-(\$L13+\$K\$6)))+(0.37/(\$L13+\$K\$8))*(1-EXP(-(\$L13+\$K\$8)*\$M\$6)))
14	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$14*Relocation!\$J\$14*M14	=T_halfIC6	=0.693/K14	=(0.63/(\$L14+\$K\$6)*(1-EXP(-(\$L14+\$K\$6)))+(0.37/(\$L14+\$K\$8))*(1-EXP(-(\$L14+\$K\$8)*\$M\$6)))
15	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$15*Relocation!\$J\$15*M15	=T_halfIC7	=0.693/K15	=(0.63/(\$L15+\$K\$6)*(1-EXP(-(\$L15+\$K\$6)))+(0.37/(\$L15+\$K\$8))*(1-EXP(-(\$L15+\$K\$8)*\$M\$6)))
16	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$16*Relocation!\$J\$16*M16	=T_halfIC8	=0.693/K16	=(0.63/(\$L16+\$K\$6)*(1-EXP(-(\$L16+\$K\$6)))+(0.37/(\$L16+\$K\$8))*(1-EXP(-(\$L16+\$K\$8)*\$M\$6)))
17	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$17*Relocation!\$J\$17*M17	=T_halfIC9	=0.693/K17	=(0.63/(\$L17+\$K\$6)*(1-EXP(-(\$L17+\$K\$6)))+(0.37/(\$L17+\$K\$8))*(1-EXP(-(\$L17+\$K\$8)*\$M\$6)))
18	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$18*Relocation!\$J\$18*M18	=T_halfIC10	=0.693/K18	=(0.63/(\$L18+\$K\$6)*(1-EXP(-(\$L18+\$K\$6)))+(0.37/(\$L18+\$K\$8))*(1-EXP(-(\$L18+\$K\$8)*\$M\$6)))
19	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$19*Relocation!\$J\$19*M19	=T_halfIC11	=0.693/K19	=(0.63/(\$L19+\$K\$6)*(1-EXP(-(\$L19+\$K\$6)))+(0.37/(\$L19+\$K\$8))*(1-EXP(-(\$L19+\$K\$8)*\$M\$6)))
20	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$20*Relocation!\$J\$20*M20	=T_halfIC12	=0.693/K20	=(0.63/(\$L20+\$K\$6)*(1-EXP(-(\$L20+\$K\$6)))+(0.37/(\$L20+\$K\$8))*(1-EXP(-(\$L20+\$K\$8)*\$M\$6)))
21	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$21*Relocation!\$J\$21*M21	=T_halfIC13	=0.693/K21	=(0.63/(\$L21+\$K\$6)*(1-EXP(-(\$L21+\$K\$6)))+(0.37/(\$L21+\$K\$8))*(1-EXP(-(\$L21+\$K\$8)*\$M\$6)))
22	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$22*Relocation!\$J\$22*M22	=T_halfIC14	=0.693/K22	=(0.63/(\$L22+\$K\$6)*(1-EXP(-(\$L22+\$K\$6)))+(0.37/(\$L22+\$K\$8))*(1-EXP(-(\$L22+\$K\$8)*\$M\$6)))
23	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$23*Relocation!\$J\$23*M23	=T_halfIC15	=0.693/K23	=(0.63/(\$L23+\$K\$6)*(1-EXP(-(\$L23+\$K\$6)))+(0.37/(\$L23+\$K\$8))*(1-EXP(-(\$L23+\$K\$8)*\$M\$6)))
24	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$24*Relocation!\$J\$24*M24	=T_halfIC16	=0.693/K24	=(0.63/(\$L24+\$K\$6)*(1-EXP(-(\$L24+\$K\$6)))+(0.37/(\$L24+\$K\$8))*(1-EXP(-(\$L24+\$K\$8)*\$M\$6)))
25				
26	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$26*Relocation!\$J\$26*M26	=T_halfIC18	=0.693/K26	=(0.63/(\$L26+\$K\$6)*(1-EXP(-(\$L26+\$K\$6)))+(0.37/(\$L26+\$K\$8))*(1-EXP(-(\$L26+\$K\$8)*\$M\$6)))
27	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$27*Relocation!\$J\$27*M27	=T_halfIC19	=0.693/K27	=(0.63/(\$L27+\$K\$6)*(1-EXP(-(\$L27+\$K\$6)))+(0.37/(\$L27+\$K\$8))*(1-EXP(-(\$L27+\$K\$8)*\$M\$6)))
28	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$28*Relocation!\$J\$28*M28	=T_halfIC20	=0.693/K28	=(0.63/(\$L28+\$K\$6)*(1-EXP(-(\$L28+\$K\$6)))+(0.37/(\$L28+\$K\$8))*(1-EXP(-(\$L28+\$K\$8)*\$M\$6)))
29	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$29*Relocation!\$J\$29*M29	=T_halfIC21	=0.693/K29	=(0.63/(\$L29+\$K\$6)*(1-EXP(-(\$L29+\$K\$6)))+(0.37/(\$L29+\$K\$8))*(1-EXP(-(\$L29+\$K\$8)*\$M\$6)))
30	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$30*Relocation!\$J\$30*M30	=T_halfIC22	=0.693/K30	=(0.63/(\$L30+\$K\$6)*(1-EXP(-(\$L30+\$K\$6)))+(0.37/(\$L30+\$K\$8))*(1-EXP(-(\$L30+\$K\$8)*\$M\$6)))
31	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$31*Relocation!\$J\$31*M31	=T_halfIC23	=0.693/K31	=(0.63/(\$L31+\$K\$6)*(1-EXP(-(\$L31+\$K\$6)))+(0.37/(\$L31+\$K\$8))*(1-EXP(-(\$L31+\$K\$8)*\$M\$6)))
32	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$32*Relocation!\$J\$32*M32	=T_halfIC24	=0.693/K32	=(0.63/(\$L32+\$K\$6)*(1-EXP(-(\$L32+\$K\$6)))+(0.37/(\$L32+\$K\$8))*(1-EXP(-(\$L32+\$K\$8)*\$M\$6)))
33	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$33*Relocation!\$J\$33*M33	=T_halfIC25	=0.693/K33	=(0.63/(\$L33+\$K\$6)*(1-EXP(-(\$L33+\$K\$6)))+(0.37/(\$L33+\$K\$8))*(1-EXP(-(\$L33+\$K\$8)*\$M\$6)))
34	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*\$D\$34*Relocation!\$J\$34*M34	=T_halfIC26	=0.693/K34	=(0.63/(\$L34+\$K\$6)*(1-EXP(-(\$L34+\$K\$6)))+(0.37/(\$L34+\$K\$8))*(1-EXP(-(\$L34+\$K\$8)*\$M\$6)))
35				
36		=T_halfIC28	=0.693/K36	=(0.63/(\$L36+\$K\$6)*(1-EXP(-(\$L36+\$K\$6)))+(0.37/(\$L36+\$K\$8))*(1-EXP(-(\$L36+\$K\$8)*\$M\$6)))
37		=T_halfIC29	=0.693/K37	=(0.63/(\$L37+\$K\$6)*(1-EXP(-(\$L37+\$K\$6)))+(0.37/(\$L37+\$K\$8))*(1-EXP(-(\$L37+\$K\$8)*\$M\$6)))
38				
39	=SUM(J10:J38)			

	C	D	E
44	6.90E+00	DRL (uCi/m^2) -- PAG/(CEDE+External)	
45	3.80E+00	DRL (uCi/m^2) -- PAG/(BS Dose + External)	
46	8.52E+05	DRL (uCi/m^2) -- PAG/(Skin Dose)	
47			

	C	D	E
44	=F3/(F39+G39)	DRL (uCi/m^2) -- PAG/(CEDE+External)	
45	=F4/(J39+G39)	DRL (uCi/m^2) -- PAG/(BS Dose + External)	
46	=F5/I39	DRL (uCi/m^2) -- PAG/(Skin Dose)	
47			

	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Relocation calculation for H-Separations accident.													
2	Calculation of DCF for dose from resuspended deposited radionuclides (EPA PAG manual 1991, section 7.3.2, p. 7-15)													
3	1.00E-06	Resuspension factor (1/m)				500	PAG -- Effective Dose (mrem)							
4	1.05E+04	BreathRate (m ³ /yr)				5000	PAG -- Organ-specific Dose (mrem)			Lambda 2 (1/yr)				
5	3.70E+04	CF (Bq/microCi)				25000	PAG -- Skin (mrem)			1.13		Time (years) for length of exposure		
6	1.00E+05	CF (mrem/Sv)								Lambda 3 (1/yr)		1	2	50
7	1.00E+00	microCi/m ²					PAG = Protective Action Guide			7.48E-03				
8	1.00E+00	Exposure period (1 year)												

	B	C	D	E	F	G	H	I	J	K	L	N
					External CEDE	EDE		Skin Dose	BS Dose			Weathering Factor (2
9	Nuclide	Release (Ci)	Activity fraction		(mrem per uCi/m^2)	(mrem per uCi/m^2)		(mrem per uCi/m^2)	(mrem per uCi/m^2)	Half-life (years)	Lambda1	years)
10	Am-241	6.57E-01	1.87E-02		1.07E+02	6.89E-02		1.47E-01	1.94E+03	458	0.001513	1.232E+00
11	Am-243	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	7950	8.72E-05	1.234E+00
12	Ba-133	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	10.5	0.066	1.167E+00
13	Ce-144	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.778082	0.890651	6.499E-01
14	Cf-249	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	360	0.001925	1.232E+00
15	Cf-252	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2.646	0.261905	9.968E-01
16	Cm-244	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	17.6	0.039375	1.193E+00
17	Cm-246	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	5500	0.000126	1.234E+00
18	Co-60	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	5.26	0.131749	1.105E+00
19	Cs-137	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	30	0.0231	1.210E+00
20	H-3	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	12.3	0.056341	1.176E+00
21	Np-237	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2140000	3.24E-07	1.234E+00
22	Pm-147	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2.62	0.264504	9.948E-01
23	Pu-238	1.62E+00	4.61E-02		2.33E+02	4.85E-03		4.05E-02	4.17E+03	86.4	0.008021	1.225E+00
24	Pu-239	4.23E-03	1.20E-04		6.69E-01	5.61E-06		4.16E-05	1.22E+01	24390	2.84E-05	1.234E+00
25	Pu-239/241	0.00E+00	0.00E+00									
26	Pu-240	2.43E-01	6.92E-03		3.84E+01	7.00E-04		5.83E-03	6.99E+02	6580	0.000105	1.234E+00
27	Pu-241	3.26E+01	9.28E-01		9.48E+01	0.00E+00		0.00E+00	1.79E+03	13.2	0.0525	1.180E+00
28	Pu-242	1.54E-02	4.38E-04		2.33E+00	3.69E-05		3.07E-04	4.22E+01	379000	1.83E-06	1.234E+00
29	Sr-90	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	28.1	0.024662	1.208E+00
30	Tc-99	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	212000	3.27E-06	1.234E+00
31	Th-232	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	1.4E+10	4.95E-11	1.234E+00
32	Tl-204	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	3.8	0.182368	1.061E+00
33	U-235	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	7.1E+08	9.76E-10	1.234E+00
34	U-238	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	4.51E+09	1.54E-10	1.234E+00
35												
36	Ba-137m	0.00E+00	0.00E+00							4.86E-06	142727.6	7.006E-06
37	Y-90	0.00E+00	0.00E+00							0.007317	94.7064	1.048E-02
38												
39	Total	3.51E+01	1.00E+00		4.76E+02	7.45E-02		1.94E-01	8.65E+03			
40												
41	Dose in second year following release:				1.87E+02	2.94E-02		7.65E-02	3.39E+03			
42												

	B	C	D	F	G	I
9	Nuclide	Release (Ci)	Activity fraction	CEDE (mrem per uCi/m ²)	External EDE (mrem per uCi/m ²)	Skin Dose (mrem per uCi/m ²)
10	Am-241	=Relocation!Y10	=C10/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D10*Relocation!H10*N10	=\$B\$7*\$D10*Relocation!E10*N10	=\$B\$7*\$D10*Relocation!F10*N10
11	Am-243	=Relocation!Y11	=C11/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D11*Relocation!H11*N11	=\$B\$7*\$D11*Relocation!E11*N11	=\$B\$7*\$D11*Relocation!F11*N11
12	Ba-133	=Relocation!Y12	=C12/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D12*Relocation!H12*N12	=\$B\$7*\$D12*Relocation!E12*N12	=\$B\$7*\$D12*Relocation!F12*N12
13	Ce-144	=Relocation!Y13	=C13/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D13*Relocation!H13*N13	=\$B\$7*\$D13*Relocation!E13*N13	=\$B\$7*\$D13*Relocation!F13*N13
14	Cf-249	=Relocation!Y14	=C14/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D14*Relocation!H14*N14	=\$B\$7*\$D14*Relocation!E14*N14	=\$B\$7*\$D14*Relocation!F14*N14
15	Cf-252	=Relocation!Y15	=C15/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D15*Relocation!H15*N15	=\$B\$7*\$D15*Relocation!E15*N15	=\$B\$7*\$D15*Relocation!F15*N15
16	Cm-244	=Relocation!Y16	=C16/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D16*Relocation!H16*N16	=\$B\$7*\$D16*Relocation!E16*N16	=\$B\$7*\$D16*Relocation!F16*N16
17	Cm-246	=Relocation!Y17	=C17/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D17*Relocation!H17*N17	=\$B\$7*\$D17*Relocation!E17*N17	=\$B\$7*\$D17*Relocation!F17*N17
18	Co-60	=Relocation!Y18	=C18/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D18*Relocation!H18*N18	=\$B\$7*\$D18*Relocation!E18*N18	=\$B\$7*\$D18*Relocation!F18*N18
19	Cs-137	=Relocation!Y19	=C19/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D19*Relocation!H19*N19	=\$B\$7*\$D19*Relocation!E19*N19	=\$B\$7*\$D19*Relocation!F19*N19
20	H-3	=Relocation!Y20	=C20/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D20*Relocation!H20*N20	=\$B\$7*\$D20*Relocation!E20*N20	=\$B\$7*\$D20*Relocation!F20*N20
21	Np-237	=Relocation!Y21	=C21/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D21*Relocation!H21*N21	=\$B\$7*\$D21*Relocation!E21*N21	=\$B\$7*\$D21*Relocation!F21*N21
22	Pm-147	=Relocation!Y22	=C22/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D22*Relocation!H22*N22	=\$B\$7*\$D22*Relocation!E22*N22	=\$B\$7*\$D22*Relocation!F22*N22
23	Pu-238	=Relocation!Y23	=C23/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D23*Relocation!H23*N23	=\$B\$7*\$D23*Relocation!E23*N23	=\$B\$7*\$D23*Relocation!F23*N23
24	Pu-239	=Relocation!Y24	=C24/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D24*Relocation!H24*N24	=\$B\$7*\$D24*Relocation!E24*N24	=\$B\$7*\$D24*Relocation!F24*N24
25	Pu-239/241	=Relocation!Y25	=C25/\$C\$39			
26	Pu-240	=Relocation!Y26	=C26/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D26*Relocation!H26*N26	=\$B\$7*\$D26*Relocation!E26*N26	=\$B\$7*\$D26*Relocation!F26*N26
27	Pu-241	=Relocation!Y27	=C27/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D27*Relocation!H27*N27	=\$B\$7*\$D27*Relocation!E27*N27	=\$B\$7*\$D27*Relocation!F27*N27
28	Pu-242	=Relocation!Y28	=C28/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D28*Relocation!H28*N28	=\$B\$7*\$D28*Relocation!E28*N28	=\$B\$7*\$D28*Relocation!F28*N28
29	Sr-90	=Relocation!Y29	=C29/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D29*Relocation!H29*N29	=\$B\$7*\$D29*Relocation!E29*N29	=\$B\$7*\$D29*Relocation!F29*N29
30	Tc-99	=Relocation!Y30	=C30/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D30*Relocation!H30*N30	=\$B\$7*\$D30*Relocation!E30*N30	=\$B\$7*\$D30*Relocation!F30*N30
31	Th-232	=Relocation!Y31	=C31/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D31*Relocation!H31*N31	=\$B\$7*\$D31*Relocation!E31*N31	=\$B\$7*\$D31*Relocation!F31*N31
32	Ti-204	=Relocation!Y32	=C32/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D32*Relocation!H32*N32	=\$B\$7*\$D32*Relocation!E32*N32	=\$B\$7*\$D32*Relocation!F32*N32
33	U-235	=Relocation!Y33	=C33/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D33*Relocation!H33*N33	=\$B\$7*\$D33*Relocation!E33*N33	=\$B\$7*\$D33*Relocation!F33*N33
34	U-238	=Relocation!Y34	=C34/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D34*Relocation!H34*N34	=\$B\$7*\$D34*Relocation!E34*N34	=\$B\$7*\$D34*Relocation!F34*N34
35						
36	Ba-137m	=Relocation!Y36	=C36/\$C\$39			
37	Y-90	=Relocation!Y37	=C37/\$C\$39			
38						
39	Total	=SUM(C10:C38)	=SUM(D10:D38)	=SUM(F10:F38)	=SUM(G10:G38)	=SUM(I10:I38)
40						
41	Dose in sc			=F39-'Relo_H 1yr'!F39	=G39-'Relo_H 1yr'!G39	=I39-'Relo_H 1yr'!I39
42						

	J	K	L	N
9	BS Dose (mrem per uCi/m^2)	Half-life (years)	Lambda1	Weathering Factor (2 years)
10	=B\$7*B\$3*B\$4*B\$5*B\$6*D10*Relocation!\$J10*N10	=T_halfIC2	=0.693/K10	=(0.63/(\$L10+\$K\$5))*(1-EXP(-(\$L10+\$K\$5)*\$N\$6))+((0.37/(\$L10+\$K\$7))*(1-EXP(-(\$L10+\$K\$7)*\$N\$6)))
11	=B\$7*B\$3*B\$4*B\$5*B\$6*D11*Relocation!\$J11*N11	=T_halfIC3	=0.693/K11	=(0.63/(\$L11+\$K\$5))*(1-EXP(-(\$L11+\$K\$5)*\$N\$6))+((0.37/(\$L11+\$K\$7))*(1-EXP(-(\$L11+\$K\$7)*\$N\$6)))
12	=B\$7*B\$3*B\$4*B\$5*B\$6*D12*Relocation!\$J12*N12	=T_halfIC4	=0.693/K12	=(0.63/(\$L12+\$K\$5))*(1-EXP(-(\$L12+\$K\$5)*\$N\$6))+((0.37/(\$L12+\$K\$7))*(1-EXP(-(\$L12+\$K\$7)*\$N\$6)))
13	=B\$7*B\$3*B\$4*B\$5*B\$6*D13*Relocation!\$J13*N13	=T_halfIC5	=0.693/K13	=(0.63/(\$L13+\$K\$5))*(1-EXP(-(\$L13+\$K\$5)*\$N\$6))+((0.37/(\$L13+\$K\$7))*(1-EXP(-(\$L13+\$K\$7)*\$N\$6)))
14	=B\$7*B\$3*B\$4*B\$5*B\$6*D14*Relocation!\$J14*N14	=T_halfIC6	=0.693/K14	=(0.63/(\$L14+\$K\$5))*(1-EXP(-(\$L14+\$K\$5)*\$N\$6))+((0.37/(\$L14+\$K\$7))*(1-EXP(-(\$L14+\$K\$7)*\$N\$6)))
15	=B\$7*B\$3*B\$4*B\$5*B\$6*D15*Relocation!\$J15*N15	=T_halfIC7	=0.693/K15	=(0.63/(\$L15+\$K\$5))*(1-EXP(-(\$L15+\$K\$5)*\$N\$6))+((0.37/(\$L15+\$K\$7))*(1-EXP(-(\$L15+\$K\$7)*\$N\$6)))
16	=B\$7*B\$3*B\$4*B\$5*B\$6*D16*Relocation!\$J16*N16	=T_halfIC8	=0.693/K16	=(0.63/(\$L16+\$K\$5))*(1-EXP(-(\$L16+\$K\$5)*\$N\$6))+((0.37/(\$L16+\$K\$7))*(1-EXP(-(\$L16+\$K\$7)*\$N\$6)))
17	=B\$7*B\$3*B\$4*B\$5*B\$6*D17*Relocation!\$J17*N17	=T_halfIC9	=0.693/K17	=(0.63/(\$L17+\$K\$5))*(1-EXP(-(\$L17+\$K\$5)*\$N\$6))+((0.37/(\$L17+\$K\$7))*(1-EXP(-(\$L17+\$K\$7)*\$N\$6)))
18	=B\$7*B\$3*B\$4*B\$5*B\$6*D18*Relocation!\$J18*N18	=T_halfIC10	=0.693/K18	=(0.63/(\$L18+\$K\$5))*(1-EXP(-(\$L18+\$K\$5)*\$N\$6))+((0.37/(\$L18+\$K\$7))*(1-EXP(-(\$L18+\$K\$7)*\$N\$6)))
19	=B\$7*B\$3*B\$4*B\$5*B\$6*D19*Relocation!\$J19*N19	=T_halfIC11	=0.693/K19	=(0.63/(\$L19+\$K\$5))*(1-EXP(-(\$L19+\$K\$5)*\$N\$6))+((0.37/(\$L19+\$K\$7))*(1-EXP(-(\$L19+\$K\$7)*\$N\$6)))
20	=B\$7*B\$3*B\$4*B\$5*B\$6*D20*Relocation!\$J20*N20	=T_halfIC12	=0.693/K20	=(0.63/(\$L20+\$K\$5))*(1-EXP(-(\$L20+\$K\$5)*\$N\$6))+((0.37/(\$L20+\$K\$7))*(1-EXP(-(\$L20+\$K\$7)*\$N\$6)))
21	=B\$7*B\$3*B\$4*B\$5*B\$6*D21*Relocation!\$J21*N21	=T_halfIC13	=0.693/K21	=(0.63/(\$L21+\$K\$5))*(1-EXP(-(\$L21+\$K\$5)*\$N\$6))+((0.37/(\$L21+\$K\$7))*(1-EXP(-(\$L21+\$K\$7)*\$N\$6)))
22	=B\$7*B\$3*B\$4*B\$5*B\$6*D22*Relocation!\$J22*N22	=T_halfIC14	=0.693/K22	=(0.63/(\$L22+\$K\$5))*(1-EXP(-(\$L22+\$K\$5)*\$N\$6))+((0.37/(\$L22+\$K\$7))*(1-EXP(-(\$L22+\$K\$7)*\$N\$6)))
23	=B\$7*B\$3*B\$4*B\$5*B\$6*D23*Relocation!\$J23*N23	=T_halfIC15	=0.693/K23	=(0.63/(\$L23+\$K\$5))*(1-EXP(-(\$L23+\$K\$5)*\$N\$6))+((0.37/(\$L23+\$K\$7))*(1-EXP(-(\$L23+\$K\$7)*\$N\$6)))
24	=B\$7*B\$3*B\$4*B\$5*B\$6*D24*Relocation!\$J24*N24	=T_halfIC16	=0.693/K24	=(0.63/(\$L24+\$K\$5))*(1-EXP(-(\$L24+\$K\$5)*\$N\$6))+((0.37/(\$L24+\$K\$7))*(1-EXP(-(\$L24+\$K\$7)*\$N\$6)))
25				
26	=B\$7*B\$3*B\$4*B\$5*B\$6*D26*Relocation!\$J26*N26	=T_halfIC18	=0.693/K26	=(0.63/(\$L26+\$K\$5))*(1-EXP(-(\$L26+\$K\$5)*\$N\$6))+((0.37/(\$L26+\$K\$7))*(1-EXP(-(\$L26+\$K\$7)*\$N\$6)))
27	=B\$7*B\$3*B\$4*B\$5*B\$6*D27*Relocation!\$J27*N27	=T_halfIC19	=0.693/K27	=(0.63/(\$L27+\$K\$5))*(1-EXP(-(\$L27+\$K\$5)*\$N\$6))+((0.37/(\$L27+\$K\$7))*(1-EXP(-(\$L27+\$K\$7)*\$N\$6)))
28	=B\$7*B\$3*B\$4*B\$5*B\$6*D28*Relocation!\$J28*N28	=T_halfIC20	=0.693/K28	=(0.63/(\$L28+\$K\$5))*(1-EXP(-(\$L28+\$K\$5)*\$N\$6))+((0.37/(\$L28+\$K\$7))*(1-EXP(-(\$L28+\$K\$7)*\$N\$6)))
29	=B\$7*B\$3*B\$4*B\$5*B\$6*D29*Relocation!\$J29*N29	=T_halfIC21	=0.693/K29	=(0.63/(\$L29+\$K\$5))*(1-EXP(-(\$L29+\$K\$5)*\$N\$6))+((0.37/(\$L29+\$K\$7))*(1-EXP(-(\$L29+\$K\$7)*\$N\$6)))
30	=B\$7*B\$3*B\$4*B\$5*B\$6*D30*Relocation!\$J30*N30	=T_halfIC22	=0.693/K30	=(0.63/(\$L30+\$K\$5))*(1-EXP(-(\$L30+\$K\$5)*\$N\$6))+((0.37/(\$L30+\$K\$7))*(1-EXP(-(\$L30+\$K\$7)*\$N\$6)))
31	=B\$7*B\$3*B\$4*B\$5*B\$6*D31*Relocation!\$J31*N31	=T_halfIC23	=0.693/K31	=(0.63/(\$L31+\$K\$5))*(1-EXP(-(\$L31+\$K\$5)*\$N\$6))+((0.37/(\$L31+\$K\$7))*(1-EXP(-(\$L31+\$K\$7)*\$N\$6)))
32	=B\$7*B\$3*B\$4*B\$5*B\$6*D32*Relocation!\$J32*N32	=T_halfIC24	=0.693/K32	=(0.63/(\$L32+\$K\$5))*(1-EXP(-(\$L32+\$K\$5)*\$N\$6))+((0.37/(\$L32+\$K\$7))*(1-EXP(-(\$L32+\$K\$7)*\$N\$6)))
33	=B\$7*B\$3*B\$4*B\$5*B\$6*D33*Relocation!\$J33*N33	=T_halfIC25	=0.693/K33	=(0.63/(\$L33+\$K\$5))*(1-EXP(-(\$L33+\$K\$5)*\$N\$6))+((0.37/(\$L33+\$K\$7))*(1-EXP(-(\$L33+\$K\$7)*\$N\$6)))
34	=B\$7*B\$3*B\$4*B\$5*B\$6*D34*Relocation!\$J34*N34	=T_halfIC26	=0.693/K34	=(0.63/(\$L34+\$K\$5))*(1-EXP(-(\$L34+\$K\$5)*\$N\$6))+((0.37/(\$L34+\$K\$7))*(1-EXP(-(\$L34+\$K\$7)*\$N\$6)))
35				
36		=T_halfIC28	=0.693/K36	=(0.63/(\$L36+\$K\$5))*(1-EXP(-(\$L36+\$K\$5)*\$N\$6))+((0.37/(\$L36+\$K\$7))*(1-EXP(-(\$L36+\$K\$7)*\$N\$6)))
37		=T_halfIC29	=0.693/K37	=(0.63/(\$L37+\$K\$5))*(1-EXP(-(\$L37+\$K\$5)*\$N\$6))+((0.37/(\$L37+\$K\$7))*(1-EXP(-(\$L37+\$K\$7)*\$N\$6)))
38				
39	=SUM(J10:J38)			
40				
41	=J39*Relo_H 1yr/J39			
42				

	E	F	G	H
46	2.68E+00	DRL (uCi/m^2) -- PAG/(CEDE+External)		
47	1.48E+00	DRL (uCi/m^2) -- PAG/(BS Dose + External)		
48	3.27E+05	DRL (uCi/m^2) -- PAG/(Skin Dose)		
49				

	E	F	G
46	=F3/(F41+G41)	DRL (uCi/m^2) -- PAG/(CEDE+External)	
47	=F4/(J41+G41)	DRL (uCi/m^2) -- PAG/(BS Dose + External)	
48	=F5/I41	DRL (uCi/m^2) -- PAG/(Skin Dose)	
49			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
1	Relocation calculation for H-Separations accident.															
2	Calculation of DCF for dose from resuspended deposited radionuclides (EPA PAG manual 1991, section 7.3.2, p. 7-15)															
3	1.00E-06 Resuspension factor (1/m)					5000 PAG -- Effective Dose (mrem)										
4	1.05E+04 BreathRate (m^3/yr)					50000 PAG -- Organ-specific Dose (mrem)					Lambda 2 (1/yr)					
5	3.70E+04 CF (Bq/microCi)					250000 PAG -- Skin (mrem)					1.13		Time (years) for length of exposure			
6	1.00E+05 CF (mrem/Sv)										Lambda 3 (1/yr)		1		2	50
7	1.00E+00 microCi/m^2					PAG = Protective Action Guide					7.48E-03					
8	1.00E+00 Exposure period (1 year)															

	B	C	D	E	F	G	H	I	J	K	L	O
					External							
		Release	Activity		CEDE	EDE		Skin Dose	BS Dose			Weathering
		(Ci)	fraction		(mrem per	(mrem per		(mrem per	(mrem per	Half-life		Factor (50
9	Nuclide				uCi/m ²)	uCi/m ²)		uCi/m ²)	uCi/m ²)	(years)	Lambda1	years)
10	Am-241	6.57E-01	1.87E-02		1.35E+03	8.64E-01		1.85E+00	2.44E+04	458	0.001513	1.546E+01
11	Am-243	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	7950	8.72E-05	1.596E+01
12	Ba-133	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	10.5	0.066	5.434E+00
13	Ce-144	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.778082	0.890651	7.237E-01
14	Cf-249	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	360	0.001925	1.532E+01
15	Cf-252	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2.646	0.261905	1.826E+00
16	Cm-244	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	17.6	0.039375	7.677E+00
17	Cm-246	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	5500	0.000126	1.595E+01
18	Co-60	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	5.26	0.131749	3.154E+00
19	Cs-137	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	30	0.0231	1.002E+01
20	H-3	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	12.3	0.056341	6.090E+00
21	Np-237	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2140000	3.24E-07	1.599E+01
22	Pm-147	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	2.62	0.264504	1.812E+00
23	Pu-238	1.62E+00	4.61E-02		2.55E+03	5.31E-02		4.44E-01	4.57E+04	86.4	0.008021	1.343E+01
24	Pu-239	4.23E-03	1.20E-04		8.67E+00	7.27E-05		5.39E-04	1.58E+02	24390	2.84E-05	1.598E+01
25	Pu-239/241	0.00E+00	0.00E+00									
26	Pu-240	2.43E-01	6.92E-03		4.97E+02	9.05E-03		7.54E-02	9.04E+03	6580	0.000105	1.595E+01
27	Pu-241	3.26E+01	9.28E-01		5.14E+02	0.00E+00		0.00E+00	9.68E+03	13.2	0.0525	6.394E+00
28	Pu-242	1.54E-02	4.38E-04		3.02E+01	4.78E-04		3.97E-03	5.47E+02	379000	1.83E-06	1.599E+01
29	Sr-90	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	28.1	0.024662	9.749E+00
30	Tc-99	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	212000	3.27E-06	1.599E+01
31	Th-232	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	1.4E+10	4.95E-11	1.599E+01
32	Tl-204	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	3.8	0.182368	2.429E+00
33	U-235	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	7.1E+08	9.76E-10	1.599E+01
34	U-238	0.00E+00	0.00E+00		0.00E+00	0.00E+00		0.00E+00	0.00E+00	4.51E+09	1.54E-10	1.599E+01
35												
36	Ba-137m	0.00E+00	0.00E+00							4.86E-06	142727.6	7.006E-06
37	Y-90	0.00E+00	0.00E+00							0.007317	94.7064	1.048E-02
38												
39	Total	3.51E+01	1.00E+00		4.95E+03	9.27E-01		2.37E+00	8.95E+04			
40												

	B	C	D	F	G	I
9	Nuclide	Release (Ci)	Activity fraction	CEDE (mrem per uCi/m ²)	External EDE (mrem per uCi/m ²)	Skin Dose (mrem per uCi/m ²)
10	Am-241	=Relocation!Y10	=C10/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D10*Relocation!H10*O10	=\$B\$7*\$D10*Relocation!E10*O10	=\$B\$7*\$D10*Relocation!F10*O10
11	Am-243	=Relocation!Y11	=C11/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D11*Relocation!H11*O11	=\$B\$7*\$D11*Relocation!E11*O11	=\$B\$7*\$D11*Relocation!F11*O11
12	Ba-133	=Relocation!Y12	=C12/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D12*Relocation!H12*O12	=\$B\$7*\$D12*Relocation!E12*O12	=\$B\$7*\$D12*Relocation!F12*O12
13	Ce-144	=Relocation!Y13	=C13/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D13*Relocation!H13*O13	=\$B\$7*\$D13*Relocation!E13*O13	=\$B\$7*\$D13*Relocation!F13*O13
14	Cf-249	=Relocation!Y14	=C14/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D14*Relocation!H14*O14	=\$B\$7*\$D14*Relocation!E14*O14	=\$B\$7*\$D14*Relocation!F14*O14
15	Cf-252	=Relocation!Y15	=C15/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D15*Relocation!H15*O15	=\$B\$7*\$D15*Relocation!E15*O15	=\$B\$7*\$D15*Relocation!F15*O15
16	Cm-244	=Relocation!Y16	=C16/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D16*Relocation!H16*O16	=\$B\$7*\$D16*Relocation!E16*O16	=\$B\$7*\$D16*Relocation!F16*O16
17	Cm-246	=Relocation!Y17	=C17/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D17*Relocation!H17*O17	=\$B\$7*\$D17*Relocation!E17*O17	=\$B\$7*\$D17*Relocation!F17*O17
18	Co-60	=Relocation!Y18	=C18/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D18*Relocation!H18*O18	=\$B\$7*\$D18*Relocation!E18*O18	=\$B\$7*\$D18*Relocation!F18*O18
19	Cs-137	=Relocation!Y19	=C19/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D19*Relocation!H19*O19	=\$B\$7*\$D19*Relocation!E19*O19	=\$B\$7*\$D19*Relocation!F19*O19
20	H-3	=Relocation!Y20	=C20/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D20*Relocation!H20*O20	=\$B\$7*\$D20*Relocation!E20*O20	=\$B\$7*\$D20*Relocation!F20*O20
21	Np-237	=Relocation!Y21	=C21/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D21*Relocation!H21*O21	=\$B\$7*\$D21*Relocation!E21*O21	=\$B\$7*\$D21*Relocation!F21*O21
22	Pm-147	=Relocation!Y22	=C22/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D22*Relocation!H22*O22	=\$B\$7*\$D22*Relocation!E22*O22	=\$B\$7*\$D22*Relocation!F22*O22
23	Pu-238	=Relocation!Y23	=C23/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D23*Relocation!H23*O23	=\$B\$7*\$D23*Relocation!E23*O23	=\$B\$7*\$D23*Relocation!F23*O23
24	Pu-239	=Relocation!Y24	=C24/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D24*Relocation!H24*O24	=\$B\$7*\$D24*Relocation!E24*O24	=\$B\$7*\$D24*Relocation!F24*O24
25	Pu-239/241	=Relocation!Y25	=C25/\$C\$39			
26	Pu-240	=Relocation!Y26	=C26/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D26*Relocation!H26*O26	=\$B\$7*\$D26*Relocation!E26*O26	=\$B\$7*\$D26*Relocation!F26*O26
27	Pu-241	=Relocation!Y27	=C27/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D27*Relocation!H27*O27	=\$B\$7*\$D27*Relocation!E27*O27	=\$B\$7*\$D27*Relocation!F27*O27
28	Pu-242	=Relocation!Y28	=C28/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D28*Relocation!H28*O28	=\$B\$7*\$D28*Relocation!E28*O28	=\$B\$7*\$D28*Relocation!F28*O28
29	Sr-90	=Relocation!Y29	=C29/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D29*Relocation!H29*O29	=\$B\$7*\$D29*Relocation!E29*O29	=\$B\$7*\$D29*Relocation!F29*O29
30	Tc-99	=Relocation!Y30	=C30/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D30*Relocation!H30*O30	=\$B\$7*\$D30*Relocation!E30*O30	=\$B\$7*\$D30*Relocation!F30*O30
31	Th-232	=Relocation!Y31	=C31/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D31*Relocation!H31*O31	=\$B\$7*\$D31*Relocation!E31*O31	=\$B\$7*\$D31*Relocation!F31*O31
32	Tl-204	=Relocation!Y32	=C32/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D32*Relocation!H32*O32	=\$B\$7*\$D32*Relocation!E32*O32	=\$B\$7*\$D32*Relocation!F32*O32
33	U-235	=Relocation!Y33	=C33/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D33*Relocation!H33*O33	=\$B\$7*\$D33*Relocation!E33*O33	=\$B\$7*\$D33*Relocation!F33*O33
34	U-238	=Relocation!Y34	=C34/\$C\$39	=\$B\$7*\$B\$3*\$B\$4*\$B\$5*\$B\$6*D34*Relocation!H34*O34	=\$B\$7*\$D34*Relocation!E34*O34	=\$B\$7*\$D34*Relocation!F34*O34
35						
36	Ba-137m	=Relocation!Y36	=C36/\$C\$39			
37	Y-90	=Relocation!Y37	=C37/\$C\$39			
38						
39	Total	=SUM(C10:C38)	=SUM(D10:D38)	=SUM(F10:F38)	=SUM(G10:G38)	=SUM(I10:I38)
40						

	J	K	L	O
9	BS Dose (mrem per uCi/m ²)	Half-life (years)	Lambda1	Weathering Factor (50 years)
10	=BS7*BS3*BS4*BS5*BS6*D10*Relocation!J10*O10	=T_halfIC2	=0.693/K10	=(0.63/(\$L10+\$K\$5)*(1-EXP(-(\$L10+\$K\$5)*\$O\$6)))+(0.37/(\$L10+\$K\$7)*(1-EXP(-(\$L10+\$K\$7)*\$O\$6)))
11	=BS7*BS3*BS4*BS5*BS6*D11*Relocation!J11*O11	=T_halfIC3	=0.693/K11	=(0.63/(\$L11+\$K\$5)*(1-EXP(-(\$L11+\$K\$5)*\$O\$6)))+(0.37/(\$L11+\$K\$7)*(1-EXP(-(\$L11+\$K\$7)*\$O\$6)))
12	=BS7*BS3*BS4*BS5*BS6*D12*Relocation!J12*O12	=T_halfIC4	=0.693/K12	=(0.63/(\$L12+\$K\$5)*(1-EXP(-(\$L12+\$K\$5)*\$O\$6)))+(0.37/(\$L12+\$K\$7)*(1-EXP(-(\$L12+\$K\$7)*\$O\$6)))
13	=BS7*BS3*BS4*BS5*BS6*D13*Relocation!J13*O13	=T_halfIC5	=0.693/K13	=(0.63/(\$L13+\$K\$5)*(1-EXP(-(\$L13+\$K\$5)*\$O\$6)))+(0.37/(\$L13+\$K\$7)*(1-EXP(-(\$L13+\$K\$7)*\$O\$6)))
14	=BS7*BS3*BS4*BS5*BS6*D14*Relocation!J14*O14	=T_halfIC6	=0.693/K14	=(0.63/(\$L14+\$K\$5)*(1-EXP(-(\$L14+\$K\$5)*\$O\$6)))+(0.37/(\$L14+\$K\$7)*(1-EXP(-(\$L14+\$K\$7)*\$O\$6)))
15	=BS7*BS3*BS4*BS5*BS6*D15*Relocation!J15*O15	=T_halfIC7	=0.693/K15	=(0.63/(\$L15+\$K\$5)*(1-EXP(-(\$L15+\$K\$5)*\$O\$6)))+(0.37/(\$L15+\$K\$7)*(1-EXP(-(\$L15+\$K\$7)*\$O\$6)))
16	=BS7*BS3*BS4*BS5*BS6*D16*Relocation!J16*O16	=T_halfIC8	=0.693/K16	=(0.63/(\$L16+\$K\$5)*(1-EXP(-(\$L16+\$K\$5)*\$O\$6)))+(0.37/(\$L16+\$K\$7)*(1-EXP(-(\$L16+\$K\$7)*\$O\$6)))
17	=BS7*BS3*BS4*BS5*BS6*D17*Relocation!J17*O17	=T_halfIC9	=0.693/K17	=(0.63/(\$L17+\$K\$5)*(1-EXP(-(\$L17+\$K\$5)*\$O\$6)))+(0.37/(\$L17+\$K\$7)*(1-EXP(-(\$L17+\$K\$7)*\$O\$6)))
18	=BS7*BS3*BS4*BS5*BS6*D18*Relocation!J18*O18	=T_halfIC10	=0.693/K18	=(0.63/(\$L18+\$K\$5)*(1-EXP(-(\$L18+\$K\$5)*\$O\$6)))+(0.37/(\$L18+\$K\$7)*(1-EXP(-(\$L18+\$K\$7)*\$O\$6)))
19	=BS7*BS3*BS4*BS5*BS6*D19*Relocation!J19*O19	=T_halfIC11	=0.693/K19	=(0.63/(\$L19+\$K\$5)*(1-EXP(-(\$L19+\$K\$5)*\$O\$6)))+(0.37/(\$L19+\$K\$7)*(1-EXP(-(\$L19+\$K\$7)*\$O\$6)))
20	=BS7*BS3*BS4*BS5*BS6*D20*Relocation!J20*O20	=T_halfIC12	=0.693/K20	=(0.63/(\$L20+\$K\$5)*(1-EXP(-(\$L20+\$K\$5)*\$O\$6)))+(0.37/(\$L20+\$K\$7)*(1-EXP(-(\$L20+\$K\$7)*\$O\$6)))
21	=BS7*BS3*BS4*BS5*BS6*D21*Relocation!J21*O21	=T_halfIC13	=0.693/K21	=(0.63/(\$L21+\$K\$5)*(1-EXP(-(\$L21+\$K\$5)*\$O\$6)))+(0.37/(\$L21+\$K\$7)*(1-EXP(-(\$L21+\$K\$7)*\$O\$6)))
22	=BS7*BS3*BS4*BS5*BS6*D22*Relocation!J22*O22	=T_halfIC14	=0.693/K22	=(0.63/(\$L22+\$K\$5)*(1-EXP(-(\$L22+\$K\$5)*\$O\$6)))+(0.37/(\$L22+\$K\$7)*(1-EXP(-(\$L22+\$K\$7)*\$O\$6)))
23	=BS7*BS3*BS4*BS5*BS6*D23*Relocation!J23*O23	=T_halfIC15	=0.693/K23	=(0.63/(\$L23+\$K\$5)*(1-EXP(-(\$L23+\$K\$5)*\$O\$6)))+(0.37/(\$L23+\$K\$7)*(1-EXP(-(\$L23+\$K\$7)*\$O\$6)))
24	=BS7*BS3*BS4*BS5*BS6*D24*Relocation!J24*O24	=T_halfIC16	=0.693/K24	=(0.63/(\$L24+\$K\$5)*(1-EXP(-(\$L24+\$K\$5)*\$O\$6)))+(0.37/(\$L24+\$K\$7)*(1-EXP(-(\$L24+\$K\$7)*\$O\$6)))
25				
26	=BS7*BS3*BS4*BS5*BS6*D26*Relocation!J26*O26	=T_halfIC18	=0.693/K26	=(0.63/(\$L26+\$K\$5)*(1-EXP(-(\$L26+\$K\$5)*\$O\$6)))+(0.37/(\$L26+\$K\$7)*(1-EXP(-(\$L26+\$K\$7)*\$O\$6)))
27	=BS7*BS3*BS4*BS5*BS6*D27*Relocation!J27*O27	=T_halfIC19	=0.693/K27	=(0.63/(\$L27+\$K\$5)*(1-EXP(-(\$L27+\$K\$5)*\$O\$6)))+(0.37/(\$L27+\$K\$7)*(1-EXP(-(\$L27+\$K\$7)*\$O\$6)))
28	=BS7*BS3*BS4*BS5*BS6*D28*Relocation!J28*O28	=T_halfIC20	=0.693/K28	=(0.63/(\$L28+\$K\$5)*(1-EXP(-(\$L28+\$K\$5)*\$O\$6)))+(0.37/(\$L28+\$K\$7)*(1-EXP(-(\$L28+\$K\$7)*\$O\$6)))
29	=BS7*BS3*BS4*BS5*BS6*D29*Relocation!J29*O29	=T_halfIC21	=0.693/K29	=(0.63/(\$L29+\$K\$5)*(1-EXP(-(\$L29+\$K\$5)*\$O\$6)))+(0.37/(\$L29+\$K\$7)*(1-EXP(-(\$L29+\$K\$7)*\$O\$6)))
30	=BS7*BS3*BS4*BS5*BS6*D30*Relocation!J30*O30	=T_halfIC22	=0.693/K30	=(0.63/(\$L30+\$K\$5)*(1-EXP(-(\$L30+\$K\$5)*\$O\$6)))+(0.37/(\$L30+\$K\$7)*(1-EXP(-(\$L30+\$K\$7)*\$O\$6)))
31	=BS7*BS3*BS4*BS5*BS6*D31*Relocation!J31*O31	=T_halfIC23	=0.693/K31	=(0.63/(\$L31+\$K\$5)*(1-EXP(-(\$L31+\$K\$5)*\$O\$6)))+(0.37/(\$L31+\$K\$7)*(1-EXP(-(\$L31+\$K\$7)*\$O\$6)))
32	=BS7*BS3*BS4*BS5*BS6*D32*Relocation!J32*O32	=T_halfIC24	=0.693/K32	=(0.63/(\$L32+\$K\$5)*(1-EXP(-(\$L32+\$K\$5)*\$O\$6)))+(0.37/(\$L32+\$K\$7)*(1-EXP(-(\$L32+\$K\$7)*\$O\$6)))
33	=BS7*BS3*BS4*BS5*BS6*D33*Relocation!J33*O33	=T_halfIC25	=0.693/K33	=(0.63/(\$L33+\$K\$5)*(1-EXP(-(\$L33+\$K\$5)*\$O\$6)))+(0.37/(\$L33+\$K\$7)*(1-EXP(-(\$L33+\$K\$7)*\$O\$6)))
34	=BS7*BS3*BS4*BS5*BS6*D34*Relocation!J34*O34	=T_halfIC26	=0.693/K34	=(0.63/(\$L34+\$K\$5)*(1-EXP(-(\$L34+\$K\$5)*\$O\$6)))+(0.37/(\$L34+\$K\$7)*(1-EXP(-(\$L34+\$K\$7)*\$O\$6)))
35				
36		=T_halfIC28	=0.693/K36	=(0.63/(\$L36+\$K\$5)*(1-EXP(-(\$L36+\$K\$5)*\$O\$6)))+(0.37/(\$L36+\$K\$7)*(1-EXP(-(\$L36+\$K\$7)*\$O\$6)))
37		=T_halfIC29	=0.693/K37	=(0.63/(\$L37+\$K\$5)*(1-EXP(-(\$L37+\$K\$5)*\$O\$6)))+(0.37/(\$L37+\$K\$7)*(1-EXP(-(\$L37+\$K\$7)*\$O\$6)))
38				
39	=SUM(J10:J38)			
40				

	F	G	I	J
44	1.01E+00 DRL (uCi/m^2) -- PAG/(CEDE+External)			
45	5.59E-01 DRL (uCi/m^2) -- PAG/(BS Dose + External)			
46	1.05E+05 DRL (uCi/m^2) -- PAG/(Skin Dose)			
47				

	F	G	I
44	=F3/(F39+G39)	DRL (uCi/m^2) -- PAG/(CEDE+External)	
45	=F4/(J39+G39)	DRL (uCi/m^2) -- PAG/(BS Dose + External)	
46	=F5/I39	DRL (uCi/m^2) -- PAG/(Skin Dose)	
47			

	B	C
1	Nuclide	Half-life (years)
2	Am-241	458
3	Am-243	7950
4	Ba-133	10.5
5	Ce-144	0.778082192
6	Cf-249	360
7	Cf-252	2.646
8	Cm-244	17.6
9	Cm-246	5500
10	Co-60	5.26
11	Cs-137	30
12	H-3	12.3
13	Np-237	2140000
14	Pm-147	2.62
15	Pu-238	86.4
16	Pu-239	24390
17	Pu mix-239/241	
18	Pu-240	6580
19	Pu-241	13.2
20	Pu pure-242	379000
21	Sr-90	28.1
22	Tc-99	212000
23	Th-232	14000000000
24	Tl-204	3.8
25	U-235	710000000
26	U-238	4510000000
27		
28	Ba-137m	4.8554E-06
29	Y-90	0.007317352
30	Pr-144	3.28767E-05
31	Pa-233	0.073972603
32	Th-234	0.066027397
33	Pa-234	0.00076484
34	Np-239	0.006452055
35	Th-231	0.002913242
36	Ra-228	5.75
37	Ac-228	0.000699772
38		

B		C
1	Nuclide	Half-life (years)
2	Am-241	=IF(Relocation!\$D10="y", Relocation!\$C10,IF(Relocation!\$D10="d",Relocation!\$C10/365,IF(Relocation!\$D10="h",Relocation!\$C10/(365*24),IF(Relocation!\$D10="m",Relocation!\$C10/(365*24*60),"error"))))
3	Am-243	=IF(Relocation!\$D11="y", Relocation!\$C11,IF(Relocation!\$D11="d",Relocation!\$C11/365,IF(Relocation!\$D11="h",Relocation!\$C11/(365*24),IF(Relocation!\$D11="m",Relocation!\$C11/(365*24*60),"error"))))
4	Ba-133	=IF(Relocation!\$D12="y", Relocation!\$C12,IF(Relocation!\$D12="d",Relocation!\$C12/365,IF(Relocation!\$D12="h",Relocation!\$C12/(365*24),IF(Relocation!\$D12="m",Relocation!\$C12/(365*24*60),"error"))))
5	Ce-144	=IF(Relocation!\$D13="y", Relocation!\$C13,IF(Relocation!\$D13="d",Relocation!\$C13/365,IF(Relocation!\$D13="h",Relocation!\$C13/(365*24),IF(Relocation!\$D13="m",Relocation!\$C13/(365*24*60),"error"))))
6	Cf-249	=IF(Relocation!\$D14="y", Relocation!\$C14,IF(Relocation!\$D14="d",Relocation!\$C14/365,IF(Relocation!\$D14="h",Relocation!\$C14/(365*24),IF(Relocation!\$D14="m",Relocation!\$C14/(365*24*60),"error"))))
7	Cf-252	=IF(Relocation!\$D15="y", Relocation!\$C15,IF(Relocation!\$D15="d",Relocation!\$C15/365,IF(Relocation!\$D15="h",Relocation!\$C15/(365*24),IF(Relocation!\$D15="m",Relocation!\$C15/(365*24*60),"error"))))
8	Cm-244	=IF(Relocation!\$D16="y", Relocation!\$C16,IF(Relocation!\$D16="d",Relocation!\$C16/365,IF(Relocation!\$D16="h",Relocation!\$C16/(365*24),IF(Relocation!\$D16="m",Relocation!\$C16/(365*24*60),"error"))))
9	Cm-246	=IF(Relocation!\$D17="y", Relocation!\$C17,IF(Relocation!\$D17="d",Relocation!\$C17/365,IF(Relocation!\$D17="h",Relocation!\$C17/(365*24),IF(Relocation!\$D17="m",Relocation!\$C17/(365*24*60),"error"))))
10	Co-60	=IF(Relocation!\$D18="y", Relocation!\$C18,IF(Relocation!\$D18="d",Relocation!\$C18/365,IF(Relocation!\$D18="h",Relocation!\$C18/(365*24),IF(Relocation!\$D18="m",Relocation!\$C18/(365*24*60),"error"))))
11	Cs-137	=IF(Relocation!\$D19="y", Relocation!\$C19,IF(Relocation!\$D19="d",Relocation!\$C19/365,IF(Relocation!\$D19="h",Relocation!\$C19/(365*24),IF(Relocation!\$D19="m",Relocation!\$C19/(365*24*60),"error"))))
12	H-3	=IF(Relocation!\$D20="y", Relocation!\$C20,IF(Relocation!\$D20="d",Relocation!\$C20/365,IF(Relocation!\$D20="h",Relocation!\$C20/(365*24),IF(Relocation!\$D20="m",Relocation!\$C20/(365*24*60),"error"))))
13	Np-237	=IF(Relocation!\$D21="y", Relocation!\$C21,IF(Relocation!\$D21="d",Relocation!\$C21/365,IF(Relocation!\$D21="h",Relocation!\$C21/(365*24),IF(Relocation!\$D21="m",Relocation!\$C21/(365*24*60),"error"))))
14	Pm-147	=IF(Relocation!\$D22="y", Relocation!\$C22,IF(Relocation!\$D22="d",Relocation!\$C22/365,IF(Relocation!\$D22="h",Relocation!\$C22/(365*24),IF(Relocation!\$D22="m",Relocation!\$C22/(365*24*60),"error"))))
15	Pu-238	=IF(Relocation!\$D23="y", Relocation!\$C23,IF(Relocation!\$D23="d",Relocation!\$C23/365,IF(Relocation!\$D23="h",Relocation!\$C23/(365*24),IF(Relocation!\$D23="m",Relocation!\$C23/(365*24*60),"error"))))
16	Pu-239	=IF(Relocation!\$D24="y", Relocation!\$C24,IF(Relocation!\$D24="d",Relocation!\$C24/365,IF(Relocation!\$D24="h",Relocation!\$C24/(365*24),IF(Relocation!\$D24="m",Relocation!\$C24/(365*24*60),"error"))))
17	Pu mix-239/241	
18	Pu-240	=IF(Relocation!\$D26="y", Relocation!\$C26,IF(Relocation!\$D26="d",Relocation!\$C26/365,IF(Relocation!\$D26="h",Relocation!\$C26/(365*24),IF(Relocation!\$D26="m",Relocation!\$C26/(365*24*60),"error"))))
19	Pu-241	=IF(Relocation!\$D27="y", Relocation!\$C27,IF(Relocation!\$D27="d",Relocation!\$C27/365,IF(Relocation!\$D27="h",Relocation!\$C27/(365*24),IF(Relocation!\$D27="m",Relocation!\$C27/(365*24*60),"error"))))
20	Pu pure-242	=IF(Relocation!\$D28="y", Relocation!\$C28,IF(Relocation!\$D28="d",Relocation!\$C28/365,IF(Relocation!\$D28="h",Relocation!\$C28/(365*24),IF(Relocation!\$D28="m",Relocation!\$C28/(365*24*60),"error"))))
21	Sr-90	=IF(Relocation!\$D29="y", Relocation!\$C29,IF(Relocation!\$D29="d",Relocation!\$C29/365,IF(Relocation!\$D29="h",Relocation!\$C29/(365*24),IF(Relocation!\$D29="m",Relocation!\$C29/(365*24*60),"error"))))
22	Tc-99	=IF(Relocation!\$D30="y", Relocation!\$C30,IF(Relocation!\$D30="d",Relocation!\$C30/365,IF(Relocation!\$D30="h",Relocation!\$C30/(365*24),IF(Relocation!\$D30="m",Relocation!\$C30/(365*24*60),"error"))))
23	Th-232	=IF(Relocation!\$D31="y", Relocation!\$C31,IF(Relocation!\$D31="d",Relocation!\$C31/365,IF(Relocation!\$D31="h",Relocation!\$C31/(365*24),IF(Relocation!\$D31="m",Relocation!\$C31/(365*24*60),"error"))))
24	Tl-204	=IF(Relocation!\$D32="y", Relocation!\$C32,IF(Relocation!\$D32="d",Relocation!\$C32/365,IF(Relocation!\$D32="h",Relocation!\$C32/(365*24),IF(Relocation!\$D32="m",Relocation!\$C32/(365*24*60),"error"))))
25	U-235	=IF(Relocation!\$D33="y", Relocation!\$C33,IF(Relocation!\$D33="d",Relocation!\$C33/365,IF(Relocation!\$D33="h",Relocation!\$C33/(365*24),IF(Relocation!\$D33="m",Relocation!\$C33/(365*24*60),"error"))))
26	U-238	=IF(Relocation!\$D34="y", Relocation!\$C34,IF(Relocation!\$D34="d",Relocation!\$C34/365,IF(Relocation!\$D34="h",Relocation!\$C34/(365*24),IF(Relocation!\$D34="m",Relocation!\$C34/(365*24*60),"error"))))
27		
28	Ba-137m	=IF(Relocation!\$D36="y", Relocation!\$C36,IF(Relocation!\$D36="d",Relocation!\$C36/365,IF(Relocation!\$D36="h",Relocation!\$C36/(365*24),IF(Relocation!\$D36="m",Relocation!\$C36/(365*24*60),"error"))))
29	Y-90	=IF(Relocation!\$D37="y", Relocation!\$C37,IF(Relocation!\$D37="d",Relocation!\$C37/365,IF(Relocation!\$D37="h",Relocation!\$C37/(365*24),IF(Relocation!\$D37="m",Relocation!\$C37/(365*24*60),"error"))))
30	Pr-144	=IF(Relocation!\$D38="y", Relocation!\$C38,IF(Relocation!\$D38="d",Relocation!\$C38/365,IF(Relocation!\$D38="h",Relocation!\$C38/(365*24),IF(Relocation!\$D38="m",Relocation!\$C38/(365*24*60),"error"))))
31	Pa-233	=IF(Relocation!\$D39="y", Relocation!\$C39,IF(Relocation!\$D39="d",Relocation!\$C39/365,IF(Relocation!\$D39="h",Relocation!\$C39/(365*24),IF(Relocation!\$D39="m",Relocation!\$C39/(365*24*60),"error"))))
32	Th-234	=IF(Relocation!\$D40="y", Relocation!\$C40,IF(Relocation!\$D40="d",Relocation!\$C40/365,IF(Relocation!\$D40="h",Relocation!\$C40/(365*24),IF(Relocation!\$D40="m",Relocation!\$C40/(365*24*60),"error"))))
33	Pa-234	=IF(Relocation!\$D41="y", Relocation!\$C41,IF(Relocation!\$D41="d",Relocation!\$C41/365,IF(Relocation!\$D41="h",Relocation!\$C41/(365*24),IF(Relocation!\$D41="m",Relocation!\$C41/(365*24*60),"error"))))
34	Np-239	=IF(Relocation!\$D42="y", Relocation!\$C42,IF(Relocation!\$D42="d",Relocation!\$C42/365,IF(Relocation!\$D42="h",Relocation!\$C42/(365*24),IF(Relocation!\$D42="m",Relocation!\$C42/(365*24*60),"error"))))
35	Th-231	=IF(Relocation!\$D43="y", Relocation!\$C43,IF(Relocation!\$D43="d",Relocation!\$C43/365,IF(Relocation!\$D43="h",Relocation!\$C43/(365*24),IF(Relocation!\$D43="m",Relocation!\$C43/(365*24*60),"error"))))
36	Ra-228	=IF(Relocation!\$D44="y", Relocation!\$C44,IF(Relocation!\$D44="d",Relocation!\$C44/365,IF(Relocation!\$D44="h",Relocation!\$C44/(365*24),IF(Relocation!\$D44="m",Relocation!\$C44/(365*24*60),"error"))))
37	Ac-228	=IF(Relocation!\$D45="y", Relocation!\$C45,IF(Relocation!\$D45="d",Relocation!\$C45/365,IF(Relocation!\$D45="h",Relocation!\$C45/(365*24),IF(Relocation!\$D45="m",Relocation!\$C45/(365*24*60),"error"))))
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Attachment C

HOTSPOT results - average meteorology, 1.0 cm s^{-1}

Attachment D

HOTSPOT results - average meteorology, 10 cm s^{-1}

Attachment E

HOTSPOT results - adverse meteorology, 0.1 cm s^{-1}

Attachment F

HOTSPOT results - adverse meteorology, 1.0 cm s^{-1}

Attachment G

HOTSPOT results - adverse meteorology, 10 cm s^{-1}