APPENDIX C

APPENDIX C

GENERIC DATA

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APPENDIX C
GENERIC DATA

C.1 INTRODUCTION

This appendix contains generic (common to one or more of the stations) offsite dose calculation parameter factors, or values. Site specific factors are provided in the station annex Appendix F. The factors described in section C.2 are found in the prescribed references and are not repeated in this appendix.

C.2 10CFR50 DOSE COMMITMENT FACTORS

With the exception of H-3, the dose commitment factors for 10CFR50 related calculations are exactly those provided in Regulatory Guide 1.109 (Reference 6). The following table lists the parameters and the corresponding data tables in the RG 1.109:

PATHWAY	ADULT	TEENAGER	CHILD	INFANT
Inhalation	RG 1.109:Table E-7	RG 1.109:Table E-8	RG 1.109:Table E-9	RG 1.109:Table E-10
Ingestion	RG 1.109:Table E-11	RG 1.109:Table E-12	RG 1.109:Table E-13	RG 1.109:Table E-14

These tables are contained in Regulatory Guide 1.109 (Reference 6). Each table (E-7 through E-14) provides dose factors for seven organs for each of 73 radionuclides. For radionuclides not found in these tables, dose factors will be derived from ICRP 2 (Reference 50) or NUREG-0172 (Reference 51). The values for H-3 are taken from NUREG-4013 (Reference 107).

Table C-1
Miscellaneous Dose Assessment Factors -
Environmental Parameters

Parameter	Value	Comment	Equation	Basis[a]
f_g	0.76		A-10, A-11	A
f_L	1.0		A-10, A-11	A
f_p	1.0		A-12, A-14	A
f_s	1.0		A-12, A-14	A
t_b	262,800 hrs	30 years	A-8	C
t_f	48 hrs	Cow Milk Pathway	A-12	A
t_f	480 hrs	Cow Meat Pathway	A-14	A
t_h	1440 hrs	60 days for produce	A-10	A
t_h	2160 hrs	90 days for produce	A-12, A-14	A
t_L	24 hrs	1 day for leafy vegetables	A-10	A
Q_F	50 Kg/da		A-12, A-13, A-14, A-15	B
r	1.0	For Iodines	A-10, A-12, A-14	A
r	0.2	For Particulates	A-10, A-12, A-14	A
Y_p	0.7 Kg/m^2		A-12, A-14	A
Y_s	2.0 Kg/m^2		A-12, A-14	A
Y_v	2.0 Kg/m^2		A-10	A
λ_w	0.0021 hr^{-1}		A-10, A-12, A-14	A
H	8 gm/m^3	Absolute Atmospheric Humidity	A-11, A-13, A-15	D

[a]Basis key:

A: Reference 6, Table E-15.
B: Reference 6, Table E-3.
C: The parameter t_b is taken as the midpoint of plant operating life (based upon an assumed 60 year plant operating lifetime).
D: Reference 14, Section 5.3.1.3.

Table C-2
Miscellaneous Dose Assessment Factors -
Consumption Parameters

Type	Variable	Infant	Child	Teenager	Adult
Air	BR_a (m^3/yr)	1400	3700	8000	8000
Milk	U_{am} (L/yr)	330	330	400	310
Produce	U_a^S (Kg/yr)	0	520	630	520
Leafy Vegetables	U_a^L (Kg/yr)	0	26	42	64
Meat	U_{af} (Kg/yr)	0	41	65	110
Water	U_a^W (L/yr)	330	510	510	730
Fish	U_a^F (Kg/yr)	0	6.9	16	21

From Regulatory Guide 1.109, Table E-5.

Table C-3
Stable Element Transfer Data

Element	F_f Meat (d/kg)	F_M(Cow) Milk (d/L)	Reference
H	1.2E-02	1.0E-02	6
Be	1.5E-03	3.2E-03	Footnote 1
C	3.1E-02	1.2E-02	6
F	2.9E-03	1.4E-02	Footnote 2
Na	3.0E-02	4.0E-02	6
Mg	1.5E-03	3.2E-03	Footnote 1
Al	1.5E-02	1.3E-03	Footnote 3
P	4.6E-02	2.5E-02	6
Cl	2.9E-03	1.4E-02	Footnote 2
Ar	NA	NA	NA
K	1.8E-02	7.2E-03	16
Ca	1.6E-03	1.1E-02	16
Sc	2.4E-03	7.5E-06	Footnote 4
Ti	3.4E-02	5.0E-06	Footnote 5
V	2.8E-01	1.3E-03	Footnote 6
Cr	2.4E-03	2.2E-03	6
Mn	8.0E-04	2.5E-04	6
Fe	4.0E-02	1.2E-03	6
Co	1.3E-02	1.0E-03	6
Ni	5.3E-02	6.7E-03	6
Cu	8.0E-03	1.4E-02	6
Zn	3.0E-02	3.9E-02	6
Ga	1.5E-02	1.3E-03	Footnote 3
Ge	9.1E-04	9.9E-05	Footnote 7
As	1.7E-02	5.0E-04	Footnote 8
Se	7.7E-02	1.0E-03	Footnote 9
Br	2.9E-03	2.2E-02	F_f Footnote 2;F_M from Ref. 16
Kr	NA	NA	NA
Rb	3.1E-02	3.0E-02	6
Sr	6.0E-04	8.0E-04	6
Y	4.6E-03	1.0E-05	6
Zr	3.4E-02	5.0E-06	6
Nb	2.8E-01	2.5E-03	6
Mo	8.0E-03	7.5E-03	6
Tc	4.0E-01	2.5E-02	6
Ru	4.0E-01	1.0E-06	6
Rh	1.5E-03	1.0E-02	6
Pd	5.3E-02	6.7E-03	Footnote 10
Cd	3.0E-02	2.0E-02	Footnote 11
In	1.5E-02	1.3E-03	Footnote 3
Sn	9.1E-04	9.9E-05	Footnote 7
Sb	5.0E-03	2.0E-05	98
Ag	1.7E-02	5.0E-02	6
Te	7.7E-02	1.0E-03	6
I	2.9E-03	6.0E-03	6
Xe	NA	NA	NA
Cs	4.0E-03	1.2E-02	6
Ba	3.2E-03	4.0E-04	6
La	2.0E-04	5.0E-06	6
Ce	1.2E-03	1.0E-04	6
Pr	4.7E-03	5.0E-06	6
Nd	3.3E-03	5.0E-06	6

Table C-3 (Cont'd)
Stable Element Transfer Data

Element	F_f Meat (d/kg)	F_M (Cow) Milk (d/L)	Reference
Pm	2.9E-04	2.0E-05	16
Sm	2.9E-04	2.0E-05	16
Eu	2.9E-04	2.0E-05	16
Gd	2.9E-04	2.0E-05	16
Dy	2.9E-04	2.0E-05	16
Er	2.9E-04	2.0E-05	16
Tm	2.9E-04	2.0E-05	16
Yb	2.9E-04	2.0E-05	16
Lu	2.9E-04	2.0E-05	16
Hf	3.4E-02	5.0E-06	Footnote 5
Ta	2.8E-01	1.3E-03	F_M - Ref.16; F_f -Footnote 6
W	1.3E-03	5.0E-04	6
Re	1.0E-01	1.3E-03	F_M - Ref.16; F_f -Footnote 12
Os	2.2E-01	6.0E-04	Footnote 13
Ir	7.3E-03	5.5E-03	Footnote 14
Pt	5.3E-02	6.7E-03	Footnote 10
Au	1.3E-02	3.2E-02	Footnote 15
Hg	3.0E-02	9.7E-06	F_M - Ref.16; F_f -Footnote 11
Tl	1.5E-02	1.3E-03	F_M - Ref.16; F_f -Footnote 3
Pb	9.1E-04	9.9E-05	98
Bi	1.7E-02	5.0E-04	98
Ra	5.5E-04	5.9E-04	98
Th	1.6E-06	5.0E-06	98
U	1.6E-06	1.2E-04	98
Np	2.0E-04	5.0E-06	6
Am	1.6E-06	2.0E-05	98

Notes:

1. NA = It is assumed that noble gases are not deposited on the ground.
2. Elements listed are those considered for 10CFR20 assessment and compliance.

Footnotes:

There are numerous F_f and F_M values that were not found in published literature. In these cases, the periodic table was used in conjunction with published values. The periodic table was used based on a general assumption that elements have similar characteristics when in the same column of the periodic table. The values of elements in the same column of the periodic table, excluding atomic numbers 58-71 and 90-103, were averaged then assigned to elements missing values located in the same column of the periodic table. This method was used for all columns where there were missing values except column 3A, where there was no data, hence, the average of column 2B and 4A were used.

1. Values obtained by averaging Reference 6 values of Ca, Sr, Ba and Ra.
2. F_f value obtained by assigning the Reference 6 value for I. F_M value obtained by averaging I(Ref. 6) and Br (Ref.16).
3. F_f values obtained by averaging Zn (Ref.6) and Pb (Ref. 98); there were novalues for elements in the same column; an average is taken between values of columns 2B and 4A on the periodic table. F_M values obtained by using the value for Tl from Reference 16.
4. Values obtained by averaging Reference 6 values of Y and La.
5. Values obtained by assigning the Reference 6 value for Zr.
6. F_f values obtained from Ref. 6 value for Nb. F_M values obtained by averaging values for Nb (Ref.6) and Ta (Ref. 16).
7. Values obtained from the Reference 6 values for Pb.
8. Values obtained from the Reference 6 values for Bi.
9. Values obtained from the Reference 6 values for Te.
10. Values obtained from the Reference 6 values for Ni.
11. F_f values obtained from Ref 6 values for Zn. F_M values obtained by averaging the Reference 6 values for Zn and Hg.
12. Values obtained by averaging Reference 6 values for Mn, Tc, Nd and Reference 98 value for U.
13. Values obtained by averaging Reference 6 values from Fe and Ru.
14. Values obtained by averaging Reference 6 values from Co and Rh.
15. Values obtained by averaging Reference 6 values from Cu and Ag.

Table C-4
Atmospheric Stability Classes

Description	Pasquill Stability Class	$^{a}\sigma_{\theta}$ (degrees)	Temperature Change with Height (°C/100 m)
Extremely Unstable	A	>22.5	<-1.9
Moderately Unstable	B	17.5 to 22.5	-1.9 to -1.7
Slightly Unstable	C	12.5 to 17.5	-1.7 to -1.5
Neutral	D	7.5 to 12.5	-1.5 to -0.5
Slightly Stable	E	3.8 to 7.5	-0.5 to 1.5
Moderately Stable	F	2.1 to 3.8	1.5 to 4.0
Extremely Stable	G	0 to 2.1	>4.0

$^{a}\sigma_{\theta}$ is the standard deviation of horizontal wind direction fluctuation over a period of 15 minutes to 1 hour.

From Regulatory Guide 1.21, Table 4B.

Table C-5
Vertical Dispersion Parameters

Section 1

Vertical Dispersion Parameters σ_z

σ_z (meters) = aR^b+c with σ_z limited to a maximum of 1000 meters
R = downwind range (meters)
a, b and c have the values listed below:

Stability Class	100 < R < 1000 a	b	c	R > 1000 a	b	c
A	*	*	*	0.00024	2.094	-9.6
B	*	*	*	*	*	*
C	0.113	0.911	0.0	*	*	*
D	0.222	0.725	-1.7	1.26	0.516	-13.0
E	0.211	0.678	-1.3	6.73	0.305	-34.0
F	0.086	0.74	-0.35	18.05	0.18	-48.6
G	0.052	0.74	-0.21	10.83	0.18	-29.2

Basis: Reference 53, except for cases denoted by an asterisk. In these cases, the value of σ_z is obtained by a polynomial approximation to the data from Reference 53 (see Section 2 of this table). The functions given in Reference 50 are not used because they are discontinuous at 1000 meters.

Section 2

Polynomial Approximation for σ_z:
σ_z (meters) = $\exp [a_0 + a_1P + a_2P^2 + a_3P^3]$ with σ_z limited to a maximum of 1000 meters
$P = \log_e [R(\text{meters})]$

a_0, a_1, a_2 and a_3 have the values listed below:

Stability Class	Range	Coefficients	
A	$100 \leq R \leq 1000$	a_0 =	-10.50
		a_1 =	6.879
		a_2 =	-1.309
		a_3 =	0.0957
B	$100 \leq R \leq 1000$	a_0 =	-0.449
		a_1 =	0.218
		a_2 =	0.112
		a_3 =	-0.00517
B	R > 1000	a_0 =	319.148
		a_1 =	-127.806
		a_2 =	17.093
		a_3 =	-0.750
C	R > 1000	a_0 =	5.300
		a_1 =	-1.866
		a_2 =	0.3509
		a_3 =	-0.01514

Table C-6
Allowable Concentration of Dissolved or Entrained Noble Gases
Released from the Site to Unrestricted Areas in Liquid Waste

	Allowable Concentration (μCi/mL)[a]	
Nuclide	Braidwood Byron	Dresden LaSalle Quad Cities Zion
Kr 85m	2E-4	2E-4
Kr 85	2E-4	5E-4
Kr 87	2E-4	4E-5
Kr 88	2E-4	9E-5
Ar 41	2E-4	7E-5
Xe 131m	2E-4	7E-4
Xe 133m	2E-4	5E-4
Xe 133	2E-4	6E-4
Xe 135m	2E-4	2E-4
Xe 135	2E-4	2E-4

[a]Computed from Equation 17 of ICRP Publication 2 (Reference 47) adjusted for infinite cloud submersion in water, and R = 0.01 rem/week, ρ_w = 1.0 gm/cm^3, and P_w / P_t = 1.0.

Table C-7
Radiological Decay Constants (λ_i) in hr^{-1}

Isotope	Lambda		Isotope	Lambda		Isotope	Lambda
H-3	6.44E-06		As-73	3.6E-04		Tc-104	2.31E+00
Be-7	5.4E-04		As-74	1.62E-03		Ru-97	9.96E-03
C-14	1.38E-08		As-76	2.63E-02		Ru-103	7.34E-04
F-18	3.78E-01		As-77	1.79E-02		Ru-105	1.56E-01
Na-22	3.04E-05		Se-73	9.69E-02		Ru-106	7.84E-05
Na-24	4.62E-02		Se-75	2.41E-04		Rh-106	8.33E+01
Mg-27	4.39E+00		Br-77	1.21E-02		Pd-109	5.15E-02
Mg-28	3.31E-02		Br-80	2.38E+00		Cd-109	6.22E-05
Al-26	1.10E-10		Br-82	1.96E-02		In-111	1.02E-02
Al-28	1.85E+01		Br-83	2.90E-01		In-115M	1.59E-01
P-32	2.02E-03		Br-84	1.30E+00		In-116	7.66E-01
Cl-38	1.12E+00		Br-85	1.45E+01		Sn-113	2.51E-04
Ar-41	3.79E-01		Kr-79	1.98E-02		Sn-117M	2.12E-03
K-40	6.19E-14		Kr-81	3.77E-10		Sn-119M	9.85E-05
K-42	5.61E-02		Kr-83M	3.79E-01		Sb-117	2.48E-01
K-43	3.07E-02		Kr-85M	1.55E-01		Sb-122	1.07E-02
Ca-47	6.37E-03		Kr-85	7.38E-06		Sb-124	4.80E-04
Sc-44	1.76E-01		Kr-87	5.44E-01		Sb-125	2.86E-05
Sc-46M	1.33E+02		Kr-88	2.44E-01		Sb-126	2.33E-03
Sc-46	3.44E-04		Kr-90	7.71E+00		Ag-108M	6.23E-07
Sc-47	8.44E-03		Rb-84	8.78E-04		Ag-108	1.75E+01
Ti-44	1.67E-06		Rb-86	1.55E-03		Ag-110M	1.16E-04
V-48	1.81E-03		Rb-87	1.67E-15		Ag-111	3.87E-03
Cr-51	1.04E-03		Rb-88	2.33E+00		Te-121M	1.88E-04
Mn-52M	1.94E+00		Rb-89	2.69E+00		Te-121	1.72E-03
Mn-52	5.16E-03		Sr-85	4.45E-04		Te-123M	2.41E-04
Mn-54	9.23E-05		Sr-87M	2.47E-01		Te-125M	4.98E-04
Mn-56	2.69E-01		Sr-89	5.71E-04		Te-125	0.00E+00
Fe-52	8.37E-02		Sr-90	2.77E-06		Te-127M	2.65E-04
Fe-55	2.93E-05		Sr-91	7.29E-02		Te-127	7.41E-02
Fe-59	6.47E-04		Sr-92	2.56E-01		Te-129M	8.59E-04
Co-57	1.07E-04		Y-86	4.70E-02		Te-129	5.96E-01
Co-58	4.08E-04		Y-87	8.63E-03		Te-131M	2.31E-02
Co-60	1.50E-05		Y-88	2.71E-04		Te-131	1.66E+00
Ni-63	7.90E-07		Y-90	1.08E-02		Te-132	8.86E-03
Ni-65	2.75E-01		Y-91M	8.35E-01		Te-134	9.93E-01
Cu-64	5.46E-02		Y-91	4.94E-04		I-123	5.28E-02
Cu-67	4.67E-04		Y-92	1.96E-01		I-124	6.91E-03
Cu-68	8.31E+01		Y-93	6.86E-02		I-125	4.80E-04
Zn-65	1.18E-04		Zr-95	4.51E-04		I-130	5.61E-02
Zn-69M	5.04E-02		Zr-97	4.10E-02		I-131	3.59E-03
Zn-69	7.46E-01		Nb-94	3.90E-09		I-132	3.01E-01
Ga-66	7.37E-02		Nb-95	8.00E-03		I-133	3.33E-02
Ga-67	8.85E-03		Nb-97M	4.15E+01		I-134	7.89E-01
Ga-68	6.10E-01		Nb-97	5.76E-01		I-135	1.05E-01
Ga-72	4.91E-02		Mo-99	1.05E-02		Xe-127	7.93E-04
Ge-77	6.13E-02		Tc-99M	1.15E-01		Xe-129M	3.25E-03
As-72	2.67E-02		Tc-101	2.92E+00		Xe-131M	2.44E-03

Table C-7 (Cont'd)
Radiological Decay Constants (λ_i) in hr^{-1}

Isotope	Lambda		Isotope	Lambda
Xe-133M	1.32E-02		Yb-175	6.89E-03
Xe-133	5.51E-03		Lu-177	4.30E-03
Xe-135M	2.70E+00		Hf-181	6.81E-04
Xe-135	7.61E-02		Ta-182	2.52E-04
Xe-137	1.08E+01		Ta-183	5.78E-03
Xe-138	2.94E+00		W-187	2.91E-02
Cs-129	2.16E-02		Re-188	4.08E-02
Cs-132	4.46E-03		Os-191	1.88E-03
Cs-134	3.84E-05		Ir-194	3.62E-02
Cs-136	2.19E-03		Pt-195M	7.18E-03
Cs-137	2.62E-06		Pt-197	3.79E-02
Cs-138	1.29E+00		Au-195M	8.15E+01
Cs-139	4.41E+00		Au-195	1.58E-04
Ba-131	2.45E-03		Au-198	1.07E-02
Ba-133M	1.78E-02		Au-199	9.20E-03
Ba-133	7.53E-06		Hg-197	2.91E-02
Ba-135M	2.41E-02		Hg-203	6.20E-04
Ba-137M	1.63E+01		Tl-201	9.49E-03
Ba-137	0.00E+00		Tl-206	9.90E+00
Ba-139	4.99E-01		Tl-208	1.36E+01
Ba-140	2.26E-03		Pb-203	1.33E-02
Ba-141	2.27E+00		Pb-210	3.55E-06
Ba-142	3.88E+00		Pb-212	6.51E-02
La-140	1.72E-02		Pb-214	1.55E+00
La-142	4.35E-01		Bi-206	4.63E-03
Ce-139	2.10E-04		Bi-207	2.37E-06
Ce-141	8.88E-04		Bi-214	2.09E+00
Ce-143	2.10E-02		Ra-226	4.94E-08
Ce-144	1.02E-04		Th-232	5.63E-15
Pr-142	3.62E-02		U-238	1.77E-14
Pr-143	2.13E-03		Np-239	1.23E-02
Pr-144	2.40E+00		Am-241	1.83E-07
Nd-147	2.63E-03			
Nd-149	4.01E-01			
Pm-145	4.47E-06			
Pm-148M	6.99E-04			
Pm-148	5.38E-03			
Pm-149	1.31E-02			
Sm-153	1.48E-02			
Eu-152	5.82E-06			
Eu-154	8.99E-06			
Eu-155	1.59E-05			
Gd-153	1.20E-04			
Dy-157	8.60E-02			
Er-169	3.07E-03			
Er-171	9.22E-02			
Tm-170	2.25E-04			
Yb-169	9.03E-04			

(λ_i) =Radiological Decay Constant
$= 0.693/T_i$

T_i = Radiological Half-Life in hours
(from Reference 70).
Except for Cu-68, Tc-104, Ba-137, Ta-183, TL-206, Bi-206 which are from References 100.

Table C-8
Bioaccumulation Factors (BF_i) to be Used in the Absence of Site-Specific Data

Element	BF_i for Freshwater Fish (pCi/kg per pCi/L)	Reference
H	9.0E-01	6
Be	2.8E+01	Footnote 2
C	4.6E+03	6
F	2.2E+02	Footnote 16
Na	1.0E+02	6
Mg	2.8E+01	Footnote 2
Al	2.2E+03	Footnote 13
P	1.0E+05	6
Cl	2.2E+02	Footnote 16
Ar	NA	NA
K	1.0E+03	Footnote 1
Ca	2.8E+01	Footnote 2
Sc	2.5E+01	Footnote 3
Ti	3.3E+00	Footnote 4
V	3.0E+04	Footnote 5
Cr	2.0E+02	6
Mn	4.0E+02	6
Fe	1.0E+02	6
Co	5.0E+01	6
Ni	1.0E+02	6
Cu	5.0E+01	6
Zn	2.0E+03	6
Ga	2.2E+03	Footnote 13
Ge	2.4E+03	Footnote 12
As	3.3E+04	Footnote 14
Se	4.0E+02	Footnote 15
Br	4.2E+02	6
Kr	NA	NA
Rb	2.0E+03	6
Sr	3.0E+01	6
Y	2.5E+01	6
Zr	3.3E+00	6
Nb	3.0E+04	6
Mo	1.0E+01	6
Tc	1.5E+01	6
Ru	1.0E+01	6
Rh	1.0E+01	6
Pd	1.0E+02	Footnote 9
Cd	2.0E+03	Footnote 11
In	2.2E+03	Footnote 13
Sn	2.4E+03	Footnote 12
Sb	1.0E+00	98
Ag	2.3E+00	56
Te	4.0E+02	6
I	1.5E+01	6
Xe	NA	NA
Cs	2.0E+03	6
Ba	4.0E+00	6
La	2.5E+01	6
Ce	1.0E+00	6
Pr	2.5E+01	6
Nd	2.5E+01	6
Pm	3.0E+01	98
Sm	3.0E+01	Footnote 3

Table C-8 (Cont'd)
Bioaccumulation Factors (BF_i) to be Used
in the Absence of Site-Specific Data

Element	BF_i for Freshwater Fish (pCi/kg per pCi/L)	Reference
Eu	1.0E+02	Footnote 3
Gd	2.6E+01	Footnote 3
Dy	2.2E+03	Footnote 3
Er	3.3E+04	Footnote 3
Tm	4.0E+02	Footnote 3
Yb	2.2E+02	Footnote 3
Lu	2.5E+01	Footnote 3
Hf	3.3E+00	Footnote 4
Ta	3.0E+04	Footnote 5
W	1.2E+03	6
Re	2.1E+02	Footnote 6
Os	5.5E+01	Footnote 7
Ir	3.0E+01	Footnote 8
Pt	1.0E+02	Footnote 9
Au	2.6E+01	Footnote 10
Hg	2.0E+03	Footnote 11
Tl	2.2E+03	Footnote 13
Pb	3.0E+02	98
Bi	2.0E+01	98
Ra	5.0E+01	98
Th	3.0E+01	98
U	1.0E+01	98
Np	1.0E+01	6
Am	3.0E+01	98

Footnotes:
NA = It is assumed that noble gases are not accumulated.

In Reference 6, see Table A-1.

A number of bioaccumulation factors could not be found in literature. In this case, the periodic table was used in conjunction with published element values. This method was used for periodic table columns except where there were no values for column 3A so the average of columns 2B and 4A was assigned.

1. Value is the average of Reference 6 values in literature for H, Na, Rb and Cs.
2. Value is the average of Ref. 6 values in literature for Sr, Ba and Ref. 98 values for Ra.
3. Value is the same as the Reference 6 value used for Y.
4. Value is the same as the Reference 6 value used for Zr.
5. Value is the same as the Reference 6 value used for Nb.
6. Value is the average of Reference 6 values in literature for Mn and Tc.
7. Value is the average of Reference 6 values in literature for Fe and Ru.
8. Value is the average of Reference 6 values in literature for Co and Rh.
9. Value is the same as the Reference 6 value used for Ni.
10. Value is the average of Reference 6 values in literature for Cu and Reference 56 value for Ag.
11. Value used is the same as the Reference 6 value used for Zn.
12. Value is the average of Reference 6 value in literature for C and Reference 98 value for Pb.
13. Value is the average of columns 2B and 4A, where column 2B is the "Reference 6 value for Zn" and column 4A is the average of "Reference 6 value for C and Reference 98 value for Pb".
14. Value is the average of Ref. 6 value found in literature for P and the Ref. 98 values for Bi and Sb.
15. Value is the same as the Reference 6 value used for Te.
16. Value is the average of Reference 6 values found in literature for Br and I.

Table C-9
Dose Factors for Noble Gases

Nuclide	Beta Air Dose Factor N_i (mrad/yr per uCi/m^3)	Beta Skin Dose Factor L_i (mrem/yr per uCi/m^3)	Gamma Air Dose Factor M_i (mrad/yr per uCi/m^3)	Gamma Total Body Dose Factor K_i (mrem/yr per uCi/m^3)
Kr-83m	2.88E+02	—	1.93E+01	7.56E-02
Kr-85m	1.97E+03	1.46E+03	1.23E+03	1.17E+03
Kr-85	1.95E+03	1.34E+03	1.72E+01	1.61E+01
Kr-87	1.03E+04	9.73E+03	6.17E+03	5.92E+03
Kr-88	2.93E+03	2.37E+03	1.52E+04	1.47E+04
Kr-89	1.06E+04	1.01E+04	1.73E+04	1.66E+04
Kr-90	7.83E+03	7.29E+03	1.63E+04	1.56E+04
Xe-131m	1.11E+03	4.76E+02	1.56E+02	9.15E+01
Xe-133m	1.48E+03	9.94E+02	3.27E+02	2.51E+02
Xe-133	1.05E+03	3.06E+02	3.53E+02	2.94E+02
Xe-135m	7.39E+02	7.11E+02	3.36E+03	3.12E+03
Xe-135	2.46E+03	1.86E+03	1.92E+03	1.81E+03
Xe-137	1.27E+04	1.22E+04	1.51E+03	1.42E+03
Xe-138	4.75E+03	4.13E+03	9.21E+03	8.83E+03
Ar-41	3.28E+03	2.69E+03	9.30E+03	8.84E+03

Source: Table B-1 of Reference 6.

Table C-10
External Dose Factors for Standing on Contaminated Ground
DFG_{ij} (mrem/hr per pCi/ m^2)

Element	Whole Body Dose Factor	Reference	Element	Dose Factor	Reference
H-3	0.00E+00	6	Be-7	5.95E-10	99
C-14	0.00E+00	6	F-18	1.19E-08	99
Na-22	2.42E-08	99	Na-24	2.50E-08	6
Mg-27	1.14E-08	99	Mg-28	1.48E-08	99
Al-26	2.95E-08	99	Al-28	2 00E-08	99
P-32	0.00E+00	6	Cl-38	1.70E-08	99
Ar-41	1.39E-08	99	K-40	2.22E-09	99
K-42	4.64E-09	99	K-43	1.19E-08	99
Ca-47	1.14E-08	99	Sc-44	2.50E-08	99
Sc-46m	1.21E-09	99	Sc-46	2.24E-08	99
Sc-47	1.46E-09	99	Ti-44	1.95E-09	99
V-48	3.21E-08	99	Cr-51	2.20E-10	6
Mn-52m	2.79E-08	99	Mn-52	3 80E-08	99
Mn-54	5.80E-09	6	Mn-56	1.10E-08	6
Fe-52	9.12E-09	99	Fe-55	0.00E+00	6
Fe-59	8.00E-09	6	Co-57	1.65E-09	99
Co-58	7.00E-09	6	Co-60	1.70E-08	6
Ni-63	0.00E+00	6	Ni-65	3.70E-09	6
Cu-64	1.50E-09	6	Cu-67	1.52E-09	99
Cu-68	8.60E-09[1]	–	Zn-65	4 00E-09	6
Zn-69m	5.06E-09	99	Zn-69	0.00E+00	6
Ga-66	2.70E-08	99	Ga-67	1.89E-09	99
Ga-68	1.24E-08	99	Ga-72	3.00E-08	99
Ge-77	1.34E-08	99	As-72	2.23E-08	99
As-73	1.16E-10	99	As-74	9.41E-09	99
As-76	6.46E-09	99	As-77	1.79E-10	99
Se-73	1.38E-08	99	Se-75	4.98E-09	99
Br-77	3.84E-09	99	Br-80	2.01E-09	99
Br-82	3.00E-08	99	Br-83	6.40E-11	6
Br-84	1.20E-08	6	Br-85	0 00E+00	6
Kr-79	3.07E-09	99	Kr-81	1.59E-10	99
Kr-83m	1.42E-11	99	Kr-85m	2.24E-09	99
Kr-85	1.35E-10	99	Kr-87	1.03E-08	99
Kr-88	2.07E-08	99	Kr-90	1.56E-08	99
Rb-84	1.07E-08	99	Rb-86	6.30E-10	6
Rb-87	0.00E+00	99	Rb-88	3.50E-09	6
Rb-89	1.50E-08	6	Sr-85	6.16E-09	99
Sr-87m	3.92E-09	99	Sr-89	5.60E-13	6
Sr-90	1.84E-11	99	Sr-91	7.10E-09	6
Sr-92	9.00E-09	6	Y-86	4 00E-08	99
Y-87	5.53E-09	99	Y-88	2.88E-08	99
Y-90	2.20E-12	6	Y-91m	3.80E-09	6
Y-91	2.40E-11	6	Y-92	1.60E-09	6
Y-93	5.70E-10	6	Zr-95	5 00E-09	6
Zr-97	5.50E-09	6	Nb-94	1.84E-08	99
Nb-95	5.10E-09	6	Nb-97m	8.57E-09	99
Nb-97	8.48E-09	99	Mo-99	1.90E-09	6
Tc-99m	9.60E-10	6	Tc-101	2.70E-09	6
Tc-104	1.83E-08[1]	–	Ru-97	2.99E-09	99
Ru-103	3.60E-09	6	Ru-105	4.50E-09	6
Ru/Rh-106	5.76E-09[3]	6, 99	Pc-109	3.80E-10	99
Cc-109	1.12E-10	99	In-111	5.11E-09	99
In-115m	2.01E-09	99	In-116	0.00E+00[2]	–
Sn-113	1.15E-09	99	Sn-117m	1.96E-08	99
Sn-119m	7.05E-11	99	Sb-117	0.00E+00[2]	–
Sb-122	2 71E-09[1]	–	Sb-124	1.16E-08[1]	–
Sb-125	4.56E-09	99	Sb-126	7.13E-10	99
Ag-108m	1.92E-08	99	Ag-108	1.14E-09	99
Ag-110m	1.80E-08	6	Ag-111	6.75E-10	99
Te-121m	2.65E-09	99	Te-121	6.75E-09	99
Te-123m	1.88E-09	99	Te-125m	3.50E-11	6
Te-125	0.00E+00[2]	–	Te-127m	1.10E-12	6
Te-127	1.00E-11	6	Te-129m	7.70E-10	6
Te-129	7.10E-10	6	Te-131m	8.40E-09	6

Table C-10 (cont.)
External Dose Factors for Standing on Contaminated Ground
DFG_{ij} (mrem/hr per pCi/ m^2)

Element	Whole Body Dose Factor	Reference	Element	Dose Factor	Reference
Te-131	2.20E-09	6	Te-I-132	3.40E-09[5]	6
Te-134	1.05E-08	99	I-123	2.12E-09	99
I-124	1.23E-08	99	I-125	2.89E-10	99
I-130	1.40E-08	6	I-131	2.80E-09	6
I-133	3.70E-09	6	I-134	1.60E-08	6
I-135	1.20E-08	6	Xe-127	3.44E-09	99
Xe-129m	5.57E-10	99	Xe-131m	2.13E-10	99
Xe-133m	4.81E-10	99	Xe-133	5.91E-10	99
Xe-135m	5.23E-09	99	Xe-135	3.36E-09	99
Xe-137	4.26E-09	99	Xe-138	1.30E-08	99
Cs-129	3.39E-09	99	Cs-132	8.40E-09	99
Cs-134	1.20E-08	6	Cs-136	1.50E-08	6
Cs-137/Ba-137m	1.14E-08[4]	6, 99	Cs-138	2.10E-08	6
Cs-139	5.15E-09	99	Ba-131	5.74E-09	99
Ba-133m	8.10E-10	99	Ba-133	4.85E-09	99
Ba-135m	7.26E-10	99	Ba-137m	7.17E-09	99
Ba-137	0.00E+00[2]	--	Ba-139	2.40E-09	6
Ba-La-140	1.71E-08[6]	6	Ba-141	4.30E-09	6
Ba-142	7.90E-09	6	La-142	1.50E-08	6
Ce-139	2.04E-09	99	Ce-141	5.50E-10	6
Ce-143	2.20E-09	6	Ce-Pr-144	5.20E-10[7]	6
Pr-142	1.84E-09	99	Pr-143	0.00E+00	6
Nc-147	1.00E-09	6	Nc-149	5 32E-09	99
Pm-145	3.38E-10	99	Pm-148m	2.35E-08	99
Pm-148	7.22E-09	99	Pm-149	5.32E-10	99
Sm-153	8.95E-10	99	Eu-152	1.30E-08	99
Eu-154	1.41E-08	99	Eu-155	8.27E-10	99
Gc-153	1.46E-09	99	Dy-157	4.39E-09	99
Er-169	6 12E-14	99	Er-171	5.11E-09	99
Tm-170	3.41E-10	99	Yb-169	4.12E-09	99
Yb-175	4.94E-10	99	Lu-177	4.60E-10	99
Hf-181	6.67E-09	99	Ta-182	1.42E-08	99
Ta-183	2.93E-09[1]	--	W-187	3.10E-09	6
Re-188	1.89E-09	99	Os-191	9 83E-10	99
Ir-194	2.31E-09	99	Pt-195m	9.79E-10	99
Pt-197	3.57E-10	99	Au-195m	2.54E-09	99
Au-195	1.14E-09	99	Au-198	5.19E-09	99
Au-199	1.18E-09	99	Hg-197	9.33E-10	99
Hg-203	2.89E-09	99	Tl-201	1.24E-09	99
Tl-206	0.00E+00[2]	--	Tl-208	3.58E-08	99
Pb-203	3.88E-09	99	Pb-210	3.57E-11	99
Pb-212	1.91E-09	99	Pb-214	3.18E-09	99
Bi-206	3.74E-08	99	Bi-207	1.77E-08	99
Bi-214	1.71E-08	99	Ra-226	8.78E-11	99
Th-232	8.14E-12	99	U-238	7.98E-12	99
Np-239	9.50E-10	6	Am-241	3.48E-10	99

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1 Valued derived by comparing the percentage and MeV of the nuclide's gammas and then comparing to Cesium-137, as a value was not available in the literature.

2 0.0 due to low yield and short half life. A value was not available in the literature.

3 Value is the sum of Ru-106 (1.50E-9) and Rh-106 (4.26E-9). The Rh-106 value is from Reference 99 and the Ru-106 value is from Reference 6.

4 Value is the sum of Cs-137 (4.20E-9) and Ba-137m (7.17E-9) The values are from references 6 and 99, respectively.

5 Value is the sum of Te-132 (1.70E-9) and I-132 (1.70E-9).

6 Value is the sum of Ba-140 (2.10E-9) and La-140 (1.50E-8) from reference 6. In Reference 6, see Table E-6.

7 Value is the sum of Ce-144 (3 20E-10) and Pr-144 (2.00E-10) from reference 6.

Note: Dose assessments for 10CFR20 and 40CFR190 compliance are made for an adult only.

Dose assessments for 10CFR50 Appendix are made using dose factors of Regulatory Guide 1.109 (Reference 6) for all age groups.

Table C-11

Sector Code Definitions

Sector Code	Sector Direction	Angle from North (Degrees)
A	N	$348.75 < \theta \leq 11.25$
B	NNE	$11.25 < \theta \leq 33.75$
C	NE	$33.75 < \theta \leq 56.25$
D	ENE	$56.25 < \theta \leq 78.75$
E	E	$78.75 < \theta \leq 101.25$
F	ESE	$101.25 < \theta \leq 123.75$
G	SE	$123.75 < \theta \leq 146.25$
H	SSE	$146.25 < \theta \leq 168.75$
J	S	$168.75 < \theta \leq 191.25$
K	SSW	$191.25 < \theta \leq 213.75$
L	SW	$213.75 < \theta \leq 236.25$
M	WSW	$236.25 < \theta \leq 258.75$
N	W	$258.75 < \theta \leq 281.25$
P	WNW	$281.25 < \theta \leq 303.75$
Q	NW	$303.75 < \theta \leq 326.25$
R	NNW	$326.25 < \theta \leq 348.75$

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CHAPTER 10

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RADIOACTIVE EFFLUENT TREATMENT AND MONITORING

10.1 AIRBORNE RELEASES

10.1.1 System Description

A simplified HVAC and gaseous effluent flow diagram is provided in Figure 10-1. The principal release points for potentially radioactive airborne effluents are the two auxiliary building vent stacks (designated Unit 1 Vent Stack and Unit 2 Vent Stack in Figure 10-1). In the classification scheme of Section 4.1.4, each is classified as a vent release point (see Table A-1 of Appendix A).

10.1.1.1 Waste Gas Holdup System

The waste gas holdup system is designed and installed to reduce radioactive gaseous effluents by collecting reactor coolant system off-gases from the reactor coolant system and providing for delay or holdup to reduce the total radioactivity by radiodecay prior to release to the environment. The system is described in Chapter 11 of the Byron/Braidwood UFSAR.

10.1.1.2 Ventilation Exhaust Treatment System

Ventilation exhaust treatment systems are designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in gaseous effluents by passing ventilation or vent exhaust gases through HEPA filters (and charcoal adsorbers when required to mitigate potential iodine releases) prior to release to the environment. Such a system is not considered to have any effect on noble gas effluents. The ventilation exhaust treatment systems are shown in Figure 10-1.

Engineered safety features atmospheric cleanup systems are not considered to be ventilation exhaust treatment system components.

10.1.2 Radiation Monitors

10.1.2.1 Auxiliary Building Vent Effluent Monitors

Monitors 1RE-PR028 (Unit 1) and 2RE-PR028 (Unit 2) continuously monitor the final effluent from the auxiliary building vent stacks.

Both vent stack monitors feature automatic isokinetic sampling, grab sampling, and tritium sampling.

No automatic isolation or control functions are performed by these monitors. Pertinent information on these monitors is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.2 Containment Purge Effluent Monitors

Monitors 1RE-PR001 (Unit 1) and 2RE-PR001 (Unit 2) continuously monitor the effluent from the Unit 1 and Unit 2 containments, respectively. When airborne radioactivity in the containment purge effluent stream exceeds a specified level, station personnel will follow established procedures to terminate the release by manually activating the containment purge valves. Additionally, the auxiliary building vent effluent monitors provide an independent, redundant means of monitoring the containment purge effluent.

No automatic isolation or control functions are performed by these monitors.

Pertinent information on these monitors is provided in Byron/Braidwood UFSAR Table 11.5-1.

Area Radiation Monitors 1(2) RE-AR011 and 1(2) RE-AR012 monitor the containment atmosphere. On high alarm during a containment purge, these monitors will automatically terminate the purge.

10.1.2.3 Waste Gas Decay Tank Monitors

Monitors 0RE-PR002A/B continuously monitor the noble gas activity released from the gas decay tanks.

On high alarm, the monitors automatically initiate closure of the valve 0GW014 thus terminating the release.

Pertinent information on these monitors and associated control devices is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.4 Gland Steam and Condenser Air Ejector Monitors

Monitors 1RE-PR027 and 2RE-PR027 continuously monitor the condenser air ejector gas from Units 1 and 2, respectively. ~~On high alarm 1(2)RE-PR027 initiates startup of the offgas treatment system.~~ No control devices are initiated by these channels.

Pertinent information on these monitors is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.5 Radwaste Building Ventilation Monitor

Monitor 0RE-PR026 continuously monitors radioactivity in the radwaste building ventilation system. No control device is initiated by this channel.

Pertinent information on this monitor is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.6 Component Cooling Water Monitor

Monitor 0RE-PR009 (common), 1RE-PR009 (Unit 1), and 2RE-PR009 (Unit 2) continuously monitor the component cooling water heat exchanger outlets. On high alarm, 0RE-PR009 initiates closure of both component cooling water surge tank (CCWST) vents, 1RE-PR009 initiates closure of the Unit 1 CCWST vent, and 2RE-PR009 initiates closure of the Unit 2 CCWST vent.

10.1.2.7 Miscellaneous Ventilation Monitors

Monitor 0RE-PR003 continuously monitors radioactivity in the ventilation exhaust from the laboratory fume hoods. No control device is initiated by this channel.

Pertinent information on this monitor and associated devices is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.3 Alarm and Trip Setpoints

10.1.3.1 Setpoint Calculations

10.1.3.1.1 Auxiliary Building Vent Effluent Monitors

The High Alarm setpoint for the High Range Noble Gas Channel (1/2PR028D) is established at the maximum release rate for the station as calculated in 10.1.3.2. The Alert Alarm setpoint for the High Range Gas Channel is established at a fraction of the maximum release rate for the station.

The High Alarm setpoint for the Low Range Noble Gas Channel (1/2PR028B) is established at less than or equal to 50% of the maximum release rate for the station as calculated in 10.1.3.2. The Alert Alarm setpoint for the Low Range Gas Channel is established at a fraction of the High Alarm setpoint for the Low Range Noble Gas Channel.

10.1.3.1.2 Containment Purge Effluent Monitors

The setpoints are established at 1.50 times the analyzed containment noble gas activity during purge, plus the background reading of the monitor prior to purge.

10.1.3.1.3 Waste Gas Decay Tank Effluent Monitors

The setpoints are established at 1.50 times the analyzed waste gas tank activity during release.

10.1.3.2 Release Limits

Alarm and trip setpoints of gaseous effluent monitors are established to ensure that the release rate limits of RETS are not exceeded. The release limits are found by solving Equations 10-1 and 10-2 for the total allowed release rate of vent releases, Q_{tv}.

$$(\chi/Q)_v^{\gamma} Q_{tv} \sum_i K_i f_i < 500 \text{ mrem/yr} \qquad (10\text{-}1)$$

$$Q_{tv} \sum_i f_i \{L_i' (\chi/Q)_v + (1.11) M_i (\chi/Q)_v^{\gamma}\} < 3000 \text{ mrem/yr} \qquad (10\text{-}2)$$

The summations are over noble gas radionuclides i.

f_i Fractional Radionuclide Composition

The release rate of noble gas radionuclide i divided by the total release rate of all noble gas radionuclides.

Q_{tv} Total Allowed Release Rate, Vent Release [μCi/sec]

The total allowed release rate of all noble gas radionuclides released as vent releases.

The remaining parameters in Equation 10-1 have the same definitions as in Equation A-5 of Appendix A. The remaining parameters in Equation 10-2 have the same definition as in Equation A-6 of Appendix A.

Equation 10-1 is based on Equation A-5 of Appendix A and the RETS restriction on whole body dose rate (500 mrem/yr) due to noble gases released in gaseous effluents (see Section A.1.3.1 of Appendix A). Equation 10-2 is based on Equation A-6 of Appendix A and the RETS restriction on skin dose rate (3000 mrem/yr) due to noble gases released in gaseous effluents (see Section A.1.3.2 of Appendix A).

Since the solution to Equation 10-2 is more conservative than the solution to Equation 10-1, the value of Equation 10-2 (7.02×10^5 μCi/sec) is used as the limiting noble gas release rate. During evolutions involving releases from the containment or waste gas decay tanks, the release rate from each release path is procedurally limited to 1×10^5 μCi/sec.

Calibration methods and surveillance frequency for the monitors will be conducted as specified in the RETS.

10.1.3.3 Release Mixture

In the determination of alarm and trip setpoints, the radioactivity mixture in exhaust air is assumed to have the radionuclide composition of Table 10-1.

10.1.3.4 Conversion Factors

The response curves used to determine the monitor count rates are based on the sensitivity to Xe-133 for conservatism.

10.1.3.5 HVAC Flow Rates

The plant vent stack flow rates are obtained from 1/2 PR28J. However, if the readout indicates "0" flow, the following minimum rated fan flow values are currently used:

Unit 1 - 6.15×10^6 cc/sec
Unit 2 - 4.55×10^6 cc/sec

10.1.4 Allocation of Effluents from Common Release Points

Radioactive gaseous effluents released from the auxiliary building, miscellaneous ventilation systems and the gas decay tanks are comprised of contributions from both units. Consequently, allocation is made evenly between units.

10.1.5 Dose Projections for Batch Releases

Dose projections are not made prior to release. Doses are calculated after purging the containment or venting the waste gas decay tanks. Per procedure, representative samples are obtained and analyzed, and the doses calculated on a monthly basis to verify compliance with 10CFR50.

10.2 LIQUID RELEASES

10.2.1 System Description

A simplified liquid effluent flow diagram is provided in Figure 10-3. A simplified liquid waste processing diagram is provided in Figure 10-2.

The liquid radwaste treatment system is designed and installed to reduce radioactive liquid effluents by collecting the liquids, providing for retention or holdup, and providing for treatment by demineralizer or a concentrator for the purpose of reducing the total radioactivity prior to release to the environment. The system is described in Chapter 11 of the Byron/Braidwood UFSAR.

10.2.1.1 Release Tanks

There are two radwaste release tanks (0WX01T and 0WX26T) which receive liquid waste before discharge to the Kankakee river.

10.2.2 Radiation Monitors

10.2.2.1 Liquid Radwaste Effluent Monitors

Monitor 0RE-PR001 is used to monitor all releases from the release tanks. On high alarm, the monitor automatically initiates closure of valves 0WX-353 and 0WX-896 to terminate the release.

Pertinent information on the monitor and associated control devices is provided in Byron/Braidwood UFSAR Table 11.5-2.

10.2.2.2 Station Blowdown Monitor

Monitor 0RE-PR010 continuously monitors the circulating water blowdown. No control device is initiated by this channel.

Pertinent information on this monitor is provided in Byron/Braidwood UFSAR Table 11.5-2.

10.2.2.3 Reactor Containment Fan Cooler (RCFC) and Essential Service Water (ESSW) Outlet Line Monitors

Monitors 1RE-PR002, 2RE-PR002, 1RE-PR003, and 2RE-PR003 continuously monitor the RCFC and ESSW outlet lines.

No control device is initiated by these channels.

Pertinent information on these monitors is provided in Byron/Braidwood UFSAR Table 11.5-2.

10.2.2.4 Turbine Building Fire and Oil Sump Monitor

Monitor 0RE-PR005 continuously monitors the fire and oil sump discharge. On high alarm the monitor automatically initiates an interlock to trip the discharge pumps, close valve 0OD030, and terminate the release.

Pertinent information on this monitor is provided in Byron/Braidwood UFSAR Table 11.5-2.

10.2.2.5 Condensate Polisher Sump Monitor

Monitor 0RE-PR041 continuously monitors the condensate polisher sump discharge. On high alarm the monitor automatically initiates an interlock to trip the discharge pumps and terminate the release.

Pertinent information on this monitor is provided in Byron/Braidwood UFSAR Table 11.5-2.

10.2.3 Alarm and Trip Setpoints

10.2.3.1 Setpoint Calculations

Alarm and trip setpoints of liquid effluent monitors at the principal release points are established to ensure that the limits of RETS and 10CFR20 are not exceeded in the unrestricted area.

10.2.3.1.1 Station Blowdown Monitor

The monitor setpoint is found by solving equation 10-3.

$$P \leq C^{CW} + (1.25 \times C^{T}) \times [(F^{r}_{max} / (F^{CW} + F^{r}_{max})] \quad (10\text{-}3)$$

P	Release Setpoint	[µCi/ml]
1.25	Factor to account for minor fluctuations in count rate.	
C^{cw}	Concentration of activity in the circulating water blowdown at the time of discharge. ("Background reading")	[µCi/ml]
C^{T}	Analyzed activity in the release tank	[µCi/ml]
F^{CW}	Circulating Water Blowdown Rate	[gpm]
F^{r}_{max}	Maximum Release Tank Discharge Flow Rate The flow rate from the radwaste discharge tank based on the more restrictive of the maximum chemistry permitted flow rate or the Maximum Radiological Permitted Discharge Flow Rate.	[gpm]

10.2.3.1.2 Liquid Radwaste Effluent Monitor

During release the setpoint is established at 1.5 times the analyzed tank activity plus the background reading.

10.2.3.1.2.1 Release Tank Discharge Flow Rate

Prior to each batch release, a grab sample is obtained.

The results of the analysis of the waste sample determine the discharge rate of each batch as follows:

$$F^{r}_{rad} = 0.5(F^{d}_{act} / \Sigma(C^{T}_{i} / 10 * DWC_{i})) \quad (10\text{-}4)$$

The summation is over radionuclides i.

0.5	Factor for conservatism

F^r_{rad}	Maximum Radiological Permitted Discharge Flow Rate The maximum permitted flow rate from the radwaste discharge tank based on radiological limits (not chemistry limits which may be more restrictive)	[gpm]
F^d_{act}	Circulating Water Blowdown Rate	[gpm]
C_i^T	Concentration of Radionuclide i in the Release Tank The concentration of radioactivity in the radwaste discharge tank based on measurements of a sample drawn from the tank.	[µCi/ml]
DWC_i	Derived Water Concentration of Radionuclide i The concentration of radionuclide i given in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402.	[µCi/ml]
10	Multiplier	

10.2.3.1.2.2 Release Limits

Release limits are determined from RETS. Discharge rates and setpoints are adjusted to ensure that 50% of applicable RETS are not exceeded. (See Section 10.2.3.1.2.1.)

In addition to the limits identified within the RETS, an administrative action level for tritium has been established for the Braidwood cooling pond. This limit, based on drinking water pathways, has been established as a control mechanism to ensure this pathway does not become a significant contributor to public dose. Because the public has access to the Braidwood cooling pond for fishing and/or boating, an administrative limit for discharges to the cooling pond is prudent to ensure dose to the public from this path remains well below limits.

The controls for this pathway will be established by limiting the quantity (Curies) discharged to the Braidwood cooling pond. The administrative action level will be established at 4 Ci/year. During times when tritium discharged to the cooling pond is in excess of the 4 Ci/year administrative action level, cooling pond tritium samples should be collected and analyzed (tritium LLD as defined in ODCM Chapter 12, Table 12.3-1) in order to assess actual tritium cooling pond tritium concentrations. Effluent pathways to the cooling pond are analyzed for tritium in accordance with ODCM Chapter 12, Table 12.3-1.

The administrative action level was chosen based on an equilibrium concentration of 200 pCi/l in the cooling pond water (1% of the public drinking water limit as specified in 40CFR141.) Information regarding calculation and assumptions can be found in Braidwood Health Physics Technical Document 98-001, "Cooling pond tritium issues".

10.2.3.1.2.3 Release Mixture

For monitors 0RE-PR001 and 0RE-PR010 the release mixture used for the setpoint determination is the radionuclide mix identified in the grab sample isotopic analysis or the mix in Table 10-2.

10.2.3.1.2.4 Liquid Dilution Flow Rates

Dilution flow rates are obtained from circulating water blowdown transmitter loop OFT-CW032.

10.2.3.1.2.5 Projected Concentrations for Releases

After determining F^r_{max} 1from Equation 10-4, RETS compliance is verified using Equations 10-5 and 10-6.

$$C_i^a = C_i^T [F^r_{max} / (F^r_{max} + F^d_{act})] \quad (10\text{-}5)$$

$$\Sigma\{ C_i^a / 10 * DWC_i \} \leq 0.5 \quad (10\text{-}6)$$

The summation is over radionuclides i.

C_i^a Concentration of Radionuclide i in the Unrestricted Area [µCi/ml]

The calculated concentration of radionuclide i in the unrestricted area as determined by Equation 10-5.

C_i^T Concentration of Radionuclide i in the Release Tank [µCi/ml]

The concentration of radioactivity in the radwaste discharge tank based on measurements of a sample drawn from the tank.

DWC_i Derived Water Concentration of Radionuclide i of Radionuclide i [µCi/ml]

The concentration of radionuclide i given in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402.

10 Multiplier

F^r_{max} Maximum Release Tank Discharge a Flow Rate [gpm]

F^d_{act} Circulating Water Blowdown Rate [gpm]

0.5 Factor for conservatism

10.2.3.1.3 Other Liquid Effluent Monitors

For all other liquid effluent monitors, including 0RE-PR001 and 0RE-PR010 when not batch releasing, setpoints are determined such that the concentration limits do not exceed 10 times the DWC value given in Appendix B, Table 2, Column 2 to 10CFR20.1001 - 20.2402 in the unrestricted area. Release mixtures are based on a representative isotopic mixture of the waste stream or inputs to the waste stream, or defaulted to the mix listed in Table 10-2.

10.2.3.1.4 Conversion Factors

The readouts for the liquid effluent monitors are in μCi/ml. The cpm to μCi/ml conversion is determined for each monitor.

10.2.4 Allocation of Effluents from Common Release Points

Radioactive liquid effluents released from either release tank (0WX01T or 0WX26T) are comprised of contributions from both units. Under normal operating conditions, it is difficult to apportion the radioactivity between the units. Consequently, allocation is made evenly between units.

10.3 SOLIDIFICATION OF WASTE/PROCESS CONTROL PROGRAM

The process control program (PCP) contains the sampling, analysis, and formulation determination by which solidification of radioactive wastes from liquid systems is ensured.

Figure 10-4 is a simplified diagram of solid radwaste processing system.

Table 10-1

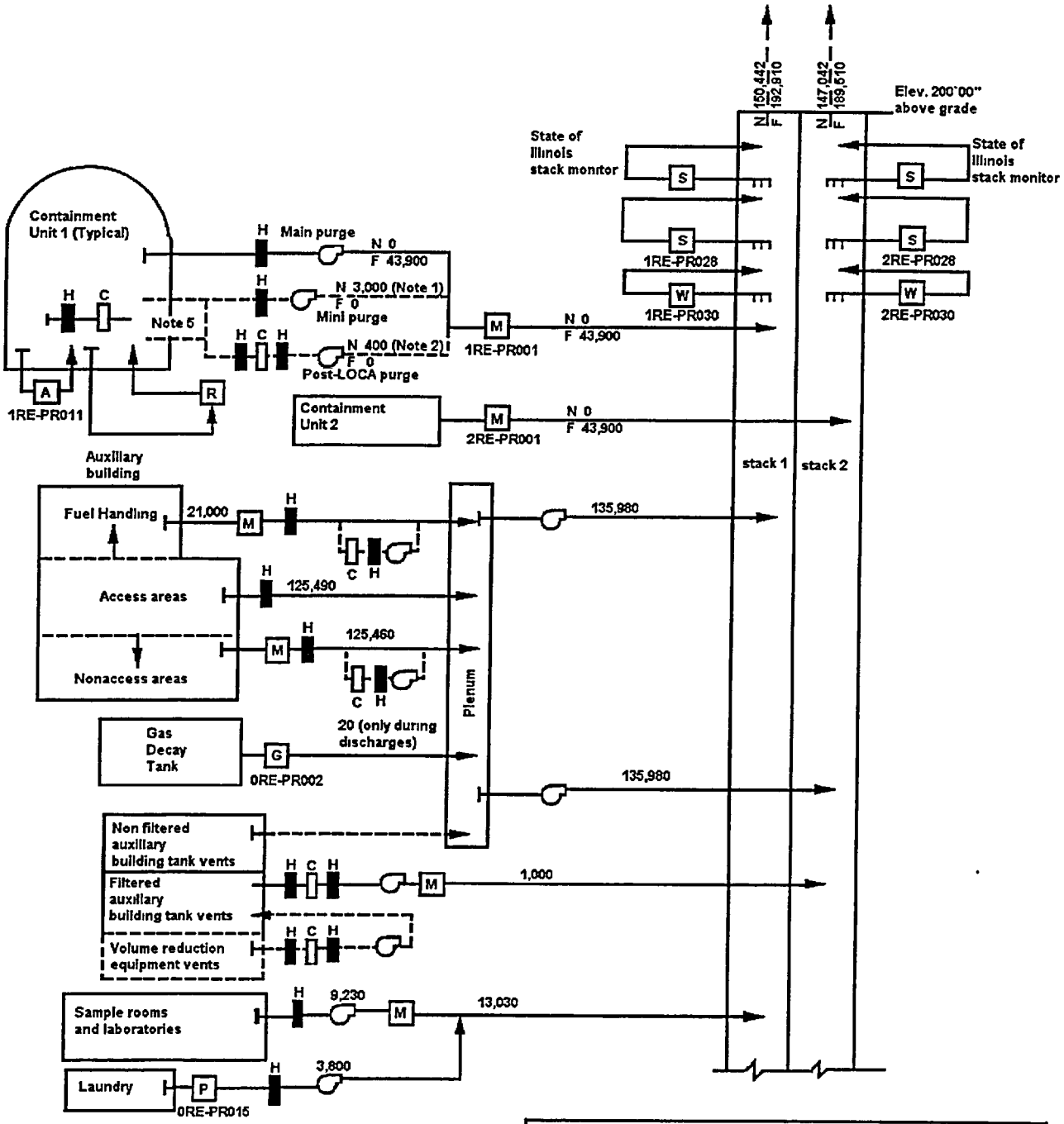
Assumed Composition of the Braidwood Station Noble Gas Effluent

Isotope	Percent of Total Annual Releases
Ar-41	00.89
Kr-85m	00.18
Kr-85	24.90
Kr-87	00.04
Kr-88	00.28
Xe-131m	01.40
Xe-133m	00.57
Xe-133	71.10
Xe-135	00.53
Xe-138	00.04

Table 10-2

Assumed Composition of the Braidwood Station Liquid Effluent

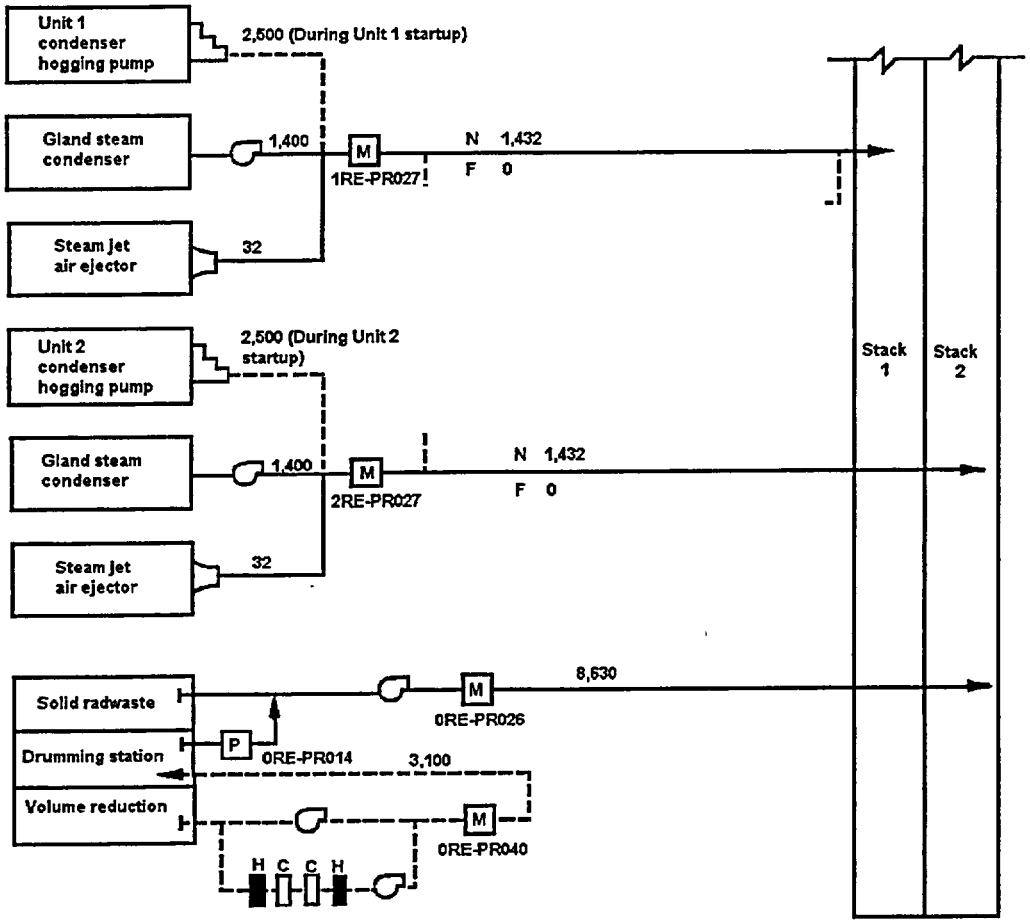
Isotope	Concentration	Isotope	Concentration
	(μCi/ml)		(μCi/ml)
Mn-54	1.00E - 05	I-132	8.00E - 07
Co-58	9.00E - 06	I-133	1.00E - 07
Fe-59	5.00E - 06	Cs-134	9.00E - 07
Co-60	3.00E - 06	I-135	4.00E - 07
Rb-86	2.00E - 06	Cs-136	9.00E - 06
Nb-95	1.00E - 05	Cs-137	2.00E - 06
Zr-95	6.00E - 06	Ce-144	1.00E - 06
Mo-99	4.00E - 06	Np-239	1.00E - 05
Ru-103	8.00E - 06		
Ag-110m	3.00E - 06		
Te-127	2.00E - 05		
Te-129m	2.00E - 06		
I-130	3.00E - 07		
I-131	3.00E - 08		
Te-131m	4.00E - 06		
Te-132	2.00E - 06		



OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 10-1

SIMPLIFIED HVAC AND GASEOUS EFFLUENT FLOW DIAGRAM
(SHEET 1 OF 2)



LEGEND

- —— Normal or frequent flow path
- ---- Occasional flow path
- A Containment atmoshpere radiation monitor
- C Charcoal filter
- F Refueling
- G Noble gas radiation monitor (offline)
- H HEPA filter
- M Three channel radiation monitor for particulate, iodine, and noble gas (offline)
- N Normal operation
- P Particulate monitor (offline)
- R Hydrogen recombiner
- S Normal range stack radiation monitor (particulate, iodine, and noble gas)
- W Wide-range stack noble gas radiation monitor

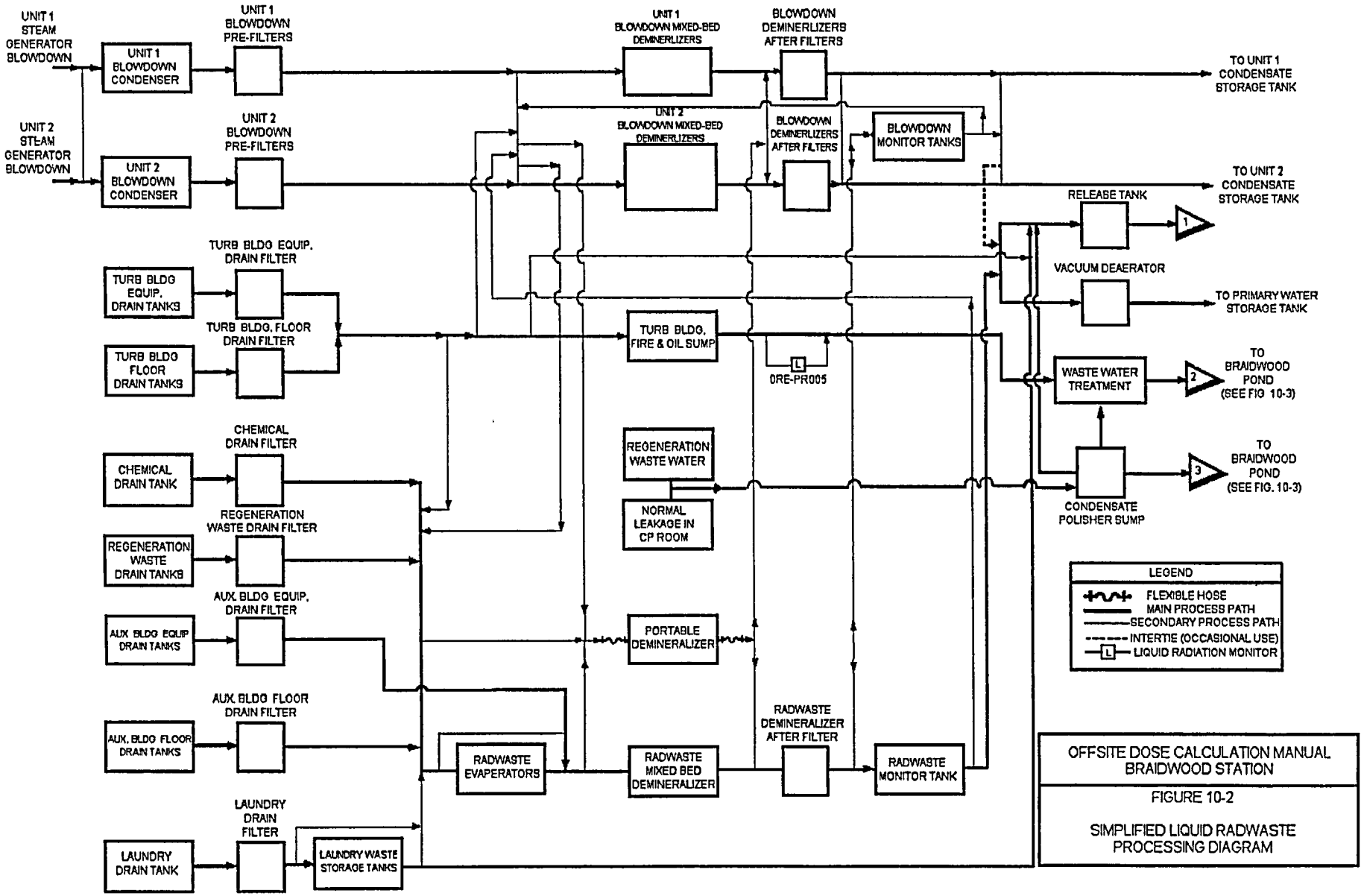
NOTES

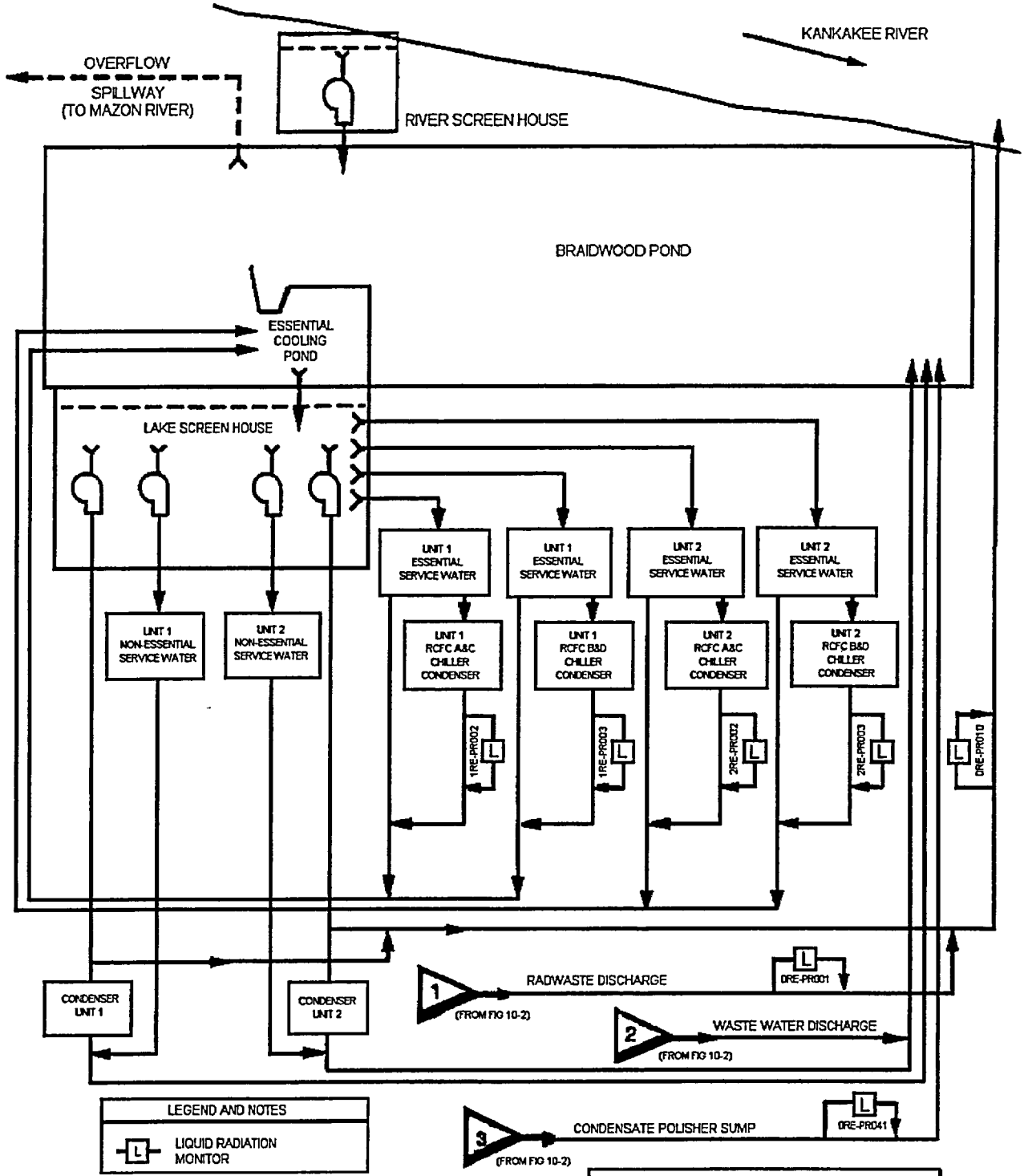
1. Used intermittently to vent containment during normal operation.
2. Used only during postaccident operation.
3. Filter unit operates only when high radiation is detected in offgas system effluent.
4. All flow rates are design flow rate in cubic feet per minute.
5. Intergrated Leak Rate Test (ILRT) pressure relief point (an alternate release point that is seldom used).

OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 10-1

SIMPLIFIED HVAC AND GASEOUS EFFLUENT FLOW DIAGRAM (SHEET 2 OF 2)

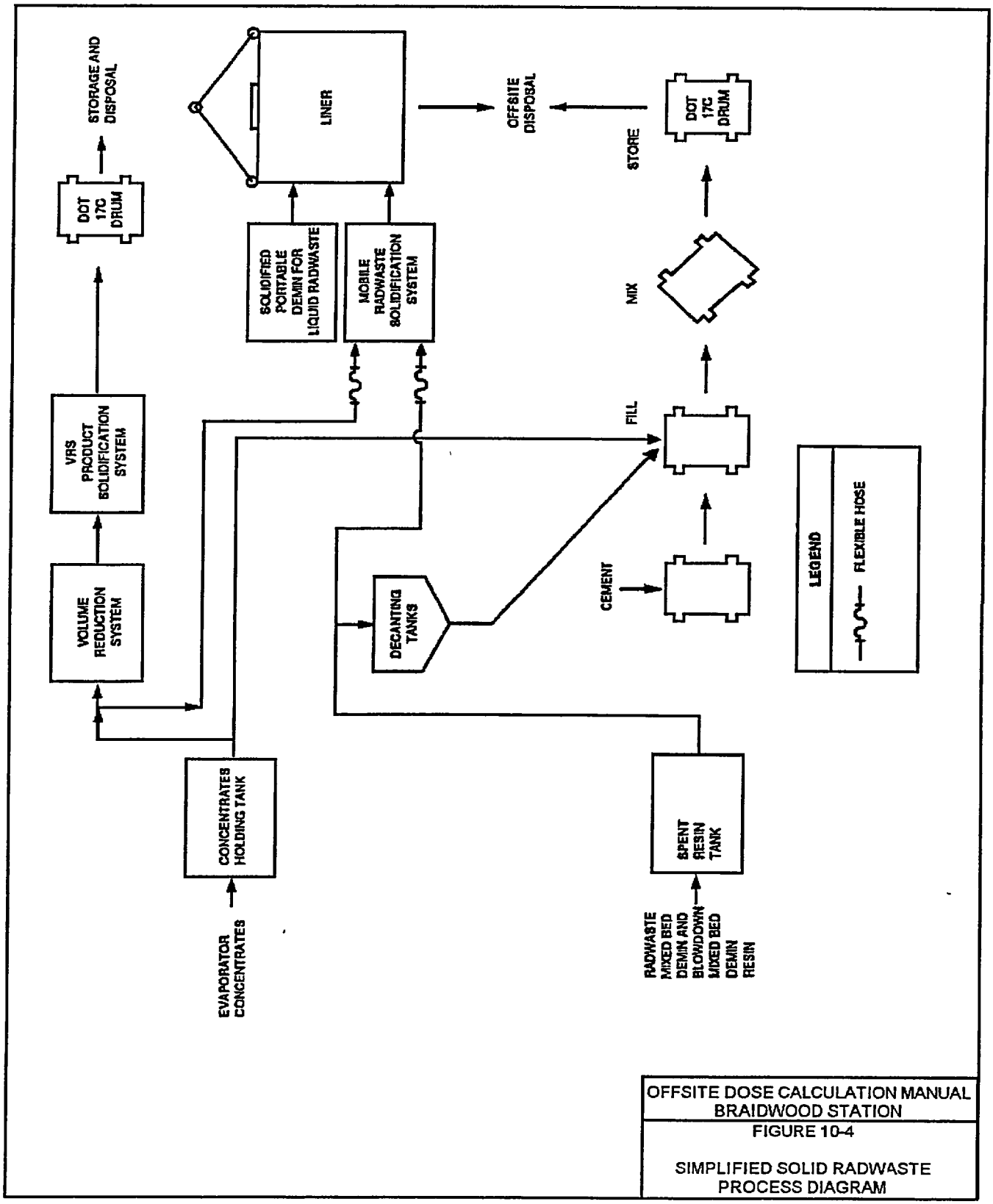

UNIT 1 STEAM GENERATOR BLOWDOWN
UNIT 2 STEAM GENERATOR BLOWDOWN
UNIT 1 BLOWDOWN CONDENSER
UNIT 2 BLOWDOWN CONDENSER
UNIT 1 BLOWDOWN PRE-FILTERS
UNIT 2 BLOWDOWN PRE-FILTERS
UNIT 1 BLOWDOWN MIXED-BED DEMINERLIZERS
UNIT 2 BLOWDOWN MIXED-BED DEMINERLIZERS
BLOWDOWN DEMINERLIZERS AFTER FILTERS
BLOWDOWN DEMINERLIZERS AFTER FILTERS
BLOWDOWN MONITOR TANKS
TO UNIT 1 CONDENSATE STORAGE TANK
TO UNIT 2 CONDENSATE STORAGE TANK
RELEASE TANK
VACUUM DEAERATOR
TO PRIMARY WATER STORAGE TANK
TURB BLDG EQUIP. DRAIN FILTER
TURB BLDG EQUIP. DRAIN TANKS
TURB BLDG. FLOOR DRAIN FILTER
TURB BLDG FLOOR DRAIN TANKS
TURB BLDG. FIRE & OIL SUMP
ORE-PR005
WASTE WATER TREATMENT
TO BRAIDWOOD POND (SEE FIG 10-3)
CHEMICAL DRAIN FILTER
CHEMICAL DRAIN TANK
REGENERATION WASTE WATER
NORMAL LEAKAGE IN CP ROOM
CONDENSATE POLISHER SUMP
TO BRAIDWOOD POND (SEE FIG. 10-3)
REGENERATION WASTE DRAIN FILTER
REGENERATION WASTE DRAIN TANKS
AUX. BLDG EQUIP. DRAIN FILTER
AUX. BLDG EQUIP DRAIN TANKS
PORTABLE DEMINERALIZER
LEGEND
FLEXIBLE HOSE
MAIN PROCESS PATH
SECONDARY PROCESS PATH
INTERTIE (OCCASIONAL USE)
LIQUID RADIATION MONITOR
AUX. BLDG FLOOR DRAIN FILTER
AUX. BLDG FLOOR DRAIN TANKS
RADWASTE EVAPERATORS
RADWASTE MIXED BED DEMINERALIZER
RADWASTE DEMINERALIZER AFTER FILTER
RADWASTE MONITOR TANK
LAUNDRY DRAIN FILTER
LAUNDRY DRAIN TANK
LAUNDRY WASTE STORAGE TANKS
OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION
FIGURE 10-2
SIMPLIFIED LIQUID RADWASTE PROCESSING DIAGRAM



OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 10-3

SIMPLIFIED LIQUID EFFLUENT
FLOW DIAGRAM



OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION
FIGURE 10-4

SIMPLIFIED SOLID RADWASTE PROCESS DIAGRAM

BRAIDWOOD
CHAPT. 11

CHAPTER 11

BRAIDWOOD ANNEX INDEX

Revision 3

CHAPTER 11
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
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CHAPTER 11
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The radiological environmental monitoring program for the environs around Braidwood Station is given in Table 11-1.

Figures 11-1 through 11-3 show sampling and monitoring locations.

Table 11-1
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Locations	Sampling or Collection Frequency	Type and Frequency of Analysis
1. Airborne Radioactive and Particulates	a. Indicators-Near Field BD-06, Godley, 0.5 mi WSW (0.8 km M) BD-19, Nearsite NW, 0.3 mi NW (0.5 km Q) BD-20, Nearsite N, 0.6 mi N (1.0 km A) BD-21, Nearsite NE, 0.5 mi NE (0.8 km C) b. Indicators-Far Field BD-02, Custer Park, 5.0 mi E (8.0 km E) BD-04, Essex, 4.8 mi SSE (7.7 km H) BD-05, Gardner, 5.5 mi SW (8.8 km L) c. Controls BD-03, County Line Road, 6.2 mi ESE (10.0 km F)	Continuous sampler operation with particulate sample collection weekly, or more frequently if required by dust loading, and radioiodine canister collection biweekly.	Radioiodine Canisters: 1-131 analysis biweekly on near field and control samples[1]. Particulate Sampler: Gross beta analysis following weekly filter change[2] and gamma isotopic analysis[3] quarterly on composite filters by location on near field and control samples[1].

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Locations	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation	a. Indicators-Inner Ring BD-101-3, 0.5 mi N (0.8 km A) BD-101-4, 0.5 mi N (0.8 km A) BD-102-1, 1.1 mi NNE (1.8 km B) BD-102-2, 1.1 mi NNE (1.8 km B) BD-103-1, 1.0 mi NE (1.6 km C) BD-103-2, 1.0 mi NE (1.6 km C) BD-104-1, 0.7 mi ENE (1.1 km D) BD-104-2, 0.7 mi ENE (1.1 km D) BD-105-1, 2.2 mi E (3.5 km E) BD-105-2, 2.2 mi E (3.5 km E) BD-106-1, 2.5 mi ESE (4.0 km F) BD-106-2, 2.5 mi ESE (4.0 km F) BD-107-1, 3.2 mi SE (5.1 km G) BD-107-2, 3.2 mi SE (5.1 km G) BD-108-1, 3.2 mi SSE (5.1 km H) BD-108-2, 3.2 mi SSE (5.1 km H) BD-109-1, 3.8 mi S (6.1 km J) BD-109-2, 3.8 mi S (6.1 km J) BD-110-1, 2.8 mi SSW (4.5 km K) BD-110-2, 2.8 mi SSW (4.5 km K) BD-111a-1, 1.4 mi SW (2.2 km L) BD-111a-2, 1.4 mi SW (2.2 km L) BD-112-1, 0.7 mi WSW (1.1 km M) BD-112-2, 0.7 mi WSW (1.1 km M) BD-113a-1, 0.5 mi W (0.8 km N) BD-113a-2, 0.5 mi W (0.8 km N)	Quarterly	Gamma dose on each TLD quarterly.

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Locations	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation (Cont'd)	a. Indicators-Inner Ring (Cont'd) BD-114-1, 0.4 mi WNW (0.6 km P) BD-114-2, 0.4 mi WNW (0.6 km P) BD-115-1, 0.3 mi NW (0.5 km Q) BD-115-2, 0.3 mi NW (0.5 km Q) BD-116-1, 0.4 mi NNW (0.6 km R) BD-116-2, 0.5 mi NNW (0.8 km R) b. Indicators-Outer Ring BD-201-1, 4.2 mi N (6.8 km A) BD-201-2, 4.2 mi N (6.8 km A) BD-202-1, 4.8 mi NNE (7.7 km B) BD-202-2, 4.8 mi NNE (7.7 km B) BD-203-1, 4.9 mi NE (7.9 km C) BD-203-2, 4.9 mi NE (7.9 km C) BD-204-1, 4.3 mi ENE (6.9 km D) BD-204-2, 4.3 mi ENE (6.9 km D) BD-205-1, 4.0 mi E (6.4 km E) BD-205-2, 4.0 mi E (6.4 km E) BD-206-1, 4.5 mi ESE (7.2 km F) BD-206-2, 4.5 mi ESE (7.2 km F) BD-207-1, 4.5 mi SE (7.2 km G) BD-207-2, 4.5 mi SE (7.2 km G) BD-208-1, 4.5 mi SSE (7.2 km H) BD-208-2, 4.5 mi SSE (7.2 km H) BD-209-1, 4.8 mi S (7.7 km J) BD-209-2, 4.8 mi S (7.7 km J)		

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Locations	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation (Cont'd)	b. Indicators-Outer Ring BD-210-1, 5.3 mi SSW (8.5 km K) BD-210-2, 5.3 mi SSW (8.5 km K) BD-211-1, 4.8 mi SW (7.7 km L) BD-211-2, 4.8 mi SW (7.7 km L) BD-212-3, 5.0 mi WSW (8.0 km M) BD-212-4, 5.0 mi WSW (8.0 km M) BD-213-3, 4.8 mi W (7.7 km N) BD-213-4, 4.8 mi W (7.7 km N) BD-214-1, 4.3 mi WNW (6.9 km P) BD-214-2, 4.3 mi WNW (6.9 km P) BD-215-1, 4.5 mi NW (7.2 km Q) BD-215-2, 4.5 mi NW (7.2 km Q) BD-216-1, 4.0 mi NNW (6.4 km R) BD-216-2, 4.0 mi NNW (6.4 km R) c. Other Indicators One at each of the airborne location given in part 1.a and 1.b.		

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Locations	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation (Cont'd)	c. Controls One at each airborne control location given in part 1.c.		
3. Waterborne			
a. Ground/Well	a. Indicators BD-13, Braidwood City Hall Well, 1.7 mi NNE (2.7 km B) BD-34, Gibson Well, 4.7 mi E (7.6 km E) [22032 Rt. 113] BD-35, Joly Well, 4.7 mi E (7.6 km E) [22028 Rt. 113] BD-36, Hutton Well, 4.7 mi E (7.6 km E) [22040 Rt. 113] BD-37, Nurczyk Well, 4.7 mi E (7.6 km E [22100 Davy Lane]	Quarterly	Gamma isotopic[3] and tritium analysis quarterly.
b. Drinking Water	a. Indicator BD-22, Wilmington 6.0 mi NE (9.7 km C)	Weekly composite samples[5]	Gross beta and gamma isotopic analysis[3] on monthly composite; tritium analysis on quarterly composite.
c. Surface Water	a. Indicator BD-10, Kankakee River downstream of discharge, 5.4 mi NE (8.7 km C)	Weekly grab samples	Gross beta and gamma isotopic analysis[3] on monthly composite; tritium analysis on quarterly composite.

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Locations	Sampling or Collection Frequency	Type and Frequency of Analysis
3. Waterborne (Cont'd)			
d. Control	a. Control BD-25, Kankakee River upstream of discharge, 9.6 mi E (15.4 km E)	Weekly grab samples	Gross beta and gamma isotopic ananalysis[3] on monthly composite; tritium analysis on quarterly composite.
e. Sediments	a. Indicators BD-10, Kankakee River downstream of discharge, 5.4 mi E (8.7 km C)	Semiannually	Gamma isotopic analysis[3] semiannually.
4. Ingestion			
a. Milk	a. Indicators BD-17, Halpin's Dairy, 5.5 mi SSW (8.8 km K) [8625 South Halpin Rd] b. Controls BD-18, Biros Farm, 8.7 mi W (14.0 km N) [1168 Reed Road]	Biweekly: May through October; monthly: November through April	Gamma isotopic[3] and I-131 analysis[4] on each sample.
b. Fish	a. Indicator BD-28, Kankakee River in discharge area, 5.4 mi E (8.7 km E) b. Control BD-25, Kankakee River upstream of discharge area, 9.6 mi E (15.4 km E)	Two times annually	Gamma isotopic analysis[3] on edible portions

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sample or Monitoring Locations	Sampling or Collection Frequency	Type and Frequency of Analysis
4. Ingestion (Cont'd) c. Food Products	a. Indicators Two samples from each of the four major quandrants within 6.2 miles of the station, if available. Sample locations for food products may vary based on availability and therefore are not required to be identified here but shall be taken. b. Controls Two samples within 9.3 to 18.6 miles of the Station, if available.	Annually	Gamma isotopic analysis[3] , I-131 on each sample.

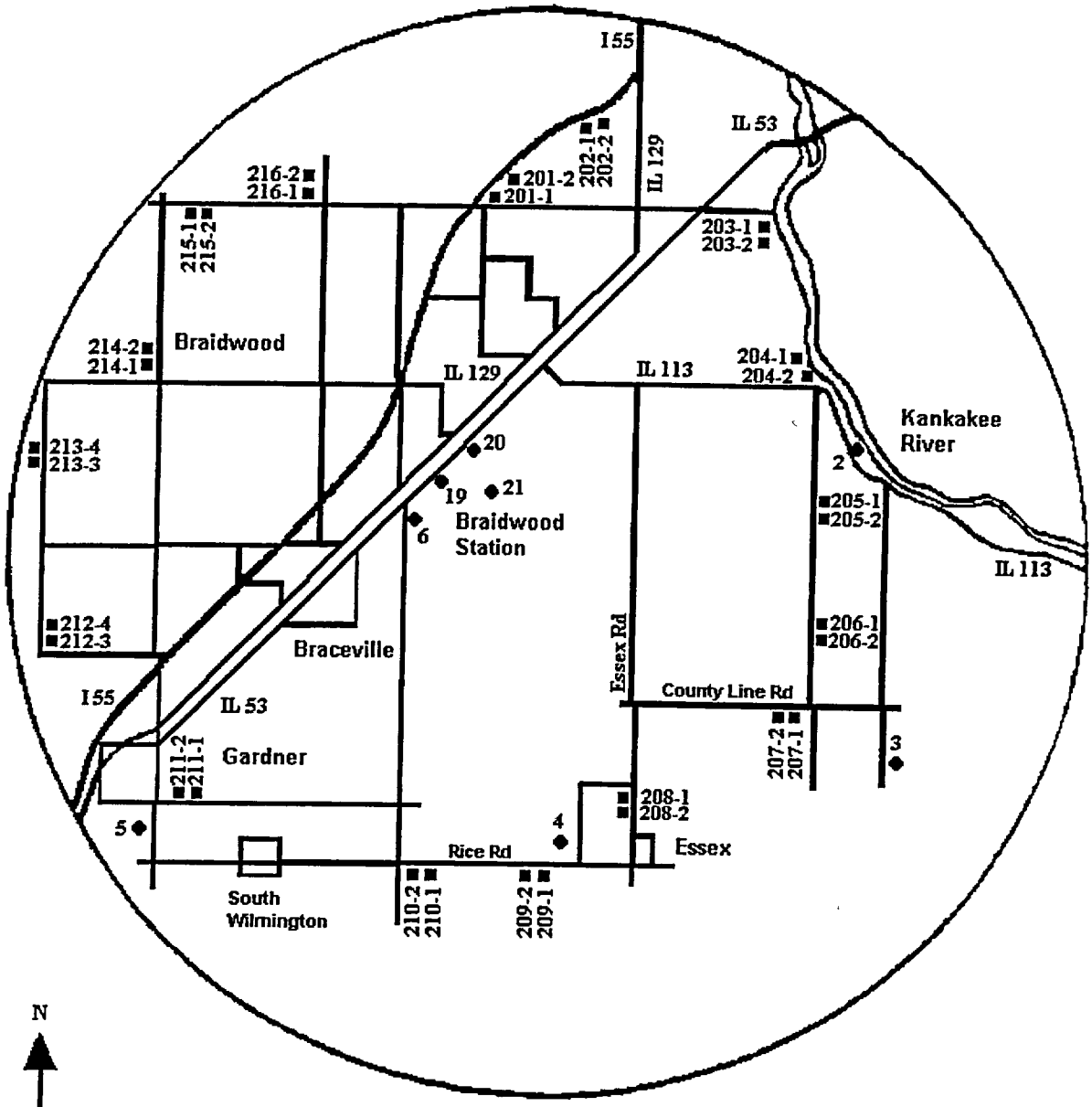
[1] Far field samples are analyzed when near field results are inconsistent with previous measurements and the radioactivity is confirmed as having its origin in airborne effluents released from the station, or at the discretion of the Radiation Protection Director.

[2] Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

[3] Gamma isotopic analysis means the identification and quantification of gamma emitting radionuclides that may be attributable to the effluents from the station.

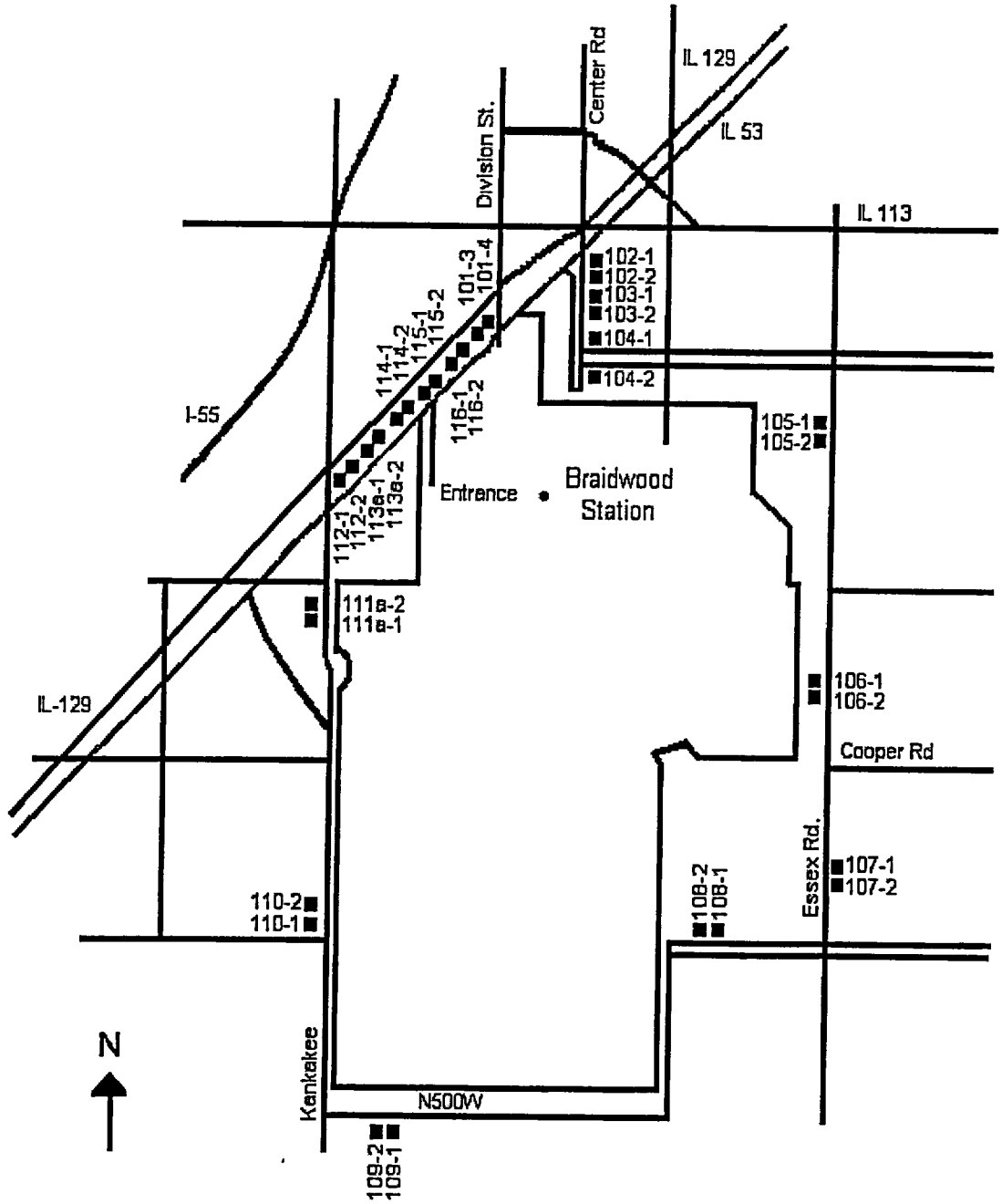
[4] I-131 analysis means the analytical separation and counting procedure are specific for this radionuclide.

[5] Grab sample(s) shall be taken at the time of collection if the compositor is not in service.

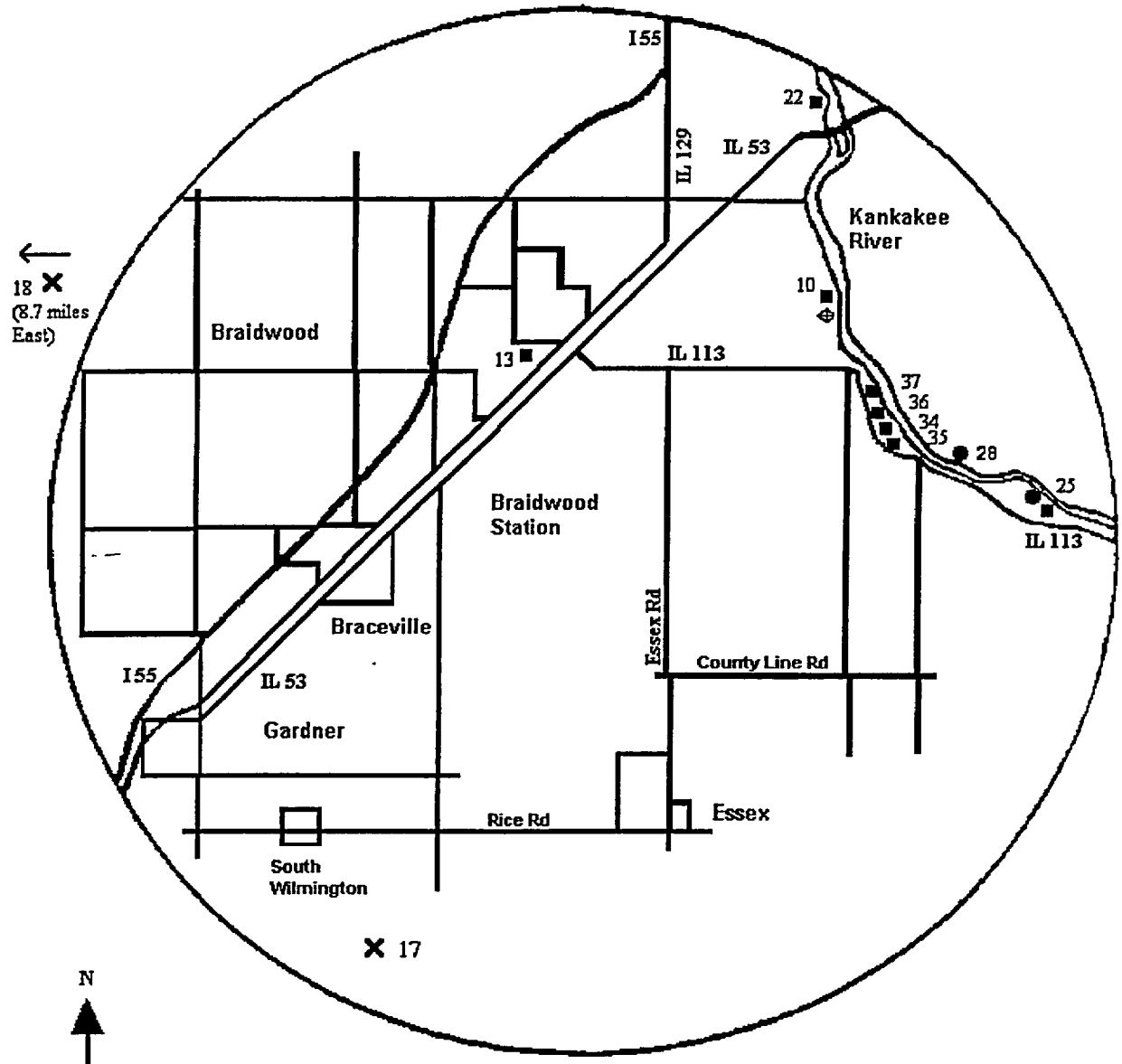


OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 11-1
FIXED AIR SAMPLING SITES
AND
OUTER RING TLD LOCATIONS



OFFSITE DOSE CALCULATION MANUAL BRAIDWOOD STATION
FIGURE 11-2 INNER RING TLD LOCATIONS



OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 11-3
INGESTION AND WATERBORNE EXPOSURE PATHWAY SAMPLE LOCATIONS

■ Water ⊕ Sediment
● Fish ✕ Milk

RETS
(CHAPT.12)

CHAPTER 12.0

SPECIAL NOTE

The transfer of the Radiological Effluent Technical Specifications to the ODCM by Technical Specification, Amendment 35, dated April 13, 1992, was approved by the Nuclear Regulatory Commission.

CHAPTER 12

ANNEX INDEX

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CHAPTER 12

RADIOACTIVE EFFLUENT TECHNICAL STANDARDS
(RETS)
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CHAPTER 12

RADIOACTIVE EFFLUENT TECHNICAL STANDARDS
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LIST OF TABLES

12.0 RADIOLOGICAL EFFLUENT TECHNICAL STANDARDS

Chapter 12 of the Braidwood Station ODCM is a compilation of the various regulatory requirements, surveillance and bases, commitments and/or components of the radiological effluent and environmental monitoring programs for Braidwood Station. To assist in the understanding of the relationship between effluent regulations, ODCM equations, RETS (Chapter 12 section) and related Technical Specification (I.T.S.) requirements, Table 12.0-1 is a matrix which relates these various components. The Radiological Environmental Monitoring Program fundamental requirements are contained within this chapter with Braidwood specific information in Chapter 11 and with a supplemental matrix in Table 12.0-2.

Table 12.0-1

EFFLUENT COMPLIANCE MATRIX

Regulation	Dose Component Limit	ODCM Equation	RETS	Technical Specification
10CFR50 Appendix I	1. Gamma air dose and beta air dose due to airborne radioactivity in effluent plume.	A-1 A-2	12.4.2	5.5.4.h N/A
	a. Total body and skin dose due to airborne radioactivity in effluent plume are reported only if certain gamma and beta air dose criteria are exceeded.	A-3 A-4	N/A	5.5.4.i
	2. Dose for all organs and all four age groups due to iodines and particulates in effluent plume. All pathways are considered.	A-7	12.4.3	5.5.4.d
	3. Dose for all organs and all four age groups due to radioactivity in liquid effluents.	A-17	12.3.2	
10CFR20	1. Total Dose, totaling all external dose components (direct, ground and plume shine) and internal dose (all pathways, both airborne and liquid-borne).	A-25	12.4.6	5.5.4.c
40CFR190 (now by reference, also part of 10CFR20)	1. Total body dose due to direct dose, ground and plume shine from all sources at a station.	A-24	12.4.5	5.5.4.j
	2. Organ doses to an adult due to all pathways.	A-25		
Technical Specifications	1. "Instantaneous" total body, skin, and organ dose rates to a child due to radioactivity in airborne effluents. For the organ dose, only inhalation is considered.	A-5 A-6 A-16	12.4.1	5.5.4.g
	2. "Instantaneous" concentration limits for liquid effluents.	A-21	12.3.1	5.5.4 b
Technical Specifications	1. Radiological Effluent Release Report	NA	12.6.2	5.6.3

Table 12.0-2

REMP COMPLIANCE MATRIX

Regulation	Dose Component Limit	RETS	Technical Specification
10CFR50 Appendix I Section IV.B.2	Implement environmental monitoring program.	12.5.1	TRM 5.2.C.1
Technical Specification	Land Use Census	12.5.2	TRM 5.2.C.2
Technical Specifications	Interlaboratory Comparison Program	12.5.3	TRM 5.2.C.3
Technical Specifications	Radiological Environmental Operating Report	12.6.1	5.6.2

12.0 RADIOLOGICAL EFFLUENT TECHNICAL STANDARDS

12.1 DEFINITIONS

12.1.1 Action shall be that which prescribes remedial measures required under designated conditions.

12.1.2 Analog Channel Operational Test shall be the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY of alarm, interlock and/or trip functions. The ANALOG CHANNEL OPERATIONAL TEST shall include adjustments, as necessary, of the alarm interlock and/or Trip Setpoints such that the Setpoints are within the required range and accuracy.

12.1.3 Channel Calibration shall be the adjustment, as necessary, of the channel such that it responds within the required range and accuracy to known values of input. The CHANNEL CALIBRATION shall encompass the entire channel including the sensors and alarm, interlock and/or trip functions and may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is calibrated.

12.1.4 Channel Check shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

12.1.5 Continuous Sampling is uninterrupted sampling with the exception of sampling interruptions of short duration's, for routine activities (e.g filter replacement)

12.1.6 Digital Channel Operational Test shall consist of exercising the digital computer hardware using data base manipulation and injecting simulated process data to verify OPERABILITY of alarm and/or trip functions.

12.1.7 Dose Equivalent I-131 shall be that concentration of I-131 (microCurie/gram) that alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in Table III of TID-14844, AEC, 1962, "Calculation of Distance Factors for Power and Test Reactor Sites," or those listed in Table E-7 of Regulatory Guide 1.109, Rev. 1, NRC, 1977, or ICRP 30, Supplement to Part 1, page 192-212, Table titled "Committed Dose Equivalent in Target Organs or Tissues per Intake of Unit Activity."

12.1.8 Frequency - Table 12.1-1 provides the definitions of various frequencies for which surveillance's, sampling, etc. are performed unless defined otherwise. The 25% variance shall not be applied to Operability Action Statements. The bases to Technical Specification 4.0.2 provide clarifications to this requirement.

12.1.9 Member(s) of the Public means any individual except when that individual is receiving an occupational dose.

12.1.10 Occupational Dose means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with 10CFR35.75, from voluntary participation in medical research programs, or as a member of the public.

12.0 RADIOLOGICAL EFFLUENT TECHNICAL STANDARDS (Cont)

12.1.11 Operable/Operability a system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s), and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its function(s) are also capable of performing their related support function(s).

12.1.12 Operational Mode (i.e. Mode) shall correspond to any one inclusive combination of core reactivity condition, power level, and average reactor coolant temperature specified in Table 1.2 of the Technical Specifications .

12.1.13 Process Control Program (PCP) shall contain the current formulas, sampling, analyses, tests, and determinations to be made to ensure that processing and packaging of solid radioactive wastes based on demonstrated processing of actual or simulated wet solid wastes will be accomplished in such a way as to assure compliance with 10 CFR Parts 20, 61, 71 and State regulations, burial ground requirements, and other requirements governing the disposal of radioactive wastes.

12.1.14 Purge/Purging shall be any controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

12.1.15 Rated Thermal Power shall be a total core heat transfer rate to the reactor coolant of 3586.6 MWt.

12.1.16 Site Boundary shall be that line beyond which the land is neither owned, nor leased, nor otherwise controlled by the licensee.

12.1.17 Solidification shall be the conversion of wet wastes into a form that meets shipping and burial ground requirements.

12.1.18 Source Check shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

12.1.19 Thermal Power shall be the total core heat transfer rate to the reactor coolant.

12.1.20 Unrestricted Area means an area, access to which is neither limited nor controlled by the licensee.

12.1.21 Ventilation Exhaust Treatment System shall be any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Features Atmospheric Cleanup Systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

12.0 RADIOLOGICAL EFFLUENT TECHNICAL STANDARDS (Cont)

12.1.22 Venting shall be any controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

12.1.23 Waste Gas Holdup System shall be any system designed and installed to reduce radioactive gaseous effluents by collecting Reactor Coolant System off-gases from the Reactor Coolant System and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

12.1.24 Definitions Peculiar to Estimating Dose to Members of the Public using the ODCM Computer Program.

a. ACTUAL - ACTUAL refers to using known release data to project the dose to members of the public for the previous time period. This data is stored in the database and used to demonstrate compliance with the reporting requirements of Chapter 12.

b. PROJECTED - PROJECTED refers to using known release data from the previous time period or estimated release data to forecast a future dose to members of the public. This data is not incorporated into the database.

TABLE 12.1-1

FREQUENCY NOTATIONS*

NOTATION	FREQUENCY
S - Shiftly	At least once per 12 hours.
D - Daily	At least once per 24 hours.
W - Weekly	At least once per 7 days.
M - Monthly	At least once per 31 days.
Q - Quarterly	At least once per 92 days.
SA - Semiannually	At least once per 184 days.
A - Annually	At least once per 366 days.
R - Refueling cycle	At least once per 18 months (550 days).
S/U - Startup	Prior to each reactor startup.
P - Prior	Prior to each radioactive release.
N.A.	Not applicable.

* Each frequency requirement shall be performed within the specified time interval with the maximum allowable extension not to exceed 25% of the frequency interval. The 25% variance shall not be applied to Operability Action Statements. The bases to Technical Specification 4.0.2 provide clarifications to this requirement. These frequency notations do not apply to the Radiological Environmental Monitoring Program (REMP) as described in Section 12.5.

12.2 INSTRUMENTATION

12.2.1 Radioactive Liquid Effluent Monitoring Instrumentation

Operability Requirements

12.2.1.A The radioactive liquid effluent monitoring instrumentation channels shown in Table 12.2-1 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of 12.3.1.A are not exceeded. The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

Applicability: At all times

Action

1. With a radioactive liquid effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above specification, immediately suspend the release of radioactive liquid effluents monitored by the affected channel, or declare the channel inoperable.

2. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 12.2-1. Restore the inoperable instrumentation to OPERABLE status within the time specified in the ACTION, or explain in the next Radioactive Effluent Release Report pursuant to Section 12.6 why this inoperability was not corrected within the time specified.

Surveillance Requirements

12.2.1.B Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and DIGITAL and ANALOG CHANNEL OPERATIONAL TEST at the frequencies shown in Table 12.2-2.

Bases

12.2.1.C The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of RETS. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10CFR50.

TABLE 12 2-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

	INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1.	Radioactivity Monitors Providing Alarm and Automatic Termination of Release		
a.	Liquid Radwaste Effluent Line (0RE-PR001)	1	31
b.	Fire and Oil Sump (0RE-PR005)	1	34
c.	Condensate Polisher Sump Discharge (0RE-PR041)	1	34
2.	Radioactivity Monitors Providing Alarm But Not Providing Automatic Termination of Release		
a.	Essential Service Water		
1)	Unit 1		
a)	RCFC 1A and 1C Outlet (1RE-PR002)	1	32
b)	RCFC 1B and 1D Outlet (1RE-PR003)	1	32
2)	Unit 2		
a)	RCFC 2A and 2C Outlet (2RE-PR002)	1	32
b)	RCFC 2B and 2D Outlet (2RE-PR003)	1	32
b.	Station Blowdown Line (0RE-PR010)	1	32
3.	Flow Rate Measurement Devices		
a.	Liquid Radwaste Effluent Line (Loop-WX001)	1	33
b.	Liquid Radwaste Effluent Low Flow Line (Loop-WX630)	1	33
c.	Station Blowdown Line (Loop-CW032)	1	33

TABLE 12.2-1 (Continued)

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

ACTION STATEMENTS

*ACTION 31 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 14 days provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Section 12.3 and

b At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge line valving.

If a and b can not be met, suspend releases of radioactive effluents via this pathway.

*ACTION 32 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided that, at least once per 12 hours, grab samples are collected and analyzed for principal gamma emitters and I-131 at a lower limit of detection as specified in Table 12.3-1.

*ACTION 33 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow.

*ACTION 34 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are analyzed for principal gamma emitters and I-131 at a lower limit of detection as specified in Table 12.3-1:

a. At least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01 microCurie/gram DOSE EQUIVALENT I-131,

OR

b. At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 microCurie/gram DOSE EQUIVALENT I-131.

* If effluent releases continue via this pathway beyond the time specified, continue to perform actions and explain in the next Radioactive Effluent Report why the time specified was exceeded.

TABLE 12.2-2

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST	ANALOG CHANNEL OPERATIONAL TEST
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release					
a. Liquid Radwaste Effluent Line (0RE-PR001)	D	P	R(3)	Q(1)	N.A.
b. Fire and Oil Sump Discharge (0RE-PR005)	D	M	R(3)	Q(1)	N.A.
c. Condensate Polisher Sump Discharge (0RE-PR041)	D	M	R(3)	Q(1)*	N.A.
2. Radioactivity Monitors Providing Alarm But Not Providing Automatic Termination of Release					
a. Essential Service Water					
1) Unit 1					
a) RCFC 1A and 1C Outlet (1RE-PR002)	D	M	R(3)	Q(2)	N.A.
b) RCFC 1B and 1D Outlet (1RE-PR003)	D	M	R(3)	Q(2)	N.A.
2) Unit 2					
a) RCFC 2A and 2C Outlet (2RE-PR002)	D	M	R(3)	Q(2)	N.A.
b) RCFC 2B and 2D Outlet (2RE-PR003)	D	M	R(3)	Q(2)	N.A.
b. Station Blowdown Line (0RE-PR010)	D	M	R(3)	Q(2)	N.A.
3. Flow Rate Measurement Devices					
a. Liquid Radwaste Effluent Line (Loop-WX001)	D(4)	N.A.	R	N.A.	Q
b. Liquid Radwaste Effluent Low Flow Line (Loop-WX630)	D(4)	N.A.	R	N.A.	Q
c. Station Blowdown Line (Loop-CW032)	D(4)	N.A.	R	N.A.	Q

TABLE 12.2-2 (Continued)

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

TABLE NOTATIONS

(1) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

a. Instrument indicates measured levels above the Alarm/Trip Setpoint, OR

b. Circuit failure (monitor loss of communications - alarm only, detector loss of counts, or monitor loss of power), OR

c. Detector check source test failure, OR

d. Detector channel out-of-service, OR

* e. Monitor loss of sample flow. This is only applicable for ORE-PR001 and ORE-PR005. (Monitor ORE-PR041 will not trip on loss of sample flow).

(2) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

a Instrument indicates measured levels above the Alarm Setpoint, OR

b. Circuit failure (monitor loss of communications - alarm only, detector loss of counts, or monitor loss of power), OR

c. Detector check source test failure, OR

d. Detector channel out-of-service, OR

e. Monitor loss of sample flow.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

(4) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

12.2 2 Radioactive Gaseous Effluent Monitoring Instrumentation

Operability Requirements

12.2.2.A The radioactive gaseous effluent monitoring instrumentation channels shown in Table 12.2-3 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Section 12.4 are not exceeded The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

Applicability: As shown in Table 12.2-3

Action:

1. With a radioactive gaseous effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above section, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel inoperable.

2. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 12.2-3. Restore the inoperable instrumentation to OPERABLE status within the time specified in the ACTION, or explain in the next Annual Radioactive Effluent Release Report pursuant to Section 12.6 why this inoperability was not corrected within the time specified.

Surveillance Requirements

12.2.2.B Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and DIGITAL and CHANNEL OPERATIONAL TEST at the frequencies shown in Table 12.2-4.

Bases

12.2.2.C The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of RETS. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10CFR50. The sensitivity of any noble gas activity monitor used to show compliance with the gaseous effluent release requirements of Section 12.4 shall be such that concentrations as low as $1x10^{-6}$ uCi/cc are measurable.

TABLE 12.2-3

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

	INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1.	Plant Vent Monitoring System - Unit 1			
a.	Noble Gas Activity Monitor Providing Alarm			
	1) High Range (1RE-PR028D)	1	*	39
	2) Low Range (1RE-PR028B)	1	*	39
b.	Iodine Sampler (1RE-PR028C)	1	*	40
c.	Particulate Sampler (1RE-PR028A)	1	*	40
d.	Effluent System Flow Rate Measuring Device (LOOP-VA019)	1	*	36
e.	Sampler Flow Rate Measuring Device (1FT-PR165)	1	*	36
2.	Plant Vent Monitoring System - Unit 2			
a.	Noble Gas Activity Monitor Providing Alarm			
	1) High Range (2RE-PR028D)	1	*	39
	2) Low Range (2RE-PR028B)	1	*	39
b.	Iodine Sampler (2RE-PR028C)	1	*	40
c.	Particulate Sampler (2RE-PR028A)	1	*	40
d.	Effluent System Flow Rate Measuring Device (LOOP-VA020)	1	*	36
e.	Sampler Flow Rate Measuring Device (2FT-PR165)	1	*	36

TABLE 12 2-3 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

	INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
3.	Not Used.			
4.	Gas Decay Tank System			
a.	Noble Gas Activity Monitor-Providing Alarm and Automatic Termination of Release (0RE-PR002A and 2B)	2	*	35
5.	Containment Purge System			
a.	Noble Gas Activity Monitor-Providing Alarm (RE-PR001B)	1	*	37
b.	Iodine Sampler (RE-PR001C)	1	*	40
c.	Particulate Sampler (RE-PR001A)	1	*	40
6.	Radioactivity Monitors Providing Alarm and Automatic Closure of Surge Tank Vent-Component Cooling Water Line (0RE-PR009 and RE-PR009)	2	*	41

TABLE 12.2-3 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

TABLE NOTATIONS

*At all times.

**ACTION 35 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, the contents of the tank(s) may be released to the environment for up to 14 days provided that prior to initiating the release:

a. At least two independent samples of the tank's contents are analyzed, and

b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge valve lineup.

If a and b can not be met, suspend releases of radioactive effluents via this pathway.

**ACTION 36 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours.

**ACTION 37 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, immediately suspend PURGING of radioactive effluents via this pathway. Releases may continue via this pathway for up to 7 days provided real time monitoring of radioactive effluents released via this pathway is established.

**ACTION 38 - Not used.

**ACTION 39 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are taken at least once per 12 hours and these samples are analyzed for principle gamma emitters at an LLD as specified in Table 12.4-1.

**ACTION 40 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via the affected pathway may continue for up to 30 days provided samples are continuously collected with auxiliary sampling equipment as required in Table 12.4-1.

**ACTION 41 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided that, at least once per 12 hours, liquid grab samples are collected and analyzed for radioactivity at a lower limit of detection as specified in Table 12.3-1.

** If effluent releases continue via this pathway beyond the time specified, continue to perform actions and explain in the next Radioactive Effluent Report why the time specified was exceeded.

TABLE 12.2-4

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

FUNCTIONAL UNIT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
1. Plant Vent Monitoring System - Unit 1					
a. Noble Gas Activity Monitor-Providing Alarm					
1) High Range (1RE-PR028D)	D	M	R(3)	Q(2)	*
2) Low Range (1RE-PR028B)	D	M	R(3)	Q(2)	*
b. Iodine Sampler (1RE-PR028C)	D	M	R(3)	Q(2)	*
c. Particulate Sampler (1RE-PR028A)	D	M	R(3)	Q(2)	*
d. Effluent System Flow Rate Measuring Device (LOOP-VA019)	D	N.A.	R	Q	*
e. Sampler Flow Rate Measuring Device (1FT-PR165)	D	N.A.	R	Q	*
2. Plant Vent Monitoring System - Unit 2					
a. Noble Gas Activity Monitor-Providing Alarm					
1) High Range (2RE-PR028D)	D	M	R(3)	Q(2)	*
2) Low Range (2RE-PR028B)	D	M	R(3)	Q(2)	*
b. Iodine Sampler (2RE-PR028C)	D	M	R(3)	Q(2)	*

TABLE 12.2-4 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

FUNCTIONAL UNIT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
2. Plant Vent Monitoring System - Unit 2 (Continued)					
c. Particulate Sampler (2RE-PR028C)	D	M	R(3)	Q(2)	*
d. Effluent System Flow Rate Measuring Device (LOOP-VA020)	D	N.A.	R	Q	*
e. Sampler Flow Rate Measuring Device (2FT-PR165)	D	N.A.	R	Q	*
3. Not Used					
4. Gas Decay Tank System					
a. Noble Gas Activity Monitor Providing Alarm and Automatic Termination of Release (0RE-PR002A and 2B)	P	P	R(3)	Q(1)**	*
5. Containment Purge System					
a. Noble Gas Activity Monitor-Providing Alarm (RE-PR001B)	D	P	R(3)	Q(2)	*
b. Iodine Sampler (RE-PR001C)	P	P	R(3)	N.A.	*
c. Particulate Sampler (RE-PR001A)	P	P	R(3)	N.A.	*
6. Radioactivity Monitors Providing Alarm and Automatic Closure of Surge Tank Vent-Component Cooling Water Line (0RE-PR009 and RE-PR009)	D	M	R(3)	Q(1)	*

TABLE 12.2-4 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS

TABLE NOTATIONS

* At all times.

(1) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

a. Instrument indicates measured levels above the Alarm/Trip Setpoint, OR

b. Circuit failure (monitor loss of communications - alarm only, detector loss of counts, or monitor loss of power), OR

c. Detector check source test failure, OR

d. Detector channel out-of-service, OR

** e. Monitor loss of sample flow. Monitoring ORE-PR002A and 2B will not trip on loss of sample flow.

(2) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the Alarm Setpoint, OR

b. Circuit failure (monitor loss of communications - alarm only, detector loss of counts, or monitor loss of power), OR

c. Detector check source test failure, OR

d. Detector channel out-of-service, OR

e. Monitor loss of sample flow.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

(4) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

12.3 LIQUID EFFLUENTS

12.3.1 Concentration

Operability Requirements

12.3.1.A The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited to 10 times the concentration values in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microCurie/ml total activity.

Applicability: At all times

Action:

1. With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within the above limits.

Surveillance Requirements

12.3.1.B.1 Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 12.3-1.

12.3.1.B.2 The results of the radioactivity analysis shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of 12.3.1.A.

Bases

12.3.1.C This section is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than 10 times the concentration values in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within: (1) the Section II.A design objectives of Appendix I, 10CFR50, to a MEMBER OF THE PUBLIC, and (2) the limits of 10CFR20.1301.

This section applies to the release of radioactive materials in liquid effluents from all units at the site.

12.3 LIQUID EFFLUENTS (Continued)

Bases

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

TABLE 12.3-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[1] (µCi/ml)
1. Batch Release Tanks[2]	P Each Batch	P Each Batch	Principal Gamma Emitters[7]	$5x10^{-7}$
			I-131	$1x10^{-6}$
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	P Each Batch	M Composite [3]	H-3	$1x10^{-5}$
	P Each Batch	Q Composite [3]	Gross Alpha	$1x10^{-7}$
			Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$
2. Continuous Releases [4]	Continuous[5]	W Composite[5]	Principal Gamma Emitters[7]	$5x10^{-7}$
			I-131	$1x10^{-6}$
a. Circulating Water Blowdown	M Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
b. Waste Water Treatment Discharge to Circulating Water Discharge	Continuous[5]	M Composite[5]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
c. Condensate Polisher Sump Discharge	Continuous[5]	Q Composite[5]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

TABLE 12.3-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[1](μCi/ml)
3. Continuous Release[4] Essential Service Water Reactor Containment Fan Cooler (RCFC) Outlet Line	W[6] Grab Sample	W[6]	Principal Gamma Emitters[7]	$5x10^{-7}$
			I-131	$1x10^{-6}$
			H-3	$1x10^{-5}$
		M[6]	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
4. Continuous Surge Tank Vent-Component Cooling Water Line[8]	None	None	Principal Gamma Emitters[7]	$5x10^{-7}$
			Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
			I-131	$1x10^{-6}$

TABLE 12.3-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATIONS

(1) The LLD is defined, for purposes of these sections, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separations:

$$LLD = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD = the lower limit of detection (microCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22×10^6 = the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}), and

Δt = the elapsed time between the midpoint of sample collection and the time of counting (sec).

Typical values of E, V, Y, and Δt should be used in the calculation

Alternative LLD Methodology

An alternative methodology for LLD determination follows and is similar to the above LLD equation:

$$LLD = \frac{(2.71 + 4.65\sqrt{B}) \cdot \text{Decay}}{E\ q\ \ b\ Y\ t\ (2.22 \times 10^6)}$$

TABLE 12.3-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[1](μCi/ml)
3. Continuous Release[4] Essential Service Water Reactor Containment Fan Cooler (RCFC) Outlet Line	W[6] Grab Sample	W[6]	Principal Gamma Emitters[7]	$5x10^{-7}$
			I-131	$1x10^{-6}$
			H-3	$1x10^{-5}$
		M[6]	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
4. Continuous Surge Tank Vent-Component Cooling Water Line[8]	None	None	Principal Gamma Emitters[7]	$5x10^{-7}$
			Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
			I-131	$1x10^{-6}$

TABLE 12.3-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATIONS

(1) The LLD is defined, for purposes of these sections, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separations:

$$LLD = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD = the lower limit of detection (microCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22×10^6 = the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}), and

Δt = the elapsed time between the midpoint of sample collection and the time of counting (sec).

Typical values of E, V, Y, and Δt should be used in the calculation.

Alternative LLD Methodology

An alternative methodology for LLD determination follows and is similar to the above LLD equation:

$$LLD = \frac{(2.71 + 4.65\sqrt{B}) \cdot \text{Decay}}{E\ q\ \ b\ Y\ t\ (2.22 \times 10^6)}$$

TABLE 12.3-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATIONS

Where:

B = background sum (counts)

E = counting efficiency, (counts detected/disintegration's)

q = sample quantity, (mass or volume)

b = abundance, (if applicable)

Y = fractional radiochemical yield or collection efficiency, (if applicable)

t = count time (minutes)

$2.22X10^6$ = number of disintegration's per minute per microCurie

$2.71 + 4.65\sqrt{B} = k^2 + (2k \sqrt{2} \sqrt{B})$, and k = 1.645.

(k=value of the t statistic from the single-tailed t distribution at a significance level of 0.95 and infinite degrees of freedom. This means that the LLD result represents a 95% detection probability with a 5% probability of falsely concluding that the nuclide present when it is not or that the nuclide is not present when it is.)

Decay = $e^{\lambda\Delta t}$ $[\lambda RT/(1-e^{-\lambda RT})]$ $[\lambda T_d/(1-e^{-\lambda Td})]$, (if applicable)

λ = radioactive decay constant, (units consistent with Δt, RT and T_d)

Δt = "delta t", or the elapsed time between sample collection or the midpoint of sample collection and the time the count is started, depending on the type of sample, (units consistent with λ)

RT= elapsed real time, or the duration of the sample count, (units consistent with λ)

T_d = sample deposition time , or the duration of analyte collection onto the sample media, (units consistent with λ)

The LLD may be determined using installed radioanalytical software, if available. In addition to determining the correct number of channels over which to total the background sum, utilizing the software's ability to perform decay corrections (i.e. during sample collection, from sample collection to start of analysis and during counting), this alternate method will result in a more accurate determination of the LLD.

It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

TABLE 12.3-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATIONS

(2) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed to assure representative sampling.

(3) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

(4) A continuous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

(5) To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously whenever the effluent stream is flowing. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

(6) Not required unless the Essential Service Water RCFC Outlet Radiation Monitors RE-PR002 and RE-PR003 indicates measured levels greater than $1x10^{-6}$ μCi/ml above background at any time during the week.

(7) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured, but with an LLD of 5E-06. This list does not mean that only these nuclides are to be considered.

Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Section 12.6.2, in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(8) A continuous release is the discharge of dissolved and entrained gaseous waste from a nondiscrete liquid volume.

12.3.2 Dose

Operability Requirements

12.3.2.A The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each unit, to UNRESTRICTED AREAS (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited:

1. During any calendar quarter to less than or equal to 1.5 mrems to the whole body and to less than or equal to 5 mrems to any organ, and

2. During any calendar year to less than or equal to 3 mrems to the whole body and to less than or equal to 10 mrems to any organ.

Applicability: At all times.

Action:

1. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to 10CFR50 Appendix I, Section IV.A, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

Surveillance Requirements

12.3.2.B Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

Bases

12.3.2.C This section is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10CFR50. The Operability Requirements implement the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents For the Purpose of Evaluating Compliance with 10CFR50, Appendix I" Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

12.3.2 Dose (Continued)

Bases

This section applies to the release of radioactive materials in liquid effluents from each reactor at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.3.3 Liquid Radwaste Treatment System

Operability Requirements

12.3.3.A The Liquid Radwaste Treatment System shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31-day period.

Applicability: At all times.

Action:

1. With radioactive liquid waste being discharged without treatment and in excess of the above limits and any portion of the Liquid Radwaste Treatment System not in operation, prepare and submit to the Commission within 30 days, pursuant to 10CFR50 Appendix I, Section IV.A, a Special Report that includes the following information:

   a. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,

   b. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   c. Summary description of action(s) taken to prevent a recurrence.

Surveillance Requirements

12.3.3.B.1 Doses due to liquid releases from each unit to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM when the Liquid Radwaste Treatment System is not being fully utilized.

12.3.3.B.2 The installed Liquid Radwaste Treatment System shall be considered OPERABLE by meeting Sections 12.3.1.A and 12.3.2.A.

Bases

12.3.3.C The OPERABILITY of the Liquid Radwaste Treatment System ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This section implements the requirements of 10CFR50.36a, General Design Criterion 60 of Appendix A to 10CFR50 and the design objective given in Section II.D of Appendix I to 10CFR50.

12.3.3 Liquid Radwaste Treatment System (Continued)

Bases

The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10CFR50, for liquid effluents.

This section applies to the release of radioactive materials in liquid effluents from each unit at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.4 GASEOUS EFFLUENTS

12.4.1 Dose Rate

Operability Requirements

12.4.1.A The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited to the following:

1. For noble gases: less than or equal to a dose rate of 500 mrems/yr to the whole body and less than or equal to a dose rate of 3000 mrems/yr to the skin, and

2. For Iodine 131 and 133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrems/yr to any organ.

Applicability: At all times.

Action:

1. With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the above limit(s).

Surveillance Requirements

12.4.1.B.1 The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM.

12.4.1.B.2 The dose rate due to Iodine 131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 12.4-1.

Bases

12.4.1.C This section is provides reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a Member of the Public in an Unrestricted Area, either at or beyond the Site Boundary in excess of the design objectives of appendix I to 10 CFR part 50. This specification is provided to ensure that gaseous effluents from all units on the site will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II. design objectives of appendix I to 10 CFR part 50.

12.4 GASEOUS EFFLUENTS (Continued)

Bases

For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. Examples of calculations for such MEMBERS OF THE PUBLIC, with the appropriate occupancy factors, shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrems/year to the whole body or to less than or equal to 3000 mrems/year to the skin. These release rate limits also restrict, at all times the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrems/year.

This section applies to the release of radioactive materials in gaseous effluents from all units at the site.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., " Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

TABLE 12.4-1

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

GASEOUS RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[1] (μCi/cc)
1. Waste Gas Decay Tank	P Each Tank Grab Sample	P Each Tank	Principal Gamma Emitters[2]	$1x10^{-4}$
2. Containment Purge	P Each Purge[3] Grab Sample	P Each Purge [3]	Principal Gamma Emitters [2]	$1x10^{-4}$
			H-3	$1x10^{-7}$
3. Auxiliary Bldg. Vent Stack (Unit 1 and 2)	M [4][5] Grab Sample	M	Principal Gamma Emitters [2]	$1x10^{-4}$
			H-3	$1x10^{-7}$
	Continuous [6]	W [7] Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous [6]	W [7] Particulate Sample	Principal Gamma Emitters[2]	$1x10^{-11}$
	Continuous [6]	Q Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous [6]	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$
	Continuous	N.A. Noble Gas Monitor	Noble Gases, Gross Beta or Gamma	$1x10^{-6}$

TABLE 12.4-1 (Continued)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATIONS

(1) The LLD is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66 S_b}{E \cdot V \cdot 2.22\ X10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD = the lower limit of detection (microCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

$2.22X10^6$ = the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

λ= the radioactive decay constant for the particular radionuclide (sec^{-1}), and

Δt = the elapsed time between the midpoint of sample collection and the time of counting (sec).

Typical values of E, V, Y, and Δt should be used in the calculation.

Alternate LLD Methodology

An alternate methodology for LLD determination follows and is similar to the above LLD equation:

$$LLD = \frac{(2.71 + 4.65\sqrt{B}) \cdot \text{Decay}}{E\ q\ b\ Y\ t\ (2.22\ X10^6)}$$

TABLE 12.4-1 (Continued)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATIONS

Where:

B = background sum (counts)

E = counting efficiency, (counts detected/disintegrations)

q = sample quantity, (mass or volume)

b = abundance, (if applicable)

Y = fractional radiochemical yield or collection efficiency, (if applicable)

t = count time (minutes)

$2.22 X10^6$ = number of disintegrations per minute per microCurie

$(2.71 + 4.65\sqrt{B}) = k^2 + (2k \sqrt{2} \sqrt{B})$, and k = 1.645.

(k=value of the t statistic from the single-tailed t distribution at a significance level of 0.95 and infinite degrees of freedom. This means that the LLD result represents a 95% detection probability with a 5% probability of falsely concluding that the nuclide present when it is not or that the nuclide is not present when it is.)

$Decay = e^{\lambda\Delta t} [\lambda RT/(1-e^{-\lambda RT})] [\lambda T_d/(1-e^{-\lambda Td})]$, (if applicable)

λ = radioactive decay constant, (units consistent with Δt, RT and T_d)

Δt = "delta t", or the elapsed time between sample collection or the midpoint of sample collection and the time the count is started, depending on the type of sample, (units consistent with λ)

RT = elapsed real time, or the duration of the sample count, (units consistent with λ)

T_d = sample deposition time, or the duration of analyte collection onto the sample media, (unit consistent with λ)

The LLD may be determined using installed radioanalytical software, if available. In addition to determining the correct number of channels over which to total the background sum, utilizing the software's ability to perform decay corrections (i.e. during sample collection, from sample collection to start of analysis and during counting), this alternate method will result in a more accurate determination of the LLD.

It should be recognized that the LLD is defined as a before the fact limit and not as an after the fact limit for a particular measurement.

TABLE 12 4-1 (Continued)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATIONS

(2) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141, and Ce-144 in particulate releases. This list does not mean that only these nuclides are to be considered.

Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Section 12.6.2, in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(3) Sampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period.

(4) Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.

(5) Tritium grab samples shall be taken at least once per 7 days from the spent fuel pool area, whenever spent fuel is in the spent fuel pool.

(6) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Sections 12.4.1.A, 12.4.2.A and 12.4.3 A.

(7) Samples shall be changed at least once per 7 days and analyses shall be completed within a timeframe necessary to meet the applicable lower limits of detection, but not to exceed 48 hours. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period and analyses shall be completed within a timeframe necessary to meet the applicable lower limits of detection, but not to exceed 48 hours. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if: (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the reactor coolant has not increased more than a factor of 3, and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

12.4.2 Dose - Noble Gases

Operability Requirements

12.4.2.A The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited to the following:

1. During any calendar quarter: Less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation, and

2. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads for beta radiation.

Applicability: At all times.

Action:

1. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to 10CFR50 Appendix I, Section IV.A, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

Surveillance Requirements

12.4.2.B Cumulative dose contributions for the current calendar quarter and the current calendar year for noble gases shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

Bases

12.4.2.C This section is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10CFR50. The Operability Requirements implement the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to area at or beyond the SITE BOUNDARY will be kept "as low as is reasonable achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

12.4.2 Dose - Noble Gases (Continued)

Bases

The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive materials in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents For the Purpose of Evaluating Compliance with 10CFR50, Appendix I" Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors, Revision 1," July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This section applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.4.3 Dose - Iodine I-131 and 133, Tritium, and Radioactive Material in Particulate Form

Operability Requirements

12 4.3.A The dose to a MEMBER OF THE PUBLIC from Iodine-131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each unit, to areas at and beyond the SITE BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited to the following:

1. During any calendar quarter: Less than or equal to 7.5 mrems to any organ, and

2. During any calendar year: Less than or equal to 15 mrems to any organ.

Applicability: At all times.

Action:

1. With the calculated dose from the release of Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to 10CFR50 Appendix I, Section IV.A, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

Surveillance Requirements

12.4.3.B Cumulative dose contributions for the current calendar quarter and the current calendar year for Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

Bases

12.4.3.C This section is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10CFR50. The Operability Requirements are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to areas at or beyond the SITE BOUNDARY will be kept "as low as is reasonable achievable." The ODCM calculational methods specified in the Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

12.4.3 Dose (Continued)

Bases

The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents For the Purpose of Evaluating Compliance with 10CFR50, Appendix I" Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of these calculations were: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat producing animal's graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure to man.

This section applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.4.4 Gaseous Radwaste Treatment System

Operability Requirements

12.4.4.A The VENTILATION EXHAUST TREATMENT SYSTEM and the WASTE GAS HOLDUP SYSTEM shall be OPERABLE and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) would exceed:

1. 0.2 mrad to air from gamma radiation, or

2. 0.4 mrad to air from beta radiation, or

3. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

Applicability: At all times.

Action:

1. With radioactive gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to 10CFR50 Appendix I, Section IV.A, a Special Report that includes the following information:

   a. Identification of any inoperable equipment or subsystems, and the reason for the inoperability,

   b. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   c. Summary description of action(s) taken to prevent a recurrence.

Surveillance Requirements

12.4.4.B.1 Doses due to gaseous releases from each unit to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM when Gaseous Radwaste Treatment Systems are not being fully utilized.

12.4.4.B.2 The installed VENTILATION EXHAUST TREATMENT SYSTEM and WASTE GAS HOLDUP SYSTEM shall be considered OPERABLE by meeting Section 12.4.1 or 12.4.2 and 12.4.3.

Bases

12.4.4.C The OPERABILITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the system will be available for use whenever gaseous effluents require treatment prior to release to the environment.

12.4.4 Gaseous Radwaste Treatment System (Continued)

Bases

The requirement that the appropriate portions of this system be used when specified provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable". This section implements the requirements of 10CFR50.36a, General Design Criterion 60 of Appendix A to 10CFR50 and the design objective given in Section II.D of Appendix I to 10CFR50. The specified limits governing the use of appropriate portions of the Gaseous Radwaste Treatment System were specified as a 2% fraction of the dose design objectives set forth in Section II.B and II.C of Appendix I, 10CFR50, for gaseous effluents.

This section applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.4.5 Total Dose

Operability Requirements

12.4.5.A The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

Applicability: At all times.

Action:

1. With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Sections 12.3.2, 12.4.2, or 12.4.3, calculations should be made including direct radiation contributions from the units and from outside storage tanks to determine whether the above limits of Section 12.4.5.A have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10CFR20.2203, shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentration of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40CFR190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40CFR190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

Surveillance Requirements

12.4.5.B.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Sections 12.3.2, 12.4.2, and 12.4.3, and in accordance with the methodology and parameters in the ODCM.

12.4.5.B 2 Cumulative dose contributions from direct radiation from the units and from radwaste storage tanks shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in ACTION 1 of Section 12.4.5.A.

12.4.5.B.3 Initial estimates of expected dose rates at the Old Steam Generator Storage Facility (OSGSF) are provided through calculations. After the old steam generators are placed in the facility and the equipment opening is sealed, a radiation survey of the walls and roof will be performed. The measured dose rates will be used for comparison to the calculated dose rates and to confirm or adjust the initial estimates for use in 10CFR20, 10CFR50 Appendix I, and 40CFR190 compliance determinations.

12.4.5 Total Dose (Continued)

Surveillance Requirements

Environmental TLDs are located near the OSGSF. The TLDs are processed quarterly to determine the dose at the locations for use in compliance determinations.

Quarterly monitoring of the sump for indications of liquid is performed and, if liquid is present and seepage appears to have occurred, a sample will be taken and analyzed.

Bases

12.4.5.C.1 This section is provided to meet the dose limitations of 40CFR190 that have been incorporated into 10CFR20 by 46FR18525. The section requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40CFR190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the reactor units and outside storage tanks are kept small. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40CFR190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40CFR190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40CFR190 have not already been corrected), in accordance with the provisions of 40CFR190.11 and 10CFR20.2203, is considered to be a timely request and fulfills the requirements of 40CFR190 until NRC staff action is completed. The variance only relates to the limits of 40CFR190, and does not apply in any way to the other requirements for dose limitation of 10CFR20, as addressed in Sections 12.3.1 and 12.4.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

12.4.5.C.2 The OSGSF was constructed to provide long-term storage of the four old steam generators removed from Braidwood Station Unit 1 during the Steam Generator Replacement Outage. The facility is designed to ensure that the dose rates at the wall and roof meet the limits of 10CFR20 (UFSAR Zone 1-A for the walls and Zone 1-B for the roof). The facility is also designed to ensure that the dose rates at the site boundary and to the nearest resident meet the limits of 10CFR20 and 40CFR190.

The OSGSF design includes 2'-6" thick concrete walls and 1'-6" inch thick concrete roof. Personnel access is through a labyrinth-style vestibule with a locked exterior door and a lockable sliding door for access beyond the vestibule to the interior of the facility. A water collection sump is provided with access from the vestibule for sampling water if liquid is present. The opening used for placement of the steam generators inside the facility will be sealed with concrete panels. The panels have a tongue and groove design to preclude radiation "shine" after installation.

12.4.5 Total Dose (Continued)

Bases

The potential for radiological release from the OSGSF is also minimized by sealing openings in the steam generators caused by removed piping with welded structural cover plates or seal plugs. Trunnions installed during removal of the old steam generators from the containment and existing opening covers remain attached to the steam generators to ensure the penetrations are leaktight. External exposed surfaces of the steam generators are coated to seal and fix surface contamination to the steam generators.

12.4.6 Dose Limits for Members of the Public

Operability Requirements

12.4.6.A The licensee shall conduct operations such that the TEDE to individual MEMBERS OF THE PUBLIC does not exceed 100 mrem in a year. In addition, the dose in any unrestricted area from external sources does not exceed 2 mrem in any one hour. The Effluents Program shall implement monitoring, sampling and analysis of radioactive liquid and gaseous effluents in accordance with 10CFR20.1302 and with the methodology and parameters in the ODCM.

Applicability: At all times.

Action:

1. If the calculated dose from the release or exposure of radiation meets or exceeds the 100 mrem/year limit for the MEMBER OF THE PUBLIC, prepare and submit a report the Commission in accordance with 10CFR20.2203.

2. If the dose in any unrestricted area from external sources of radiation meets or exceeds the 2 mrem in any one hour limit for the MEMBER OF THE PUBLIC, prepare and submit a report to the Commission in accordance with 10CFR20.2203.

Surveillance Requirements

12.4.6.B Calculate the TEDE to individual MEMBERS OF THE PUBLIC annually to determine compliance with the 100 mrem/year limit in accordance with the ODCM. In addition, evaluate and/or determine if direct radiation exposures exceed 2 mrem in any hour in unrestricted areas.

Bases

12.4.6.C This section applies to direct exposure of radioactive materials as well as radioactive materials released in gaseous and liquid effluents. 10CFR20.1301 sets forth the 100 mrem/year dose limit to members of the public; 2 mrem in any one hour limit in the unrestricted area; and reiterates that the licensee is also required to meet the 40CFR190 standards. 10CFR20.1302 provides options to determine compliance to 10CFR20.1301. Compliance to the above operability requirement is based on 10CFR20 and 40CFR190.

12.5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.5.1 Monitoring Program

Operability Requirements

12.5.1.A The Radiological Environmental Monitoring Program shall be conducted as specified in Table 12.5-1.

Applicability: At all times.

Action:

1. With the Radiological Environmental Monitoring Program not being conducted as specified in Table 12.5-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by Section 12.6.1, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

   Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of sampling equipment, if a person/business who participates in this program goes out of business or no longer can provide sample, or contractor omission which is corrected as soon as discovered. If the equipment malfunctions, corrective actions shall be completed as soon as practical. If a person/business supplying samples goes out of business, a replacement supplier shall be found as soon as possible. All deviations from the sampling schedule will be described in the Annual Radiological Environmental Operating Report.

2. With the level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 12.5-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days, pursuant to 10CFR50 Appendix I, Section IV.A, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose* to a MEMBER OF THE PUBLIC is less than the calendar year limits of Section 12.3.2, 12.4.2, or 12.4.3. When more than one of the radionuclides in Table 12.5.2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \ldots \geq 1.0$$

   When radionuclides other than those in Table 12.5-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to A MEMBER OF THE PUBLIC from all radionuclides is equal to or greater than the calendar year limits of Section 12.3.2, 12.4.2, or 12.4.3. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report required by Section 12.6.1.

*The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

12.5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

3. If the sample type or sampling location(s) as required by Table 12.5-1 become(s) permanently unavailable, identify suitable alternative sampling media for the pathway of interest and/or specific sampling locations for obtaining replacement samples and add them to the Radiological Environmental Monitoring Program as soon as practicable. The specific locations from which samples were unavailable may then be deleted from the monitoring program.

   Prepare and submit a controlled version of the ODCM within 180 days including a revised figure(s) and table reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of new location(s) for obtaining samples.

Surveillance Requirements

12.5.1.B The radiological environmental monitoring program samples shall be collected pursuant to Table 12.5-1 from the specific locations given in the table and figure(s) in the ODCM, and shall be analyzed pursuant to the requirements of Table 12.5-1 and the detection capabilities required by Table 12.5-3.

Bases

12.5.1.C The Radiological Environmental Monitoring Program required by this section provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10CFR50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 12.5-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, LA., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).s

12.5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

Interpretations

12.5.1.D Table 12.5-1 requires "one sample of each community drinking water supply downstream of the plant within 10 kilometers." Drinking water supply is defined as water taken from rivers, lakes, or reservoirs (not well water) which is used for drinking.

TABLE 12.5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Airborne Radioiodine and Particulates	Samples from a total of eight locations: a. Indicator- Near Field Four samples from locations within 4 km (2.5 mi) in different sectors. b. Indicator- Far Field Three additional locations within 4 to 10 km (2.5 to 6.2 mi) in different sectors. c. Control One sample from a control location within 10 to 30 km (6.2 to 18.6 mi).	Continuous sampler operation with particulate sample collection weekly (or more frequently if required due to dust loading), and radioiodine canister collection biweekly.	Radioiodine Canister: I-131 analysis biweekly on near field samples and control.[2] Particulate Sampler: Gross beta analysis following weekly filter change[3] and gamma isotopic analysis[4] quarterly on composite filters by location on near field samples and control.[2]

TABLE 12.5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Direct Radiation[5]	Forty routine monitoring stations either with a thermoluminescent dosimeter (TLD) or with one instrument for measuring dose rate continuously, placed as follows: a. Indicator- Inner Ring (100 Series TLD) One in each meteorological sector, in the general area of the SITE BOUNDARY (0.1 to 3.8 miles); b. Indicator- Outer Ring (200 Series TLD) One in each meteorological sector, within 6.1 to 10 km (3.8 to 6.2 mi); and c. Other One at each Airborne location given in part 1.a. and 1.b. The balance of the TLDs to be placed at special interest locations beyond the Restricted Area where either a MEMBER OF THE PUBLIC or Exelon Nuclear employees have routine access. (300 Series TLD)	Quarterly	Gamma dose on each TLD quarterly.

TABLE 12.5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Direct Radiation[5] (Cont'd)	d. Control One at each Airborne control location given in part 1.c	Quarterly	Gamma dose on each TLD quarterly.
3. Waterborne a. Ground/ Well	a. Indicator Samples from two sources only if likely to be affected.[6]	Quarterly	Gamma isotopic[4] and tritium analysis quarterly.
b. Drinking[7]	a. Indicator One Sample from each community drinking water supply that could be affected by the station discharge within 10 km (6.2 mi) downstream of discharge.	Weekly grab samples.	Gross beta and gamma isotopic analyses[4] on monthly composite; tritium analysis on quarterly composite. I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year.
c. Surface Water[7]	If no community water supply (Drinking Water) exists within 10 km downstream of discharge then surface water sampling shall be performed. a. Indicator One sample downstream	Weekly grab samples.	Gross beta and gamma isotopic analyses[4] on monthly composite; tritium analysis on quarterly composite.
d. Control Sample[7]	a. Control One surface sample upstream of discharge.	Weekly grab samples.	Gross beta and gamma isotopic analyses[4] on monthly composite; tritium analysis on quarterly composite.

TABLE 12.5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
e. Sediment	a. Indicator At least one sample from downstream[7] area within 10 km (6.2 mi).	Semiannually.	Gamma isotopic analysis [4] semiannually.
4. Ingestion a. Milk [8]	a. Indicator Samples from milking animals from a maximum of three locations within 10 km (6.2 mi) distance. b. Control One sample from milking animals at a control location within 10 to 30 km (6.2 to 18.6 mi).	Biweekly [9] when animals are on pasture (May through October), monthly at other times (November through April).	Gamma isotopic[4] and I-131[10] analysis on each sample.
b. Fish	a. Indicator Representative samples of commercially and recreationally important species in discharge area. b. Control Representative samples of commercially and recreationally important species in control locations upstream of discharge.	Two times annually.	Gamma isotopic analysis[4] on edible portions

TABLE 12 5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/ OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
c. Food Products	a. Indicator Two representative samples from the principal food pathways grown in each of four major quadrants within 10 km (6.2 mi): At least one root vegetable sample[11] At least one broad leaf vegetable (or vegetation)[11] b. Control Two representative samples similar to indicator samples grown within 15 to 30 km (9.3 to 18.6 mi).	Annually	Gamma isotopic[4], I-131 analysis on each sample.

TABLE 12.5-1 (Continued)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
TABLE NOTATIONS

(1) Specific parameters of distance and direction from the centerline of the midpoint of the two units and additional description where pertinent, shall be provided for each and every sample location in Table 12.5-1 of the ODCM Station Annexes. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979.

(2) Far field samples are analyzed when the respective near field sample results are inconsistent with previous measurements and radioactivity is confirmed as having its origin in airborne effluents from the station, or at the discretion of the Radiation Protection Director.

(3) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

(4) Gamma isotopic analysis means the identification and quantification of gamma emitting radionuclides that may be attributable to the effluents from the station.

(5) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The 40 locations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., If a station is adjacent to a lake, some sectors may be over water thereby reducing the number of dosimeters which could be placed at the indicated distances. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

(6) Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

(7) The "downstream" sample shall be taken in an area beyond but near the mixing zone. The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. Upstream samples in an estuary must be taken far enough upstream to be beyond the station influence.

(8) If milking animals are not found in the designated indicator locations, or if the owners decline to participate in the REMP, all milk sampling may be discontinued.

(9) Biweekly refers to every two weeks.

(10) I-131 analysis means the analytical separation and counting procedure are specific for this radionuclide.

(11) One sample shall consist of a volume/weight of sample large enough to fill contractor specified container.

TABLE 12.5-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES
REPORTING LEVELS

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)
H-3	20,000[1]				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2[2]	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

(1) For drinking water samples. This is 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.
(2) If no drinking water pathway exists, a value of 20 pCi/l may be used.

Table 12.5-3
DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS(1)
Lower Limit of Detection (LLD)(2)(3)

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2,000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-95	30					
Nb-95	15					
I-131	1	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60			60		
La-140	15			15		

TABLE 12.5-3 (Continued)
DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS
TABLE NOTATIONS

(1) The nuclides on this list are not the only nuclides intended to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report.

(2) Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

(3) The Lower Limit of Detection (LLD) is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separation, the LLD is defined as follows:

$$LLD = \frac{4.66\ S_b + 3/t_b}{(E)\ (V)\ (2.22)\ (Y)\ (\exp(-\lambda\Delta t))}$$

$$LLD \sim \frac{4.66\ S_b}{(E)\ (V)\ (2.22)\ (Y)\ (\exp(-\lambda\Delta t))}$$

Where: $4.66\ S_b >> 3/t_b$

LLD = the "a priori" Minimum Detectable Concentration (picoCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample, as appropriate (counts per minute),

$$= \frac{\sqrt{Total\ Counts}}{t_b}$$

E = the counting efficiency(counts per disintegration),

V = the sample size (units of mass or volume),

2.22 = the number of disintegrations per minute per picoCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}),

TABLE 12.5-3 (Continued)
DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS
TABLE NOTATIONS

t_b = counting time of the background or blank (minutes), and

Δt = the elapsed time between sample collection, or end of the sample collection period, and the time of counting (sec).

Typical values of E, V, Y, and Δt should be used in the calculation.

It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally, background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

(4) If no drinking water pathway exists, the value of 15 pCi/l may be used.

(5) A value of 0.5 pCi/l shall be used when the animals are on pasture (May through October) and a value of 5 pCi/l shall be used at all other times (November through April).

(6) This LLD applies only when the analytical separation and counting procedure are specific for this radionuclide

(7) This LLD is the minimum allowable, however, vendors performing environmental sample analyses off-site will be required to meet an LLD of 200 pCi/l.

12.5.2 Land Use Census

Operability Requirements

12.5.2.A. A Land Use Census shall be conducted and shall identify within a distance of 10 km (6.2 miles) the location in each of the 16 meteorological sectors* of the nearest milk animal, the nearest residence**, and an enumeration of livestock. For dose calculation, a garden will be assumed at the nearest residence.

Applicability: At all times.

Action:

1. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment, via the same exposure pathway 20% greater than at a location from which samples are currently being obtained in accordance with Section 12.5.1, add the new location(s) within 30 days to the Radiological Environmental Monitoring Program given in Chapter 11. The sampling location(s), excluding the control location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this Land Use Census was conducted. Submit in the next Annual Radiological Environmental Operating Report documentation for a change in the ODCM including a revised figure(s) and table(s) for the ODCM reflecting the new location(s) with information supporting the change in sampling locations.

*This requirement may be reduced according to geographical limitations; e.g. at a lake site where some sector's will be over water.

**The nearest industrial facility shall also be documented if closer than the nearest residence.

Surveillance Requirements

12.5.2.B The Land Use Census shall be conducted during the growing season, between June 1 and October 1, at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities. The results of the Land Use Census shall be included in the Annual Radiological Environmental Operating sReport.

Bases

12.5.2.C This specification is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the Radiological Environmental Monitoring Program given in the ODCM are made if required by the results of this census.

This census satisfies the requirements of Section IV.B.3 of Appendix I to 10CFR50. An annual garden census will not be required since the licensee will assume that there is a garden at the nearest residence in each sector for dose calculations.

12.5.3 Interlaboratory Comparison Program

Operability Requirements

12.5.3.A Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that is traceable to NIST.

Applicability: At all times.

Action:

1. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report.

Surveillance Requirements

12.5.3.B A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report.

Bases

12.5.3.C The requirement for participation in an Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10CFR50.

12.6 REPORTING REQUIREMENTS

12.6.1 Annual Radiological Environmental Operating Report*

Routine Annual Radiological Environmental Operating Report covering the operation of the Unit(s) during the previous calendar year shall be submitted prior to May 15 of each year.

The Annual Radiological Environmental Operating Report shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, with operational controls as appropriate, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment.

The Annual Radiological Environmental Operating Report shall include the results of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the tables and figures in Chapter 11 of the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the Radiological Environmental Monitoring Program; legible maps covering all sampling locations keyed to a table giving distances and directions from the midpoint between the two units; reasons for not conducting the Radiological Environmental Monitoring Program as required by Section 12.5.1, a Table of Missed Samples and a Table of Sample Anomalies for all deviations from the sampling schedule of Table 11.1-1; discussion of environmental sample measurements that exceed the reporting levels of Table 12.5-2 but are not the result of plant effluents, discussion of all analyses in which the LLD required by Table 12.5-3 was not achievable; result of the Land Use Census required by Section 12.5.2; and the results of the licensee participation in an Interlaboratory Comparison Program and the corrective actions being taken if the specified program is not being performed as required by Section 12.5.3.

*A single submittal may be made for a multiple unit station.

12.6 REPORTING REQUIREMENTS (Cont'd)

12.6.1 Annual Radiological Environmental Operating Report (Cont'd)

The Annual Radiological Environmental Operating Report shall also include an annual summary of hourly meteorological data collected over the applicable year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. In lieu of submission with the Annual Radiological Environmental Operating Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

The Annual Radiological Environmental Operating Report shall also include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the Unit or Station during the previous calendar year. This report shall also include an assessment of the radiation doses to the most likely exposed MEMBER OF THE PUBLIC from reactor releases and other near-by uranium fuel cycle sources including doses from primary effluent pathways and direct radiation, for the previous calendar year. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the ODCM, and in compliance with 10CFR20 and 40CFR190, "Environmental Radiation Protection Standards for Nuclear Power Operation."

12.6 REPORTING REQUIREMENTS (Continued)

12.6.2 Annual Radioactive Effluent Release Report**

Routine Annual Radioactive Effluent Release Reports covering the operation of the unit during the previous calendar year operation shall be submitted prior to May 1 of the following year.

The Annual Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

For solid wastes, the format for Table 3 in Appendix B shall be supplemented with three additional categories: class of solid wastes (as defined by 10CFR61), type of container (e.g., LSA, Type A, Type B, Large Quantity), and SOLIDIFICATION agent or absorbent (e.g., cement, urea formaldehyde).

The Annual Radioactive Effluent Release Reports shall include a list and description of unplanned releases from the site to areas beyond the site boundary of radioactive materials in gaseous and liquid effluents made during the reporting period.

The Annual Radioactive Effluent Release Reports shall include any changes made during the reporting period to the PCP, as well as any major changes to Liquid, Gaseous or Solid Radwaste Treatment Systems, pursuant to Section 12.6.3.

The Annual Radioactive Effluent Release Reports shall also include the following: an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in Section 12.2.1 or 12.2.2, respectively; and description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of Technical Specification 3.11.1.4 or 3.11.2.6, respectively.

**A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.

12.6 REPORTING REQUIREMENTS (Continued)

12.6.3 Offsite Dose Calculation Manual (ODCM)

12.6 3.1 The ODCM shall be approved by the Commission prior to initial implementation.

12.6.3.2 Licensee-initiated changes to the ODCM:

a. Shall be documented and records of reviews performed shall be retained as required by Specification 6.10.2 (UFSAR Chapter 17). This documentation shall contain:

1. Sufficient information to support the change together with the appropriate analyses or evaluations justifying the changes(s); and

2. A determination that the change will maintain the level of radioactive effluent control required by 10CFR20, 40CFR190, 10CFR50.36a, and Appendix I to 10CFR50 and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

b. Shall become effective after review and acceptance by the Onsite Review and Investigative Function and the approval of the Plant Manager on the date specified by the Onsite Review and Investigative Function.

c. Shall be submitted to the Commission in the form of a complete legible copy of the entire ODCM or updated pages if the Commission retains a controlled copy. If an entire copy of the ODCM is submitted, it shall be submitted as part of or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change to the ODCM was made effective. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.

12.6 REPORTING REQUIREMENTS (Continued)

12.6.4 Major Changes to Liquid and Gaseous Radwaste Treatment Systems*

Licensee-initiated major changes to the Radwaste Treatment Systems (liquid and gaseous):

a. Shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Onsite Review and Investigative Function. The discussion of each change shall contain:

1) A summary of the evaluation that led to the determination that the change could be made in accordance with 10CFR50.59;

2) Sufficient detailed information to totally support the reason for the change without benefit of additional and supplemental information;

3) A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems;

4) An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the License application and amendments thereto;

5) An evaluation of the change, which shows the expected maximum exposures to a MEMBER OF THE PUBLIC and to the general population that differ from those previously estimated in the License application and amendments thereto;

6) A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the changes are to be made;

7) An estimate of the exposure to plant operating personnel as a result of the change; and

8) Documentation of the fact that the change was reviewed and found acceptable by the Onsite Review and Investigative Function.

b. Shall become effective upon review and acceptance by the Onsite Review and Investigative Function.

*Licensees may choose to submit the information called for in this section as part of the annual FSAR update.

APPENDIX F

APPENDIX F

BRAIDWOOD ANNEX INDEX

REVISION 6

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STATION-SPECIFIC DATA FOR BRAIDWOOD UNITS 1 AND 2

F.1 INTRODUCTION

This appendix contains data relevant to the Braidwood site. Included is a figure showing the unrestricted area boundary and values of parameters used in offsite dose assessment.

F.2 REFERENCES

1. Sargent & Lundy, Nuclear Analysis and Technology Division Braidwood Calculation No. ATD-0149, Revisions 0, 1, 2, and 3, 3/30/95 for Braidwood.

2. "Assessment of the Impact of Liquid Radioactive Effluents from Braidwood Station on Proposed Public Water Intakes at Wilmington, Illinois", J.C. Golden NSEP, January 1990.

3. "Verification of Environmental Parameters Used for Commonwealth Edison Company's Offsite Dose Calculations," NUS Corporation, 1988.

4. "Verification of Environmental Parameters Used for Commonwealth Edison Company's Offsite Dose Calculations," NUTECH Engineers Group, 1992.

Table F-1
Aquatic Environmental Dose Parameters

General Information

There is no irrigation occurring on the Kankakee River downstream of the station.

Recreation includes one or more of the following: boating, water skiing, swimming, and sport fishing.

Downstream dams are within 50 miles of the station. One is located on the Kankakee. The other is the Illinois River at Dresden Island, Marseilles and Starved Rock. The Kankakee River flows into the Illinois River about 12 river miles downstream of the station.

This is based on information in Figure 2.1-13 of the Braidwood Environmental Report and in Section 2.4.1.1 and Figure 2.4-2 of the LaSalle Environmental Report.

Water and Fish Ingestion Parameters

Parameter[a]	Value
U^w, water usage, L/yr	730
U^f, fish consumption, kg/yr	21
D^w	4
Z	10

Limits on Radioactivity in Unprotected Outdoor Tanks[b]

Outside Temporary Tank $\leq$ 10 Ci[c]

per Technical Specification 5.5.12

[a] The parameters are defined in Section A.2.1 of Appendix A.

[b] See Section A.2.4 of Appendix A.

[c] Tritium and dissolved or entrained noble gases are excluded from this limit.

Table F-2

Station Characteristics

STATION: Braidwood

LOCATION: Braceville, Illinois

CHARACTERISTICS OF ELEVATED RELEASE POINT: Not Applicable (NA)

1) Release Height = ____m 2) Diameter = ____m

3) Exit Speed = ____ms^{-1} 4) Heat Content___Kcal s^{-1}

CHARACTERISTICS OF VENT STACK RELEASE POINT

1) Release Height = 60.66 m[a] 2) Diameter = 2.80 m

3) Exit Speed = 11.0 ms^{-1}[a]

CHARACTERISTICS OF GROUND LEVEL RELEASE

1) Release Height = 0 m

2) Building Factor (D) = 60.6 m[a]

METEOROLOGICAL DATA

A 320 ft Tower is Located 573 m NE of vent stack release point

---

Tower Data Used in Calculations

Release Point	Wind Speed and Direction	Differential Temperature
Elevated	(NA)	(NA)
Vent	203 ft	199-30 ft
Ground	34 ft	199-30 ft

[a] Used in calculating the meteorological and dose factors in Tables F-5, F-6, and F-7. See Sections B.3 through B.6 of Appendix B.

Table F-3

Critical Ranges

Direction	Unrestricted Area Boundary[a] (m)	Restricted Area Boundary (m)	Nearest Resident Within 6.2 miles (m)	Nearest Dairy Farm within 6.2 Miles[c] (m)
N	610	305	800	None
NNE	914	265	2800	None
NE	792	299	1100	None
ENE	701	361	1200	None
E	1036	355	1200	None
ESE	2713	425	3500	None
SE	3414	448	4300	None
SSE	3444	540	None	None
S	4633	530	6700	None
SSW	975	540	2000	9000
SW	632	632	600	None
WSW	555	555	800	None
W	518	500	600	None
WNW	503	434	600	None
NW	495	428	600	None
NNW	510	442	600	None

[a] See Updated Final Safety Analysis Report Table 2.1-1a and Environmental Report. Used in calculating the meteorological and dose factors in Tables F-5 and F-7. See Sections B.3 through B.6 of Appendix B.

[b] 2001 annual survey by Teledyne Isotopes Midwest Laboratories. The distances are rounded to the nearest conservative 100 meters.

[c] 2001 annual milch animal census, by Teledyne Isotopes Midwest Laboratories. Used in calculating the D/Q values in Table F-6. The distances are rounded to the nearest conservative 100 meters.

Table F-4

Average Wind Speeds

Downwind Direction	Average Wind Speed (m/sec)[a]		
	Elevated[b]	Mixed Mode	Ground Level[b]
N	7.6	6.0	4.7
NNE	7.5	5.8	4.4
NE	6.1	5.3	3.9
ENE	6.2	5.2	3.7
E	6.6	5.4	4.0
ESE	6.8	5.6	4.3
SE	6.2	5.3	3.9
SSE	5.8	5.2	4.1
S	5.5	4.9	3.6
SSW	5.5	5.0	3.7
SW	5.3	4.8	3.3
WSW	4.7	4.2	2.4
W	5.4	4.4	2.2
WNW	6.0	4.6	2.4
NW	6.0	4.8	3.1
NNW	6.8	5.4	3.9

[a] Based on Braidwood site meteorological data, January 1978 through December 1987. Calculated in Reference 1 of Section F.2, using formulas in Section B.1.3 of Appendix B.

[b] The elevated and ground level values are provided for reference purposes only. Routine dose calculations are performed using the mixed mode values.

Table F-5
X/Q and D/Q Maxima at or Beyond the Unrestricted Area Boundary

Downwind Direction	Mixed Mode (Vent) Release				Ground Level Release		
	Radius (meters)	X/Q (sec/m**3)	Radius (meters)	D/Q (1/m**2)	Radius (meters)	X/Q (sec/m**3)	D/Q (1/m**2)
N	610.	1.161E-06	610.	1.643E-08	610.	4.646E-06	3.355E-08
NNE	914.	5.076E-07	914.	7.023E-09	914.	1.783E-06	1.382E-08
NE	792.	2.990E-07	792.	4.274E-09	792.	1.738E-06	1.092E-08
ENE	701.	4.281E-07	701.	4.903E-09	701.	2.174E-06	1.310E-08
E	1036.	3.104E-07	1036.	3.780E-09	1036.	1.505E-06	8.551E-09
ESE	2713.	1.065E-07	2713.	1.164E-09	2713.	3.990E-07	1.949E-09
SE	3414.	7.575E-08	3414.	7.225E-10	3414.	2.757E-07	1.088E-09
SSE	3444.	6.028E-08	3444.	6.345E-10	3444.	2.165E-07	1.015E-09
S	4633.	4.068E-08	4633.	2.644E-10	4633.	1.749E-07	4.520E-10
SSW	975.	1.925E-07	975.	2.843E-09	975.	1.333E-06	6.781E-09
SW	632.	5.153E-07	632.	5.408E-09	632.	3.485E-06	1.494E-08
WSW	555.	7.821E-07	555.	4.558E-09	555.	5.471E-06	1.853E-08
W	518.	8.901E-07	518.	5.064E-09	518.	5.902E-06	1.830E-08
WNW	503.	1.077E-06	503.	6.100E-09	503.	6.472E-06	1.913E-08
NW	495.	1.081E-06	495.	8.650E-09	495.	5.501E-06	2.537E-08
NNW	510.	1.098E-06	510.	1.185E-08	510.	5.421E-06	3.023E-08

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Note: Based on Reference 1 of Section F.2 and the formulas in Sections B.3 and B.4 of Appendix B.

X/Q is used for beta skin, and inhalation dose pathways. See Sections A.1.2, A.1.3, and A.1.4.2 of Apprendix A.

D/Q is used for produce and leafy vegetable pathways. Section A.1.4 of Appendix A.

The ground level release data are provided for reference purposes only. Routine dose calculations are performed using mixed mode data.

Radius is the approximate distance from the midpoint between gaseous effluent release points to the location of highest X/Q or D/Q at or beyond the unrestricted area boundary (UAB).

Table F-5a

X/Q and D/Q Maxima at or Beyond the Restricted Area Boundary

Downwind Direction	Mixed Mode (Vent) Release				Ground Level Release		
	Radius (meters)	X/Q (sec/m**3)	Radius (meters)	D/Q (1/m**2)	Radius (meters)	X/Q (sec/m**3)	D/Q (1/m**2)
N	305.	3.766E-06	305.	4.266E-08	305.	1.551E-05	9.627E-08
NNE	265.	3.841E-06	265.	3.855E-08	265.	1.445E-05	9.318E-08
NE	299.	1.412E-06	299.	1.473E-08	299.	8.827E-06	4.892E-08
ENE	361.	1.265E-06	361.	1.138E-08	361.	6.706E-06	3.652E-08
E	355.	1.669E-06	355.	1.590E-08	355.	8.978E-06	4.611E-08
ESE	425.	1.264E-06	425.	1.678E-08	425.	7.012E-06	4.132E-08
SE	448.	1.056E-06	448.	1.266E-08	448.	6.269E-06	3.177E-08
SSE	540.	5.596E-07	540.	8.639E-09	540.	3.673E-06	2.258E-08
S	530.	6.166E-07	530.	5.425E-09	530.	4.576E-06	1.745E-08
SSW	540.	4.441E-07	540.	6.000E-09	540.	3.423E-06	1.748E-08
SW	632.	5.153E-07	632.	5.408E-09	632.	3.485E-06	1.494E-08
WSW	555.	7.821E-07	555.	4.558E-09	555	5.471E-06	1.853E-08
W	500.	9.431E-07	500.	5.289E-09	500.	6.265E-06	1.932E-08
WNW	434.	1.384E-06	434.	7.394E-09	434.	8.361E-06	2.399E-08
NW	428.	1.381E-06	428.	1.050E-08	428.	7.070E-06	3.170E-08
NNW	442.	1.388E-06	442.	1.444E-08	442.	6.878E-06	3.766E-08

Braidwood Site Meteorological Data 1/78 - 12/87

Note: Based on Reference 1 of Section F.2 and the formulas in Sections B.3 and B.4 of Appendix B.

The ground level release data are provided for reference purposes only. Routine dose calculations are performed using mixed mode data.

Radius is the approximate distance from the midpoint between gaseous effluent release points to the location of highest X/Q or D/Q at or beyond the restricted area boundary (RAB).

Table F-5b
Maximum Offsite Gamma-χ/Q

Downwind Direction	Radius (meters)	Ground Gamma-χ/Q (sec/m**3)	Vent Gamma-χ/Q (sec/m**3)
N	610	2.15E-06	7.12E-07
NNE	914	9.30E-07	3.46E-07
NE	792	9.02E-07	2.40E-07
ENE	701	1.06E-06	3.02E-07
E	1036	7.83E-07	2.31E-07
ESE	2713	2.28E-07	8.04E-08
SE	3414	1.54E-07	5.51E-08
SSE	3444	1.24E-07	4.57E-08
S	4633	9.27E-08	2.82E-08
SSW	975	7.00E-07	1.59E-07
SW	632	1.58E-06	3.39E-07
WSW	555	2.44E-06	4.45E-07
W	518	2.47E-06	4.95E-07
WNW	503	2.54E-06	5.53E-07
NW	495	2.33E-06	6.01E-07
NNW	510	2.45E-06	6.46E-07

Table F-6

χ/Q and D/Q at the Nearest Resident Locations within 5 miles

Location Description	Direction	Distance		Ground Level Release		Mixed Mode (Vent) Release	
		miles	meters	χ/Q sec/m^3	D/Q m^{-2}	χ/Q sec/m^3	D/Q m^{-2}
NEAREST RESIDENCE	N	0.50	800	3.30E-06	1.50E-08	1.60E-07	2.70E-09
NEAREST RESIDENCE	NNE	1.74	2800	4.10E-07	2.00E-09	8.60E-08	5.90E-10
NEAREST RESIDENCE	NE	0.68	1100	1.90E-06	7.30E-09	8.90E-08	1.30E-09
NEAREST RESIDENCE	ENE	0.75	1200	3.00E-06	8.20E-09	8.20E-08	1.20E-09
NEAREST RESIDENCE	E	0.75	1200	3.80E-06	8.40E-09	7.90E-08	1.20E-09
NEAREST RESIDENCE	ESE	2.17	3500	7.00E-07	1.30E-09	7.00E-08	3.10E-10
NEAREST RESIDENCE	SE	2.67	4300	2.70E-07	5.90E-10	4.70E-08	1.80E-10
NEAREST RESIDENCE	SSE	4.97	8000	1.20E-07	2.00E-10	3.00E-08	7.20E-11
NEAREST RESIDENCE	S	4.16	6700	1.10E-07	2.20E-10	3.20E-08	6.40E-11
NEAREST RESIDENCE	SSW	1.24	2000	8.50E-07	2.40E-09	5.70E-08	4.30E-10
NEAREST RESIDENCE	SW	0.37	600	8.10E-06	1.80E-08	8.50E-08	1.40E-09
NEAREST RESIDENCE	WSW	0.50	800	6.30E-06	1.10E-08	3.00E-08	4.50E-10
NEAREST RESIDENCE	W	0.37	600	1.10E-05	1.40E-08	2.30E-08	4.20E-10
NEAREST RESIDENCE	WNW	0.37	600	7.30E-06	1.30E-08	5.10E-08	7.70E-10
NEAREST RESIDENCE	NW	0.37	600	6.30E-06	1.70E-08	9.50E-08	1.30E-09
NEAREST RESIDENCE	NNW	0.37	600	6.00E-06	2.10E-08	1.50E-07	2.30E-09

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Note: There is no real residence within 5 miles in the SSE sector.

Table F-6a

χ/Q and D/Q at the Nearest Cow Milk Locations within 5 miles

Location Description	Direction	Distance		Ground Level Release		Mixed Mode (Vent) Release	
		miles	meters	χ/Q sec/m^3	D/Q m^{-2}	χ/Q sec/m^3	D/Q m^{-2}
COW MILK	N	4.97	8000	8.60E-08	2.90E-10	3.80E-08	9.30E-11
COW MILK	NNE	4.97	8000	8.60E-08	3.20E-10	3.80E-08	1.10E-10
COW MILK	NE	4.97	8000	8.70E-08	2.30E-10	3.10E-08	9.00E-11
COW MILK	ENE	4.97	8000	1.60E-07	3.00E-10	4.10E-08	8.80E-11
COW MILK	E	4.97	8000	2.20E-07	3.10E-10	4.30E-08	8.80E-11
COW MILK	ESE	4.97	8000	2.10E-07	3.00E-10	4.40E-08	8.80E-11
COW MILK	SE	4.97	8000	1.10E-07	2.00E-10	3.20E-08	6.70E-11
COW MILK	SSE	4.97	8000	1.20E-07	2.00E-10	3.00E-08	7.20E-11
COW MILK	S	4.97	8000	8.90E-08	1.60E-10	2.80E-08	4.80E-11
COW MILK	SSW	4.97	8000	1.10E-07	2.10E-10	3.50E-08	6.10E-11
COW MILK	SW	4.97	8000	1.30E-07	2.20E-10	4.10E-08	6.60E-11
COW MILK	WSW	4.97	8000	1.70E-07	2.10E-10	4.90E-08	4.50E-11
COW MILK	W	4.97	8000	1.70E-07	1.70E-10	3.80E-08	3.10E-11
COW MILK	WNW	4.97	8000	1.20E-07	1.60E-10	2.80E-08	3.20E-11
COW MILK	NW	4.97	8000	1.00E-07	2.00E-10	3.50E-08	4.40E-11
COW MILK	NNW	4.97	8000	9.40E-08	2.50E-10	3.90E-08	7.40E-11

Braidwood Site Meteorological Data 1/00 - 12/00

Note: There are no diary cows within 5 miles of the plant. Values provided for reference only.

Table F-6b

χ/Q and D/Q at the Nearest Cow Meat Locations within 5 miles

Location Description	Direction	Distance		Ground Level Release		Mixed Mode (Vent) Release	
		miles	meters	χ/Q sec/m^3	D/Q m^{-2}	χ/Q sec/m^3	D/Q m^{-2}
COW MEAT	N	2.55	4100	2.30E-07	9.40E-10	6.40E-08	2.70E-10
COW MEAT	NNE	4.97	8000	8.60E-08	3.20E-10	3.80E-08	1.10E-10
COW MEAT	NE	0.87	1400	1.20E-06	4.80E-09	7.70E-08	1.00E-09
COW MEAT	ENE	3.29	5300	3.00E-07	6.30E-10	5.50E-08	1.70E-10
COW MEAT	E	2.30	3700	6.50E-07	1.20E-09	6.70E-08	2.90E-10
COW MEAT	ESE	2.30	3700	6.40E-07	1.20E-09	6.80E-08	2.90E-10
COW MEAT	SE	2.67	4300	2.70E-07	5.90E-10	4.70E-08	1.80E-10
COW MEAT	SSE	4.10	6600	1.60E-07	2.80E-10	3.40E-08	9.90E-11
COW MEAT	S	4.97	7700	8.90E-08	1.15E-10	2.80E-08	1.83E-10
COW MEAT	SSW	4.97	8000	1.10E-07	2.10E-10	3.50E-08	6.10E-11
COW MEAT	SW	1.18	1900	1.10E-06	2.70E-09	5.80E-08	4.70E-10
COW MEAT	WSW	3.79	6100	2.50E-07	3.40E-10	5.70E-08	6.90E-11
COW MEAT	W	1.55	2500	9.40E-07	1.30E-09	3.90E-08	1.40E-10
COW MEAT	WNW	4.97	8000	1.20E-07	1.60E-10	2.80E-08	3.20E-11
COW MEAT	NW	4.97	8000	1.00E-07	2.00E-10	3.50E-08	4.40E-11
COW MEAT	NNW	4.97	8000	9.40E-08	2.50E-10	3.90E-08	7.40E-11

Braidwood Site Meteorological Data 1/00 - 12/00

Note: There are no meat cows within 5 miles of the plant in the following sectors:
NNE, S, SSW WNW NW and NNW.
Values provided for reference only.

Table F-7

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-83m

Downwind Direction	Unrestricted Area Bound (meters)	Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.455E-04	1.097E-04	610.	5.333E-04	4.021E-04
NNE	914.	914.	6.375E-05	4.807E-05	914.	2.125E-04	1.602E-04
NE	792.	792.	3.828E-05	2.886E-05	792.	2.007E-04	1.513E-04
ENE	701.	701.	5.294E-05	3.992E-05	701.	2.575E-04	1.941E-04
E	1036.	1036.	3.703E-05	2.792E-05	1036.	1.718E-04	1.295E-04
ESE	2713.	2713.	1.129E-05	8.514E-06	2713.	3.792E-05	2.859E-05
SE	3414.	3414.	7.089E-06	5.345E-06	3414.	2.141E-05	1.614E-05
SSE	3444.	3444.	6.047E-06	4.559E-06	3444.	1.798E-05	1.356E-05
S	4633.	4633.	3.224E-06	2.431E-06	4633.	9.268E-06	6.988E-06
SSW	975.	975.	2.363E-05	1.782E-05	975.	1.444E-04	1.088E-04
SW	632.	632.	5.930E-05	4.472E-05	632.	3.694E-04	2.786E-04
WSW	555.	555.	8.469E-05	6.386E-05	555.	5.942E-04	4.480E-04
W	518.	518.	9.909E-05	7.471E-05	518.	6.292E-04	4.744E-04
WNW	503.	503.	1.205E-04	9.082E-05	503.	6.653E-04	5.016E-04
NW	495.	495.	1.242E-04	9.366E-05	495.	6.066E-04	4.574E-04
NNW	510.	510.	1.322E-04	9.969E-05	510.	6.144E-04	4.633E-04

Braidwood Site Meteorological Data 1/78 - 12/87

Note: Based on Reference 1 of Section F.2 and the formulas in Sections B.5 and B.6 of Appendix B.

Routine dose calculations are performed using mixed mode (vent) release data.

Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-85m

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	9.989E-04	9.590E-04	610.	2.731E-03	2.164E-03
NNE	914.	914.	4.979E-04	4.785E-04	914.	1.222E-03	1.171E-03
NE	792.	792.	3.618E-04	3.481E-04	792.	1.173E-03	1.124E-03
ENE	701.	701.	4.452E-04	4.280E-04	701.	1.363E-03	1.305E-03
E	1036.	1036.	3.452E-04	3.320E-04	1036.	1.023E-03	9.809E-03
ESE	2713.	2713.	1.220E-04	1.174E-04	2713.	3.051E-04	2.930E-04
SE	3414.	3414.	8.179E-05	7.874E-05	3414.	1.970E-04	1.893E-04
SSE	3444.	3444.	6.958E-05	6.700E-05	3444.	1.634E-04	1.570E-04
S	4633.	4633.	4.000E-05	3.851E-05	4633.	1.051E-04	1.010E-04
SSW	975.	975.	2.413E-04	2.323E-04	975.	9.063E-04	8.688E-04
SW	632.	632.	5.199E-04	4.999E-04	632.	1.989E-03	1.905E-03
WSW	555.	555.	6.707E-04	6.444E-04	555.	3.061E-03	2.929E-03
W	518.	518.	6.908E-04	6.632E-04	518.	3.081E-03	2.947E-03
WNW	503.	503.	7.511E-04	7.204E-04	503.	3.126E-03	2.988E-03
NW	495.	495.	8.396E-04	8.059E-04	495.	2.915E-03	2.788E-03
NNW	510.	510.	9.023E-04	8.662E-04	510.	3.091E-03	2.958E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-85

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	1.125E-05	1.088E-05	610.	2.986E-05	2.888E-05
NNE	914.	914.	5.661E-06	5.474E-06	914.	1.344E-05	1.300E-05
NE	792.	792.	4.192E-06	4.053E-06	792.	1.311E-05	1.268E-05
ENE	701.	701.	5.150E-06	4.980E-06	701.	1.486E-05	1.437E-05
E	1036.	1036.	4.044E-06	3.911E-06	1036.	1.145E-05	1.107E-05
ESE	2713.	2713.	1.468E-06	1.420E-06	2713.	3.702E-06	3.579E-06
SE	3414.	3414.	1.025E-06	9.911E-07	3414.	2.620E-06	2.534E-06
SSE	3444.	3444.	8.593E-07	8.310E-07	3444.	2.101E-06	2.032E-06
S	4633.	4633.	5.432E-07	5.253E-07	4633.	1.699E-06	1.643E-06
SSW	975.	975.	2.853E-06	2.759E-06	975.	1.042E-05	1.008E-05
SW	632.	632.	6.098E-06	5.897E-06	632.	2.227E-05	2.154E-05
WSW	555.	555.	7.858E-06	7.599E-06	555.	3.400E-05	3.288E-05
W	518.	518.	7.924E-06	7.663E-06	518.	3.388E-05	3.276E-05
WNW	503.	503.	8.499E-06	8.219E-06	503.	3.430E-05	3.317E-05
NW	495.	495.	9.567E-06	9.251E-06	495.	3.174E-05	3.069E-05
NNW	510.	510.	1.025E-05	9.909E-06	510.	3.393E-05	3.281E-05

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-87

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	3.313E-03	3.217E-03	610.	8.088E-03	7.853E-03
NNE	914.	914.	1.650E-03	1.602E-03	914.	3.649E-03	3.543E-03
NE	792.	792.	1.249E-03	1.213E-03	792.	3.373E-03	3.275E-03
ENE	701.	701.	1.516E-03	1.472E-03	701.	4.077E-03	3.958E-03
E	1036.	1036.	1.150E-04	1.117E-03	1036.	2.954E-03	2.868E-03
ESE	2713.	2713.	3.948E-04	3.834E-04	2713.	8.084E-04	7.849E-04
SE	3414.	3414.	2.559E-04	2.486E-04	3414.	4.691E-04	4.555E-04
SSE	3444.	3444.	2.231E-04	2.167E-04	3444.	4.098E-04	3.979E-04
S	4633.	4633.	1.162E-04	1.129E-04	4633.	2.055E-04	1.996E-04
SSW	975.	975.	8.253E-04	8.015E-04	975.	2.477E-03	2.405E-03
SW	632.	632.	1.758E-03	1.707E-03	632.	5.625E-03	5.462E-03
WSW	555.	555.	2.229E-03	2.165E-03	555.	8.703E-03	8.450E-03
W	518.	518.	2.276E-03	2.210E-03	518.	8.931E-03	8.671E-03
WNW	503.	503.	2.431E-03	2.360E-03	503.	9.052E-03	8.789E-03
NW	495.	495.	2.792E-03	2.711E-03	495.	8.646E-03	8.395E-03
NNW	510.	510.	2.982E-03	2.896E-03	510.	9.023E-03	8.761E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-88

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	7.997E-03	7.772E-03	610.	1.968E-02	1.911E-02
NNE	914.	914.	4.019E-03	3.906E-03	914.	8.899E-03	8.644E-03
NE	792.	792.	3.059E-03	2.974E-03	792.	8.441E-03	8.199E-03
ENE	701.	701.	3.725E-03	3.621E-03	701.	9.870E-03	9.586E-03
E	1036.	1036.	2.878E-03	2.798E-03	1036.	7.394E-03	7.182E-03
ESE	2713.	2713.	1.022E-03	9.941E-04	2713.	2.215E-03	2.152E-03
SE	3414.	3414.	6.859E-04	6.670E-04	3414.	1.396E-03	1.357E-03
SSE	3444.	3444.	5.929E-04	5.766E-04	3444.	1.185E-03	1.151E-03
S	4633.	4633.	3.301E-04	3.210E-04	4633.	6.987E-04	6.792E-04
SSW	975.	975.	2.066E-03	2.009E-03	975.	6.466E-03	6.281E-03
SW	632.	632.	4.389E-03	4.267E-03	632.	1.422E-02	1.381E-02
WSW	555.	555.	5.589E-03	5.433E-03	555.	2.182E-02	2.119E-02
W	518.	518.	5.607E-03	5.449E-03	518.	2.205E-02	2.141E-02
WNW	503.	503.	5.947E-03	5.779E-03	503.	2.232E-02	2.167E-02
NW	495.	495.	6.814E-03	6.622E-03	495.	2.097E-02	2.036E-02
NNW	510.	510.	7.265E-03	7.060E-03	510.	2.215E-02	2.151E-02

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-89

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	4.323E-03	4.199E-03	610.	7.655E-03	7.435E-03
NNE	914.	914.	1.692E-03	1.643E-03	914.	2.645E-03	2.569E-03
NE	792.	792.	1.305E-03	1.268E-03	792.	2.219E-03	2.155E-03
ENE	701.	701.	1.577E-03	1.532E-03	701.	3.016E-03	2.929E-03
E	1036.	1036.	9.092E-04	8.833E-04	1036.	1.387E-03	1.347E-03
ESE	2713.	2713.	1.140E-04	1.108E-04	2713.	9.720E-05	9.442E-05
SE	3414.	3414.	4.392E-05	4.266E-05	3414.	2.983E-05	2.897E-05
SSE	3444.	3444.	3.822E-05	3.712E-05	3444.	3.079E-05	2.990E-05
S	4633.	4633.	9.027E-06	8.769E-06	4633.	6.198E-06	6.021E-06
SSW	975.	975.	6.764E-04	6.571E-04	975.	1.066E-03	1.036E-03
SW	632.	632.	1.750E-03	1.700E-03	632.	3.181E-03	3.089E-03
WSW	555.	555.	2.009E-03	1.951E-03	555.	4.608E-03	4.475E-03
W	518.	518.	2.170E-03	2.108E-03	518.	4.949E-03	4.807E-03
WNW	503.	503.	2.410E-03	2.341E-03	503.	5.589E-03	5.428E-03
NW	495.	495.	3.227E-03	3.134E-03	495.	7.228E-03	7.020E-03
NNW	510.	510.	3.714E-03	3.608E-03	510.	7.735E-03	7.512E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-90

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	8.576E-04	8.317E-04	610.	9.142E-04	8.863E-04
NNE	914.	914.	1.453E-04	1.409E-04	914.	1.212E-04	1.175E-04
NE	792.	792.	1.302E-04	1.263E-04	792.	1.132E-04	1.098E-04
ENE	701.	701.	1.874E-04	1.817E-04	701.	1.634E-04	1.584E-04
E	1036.	1036.	5.480E-05	5.316E-05	1036.	3.996E-05	3.875E-05
ESE	2713.	2713.	2.691E-07	2.610E-07	2713.	1.795E-07	1.741E-07
SE	3414.	3414.	1.662E-08	1.612E-08	3414.	6.748E-09	6.546E-09
SSE	3444.	3444.	2.647E-08	2.568E-08	3444.	2.033E-08	1.972E-08
S	4633.	4633.	5.354E-10	5.193E-10	4633.	3.704E-10	3.592E-10
SSW	975.	975.	4.411E-05	4.278E-05	975.	3.803E-05	3.688E-05
SW	632.	632.	2.254E-04	2.186E-04	632.	1.980E-04	1.920E-04
WSW	555.	555.	2.280E-04	2.212E-04	555.	1.855E-04	1.799E-04
W	518.	518.	2.822E-04	2.738E-04	518.	1.673E-04	1.622E-04
WNW	503.	503.	3.444E-04	3.341E-04	503.	2.412E-04	2.339E-04
NW	495.	495.	5.611E-04	5.442E-04	495.	5.535E-04	5.366E-04
NNW	510.	510.	8.014E-04	7.772E-04	510.	9.221E-04	8.940E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-131m

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(Uci/sec)	
N	610.	610.	1.355E-04	1.065E-04	610.	4.922E-04	3.831E-04
NNE	914.	914.	6.125E-05	4.839E-05	914.	1.988E-04	1.553E-04
NE	792.	792.	3.806E-05	3.031E-05	792.	1.946E-04	1.520E-04
ENE	701.	701.	5.153E-05	4.083E-05	701.	2.358E-04	1.838E-04
E	1036.	1036.	3.805E-05	3.024E-05	1036.	1.677E-04	1.310E-04
ESE	2713.	2713.	1.232E-05	9.849E-06	2713.	4.412E-05	3.474E-05
SE	3414.	3414.	8.612E-06	6.883E-06	3414.	3.046E-05	2.401E-05
SSE	3444.	3444.	6.862E-06	5.499E-06	3444.	2.387E-05	1.883E-05
S	4633.	4633.	4.603E-06	3.676E-16	4633.	1.914E-05	1.510E-05
SSW	975.	975.	2.441E-05	1.949E-05	975.	1.504E-04	1.176E-04
SW	632.	632.	6.073E-05	4.813E-05	632.	3.620E-04	2.819E-04
WSW	555.	555.	8.569E-05	6.762E-05	555.	5.701E-04	4.435E-04
W	518.	518.	9.576E-05	7.527E-05	518.	5.874E-04	4.565E-04
WNW	503.	503.	1.132E-04	8.870E-05	503.	6.171E-04	4.790E-04
NW	495.	495.	1.167E-04	9.171E-05	495.	5.515E-04	4.285E-04
NNW	510.	510.	1.244E-04	9.777E-05	510.	5.698E-04	4.432E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-133m

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	2.561E-04	2.223E-04	610.	8.256E-04	7.023E-04
NNE	914.	914.	1.216E-04	1.063E-04	914.	3.481E-04	2.984E-04
NE	792.	792.	8.185E-05	7.244E-05	792.	3.399E-04	2.912E-04
ENE	701.	701.	1.055E-04	9.274E-05	701.	4.017E-04	3.426E-04
E	1036.	1036.	8.032E-05	7.091E-05	1036.	2.943E-04	2.524E-04
ESE	2713.	2713.	2.749E-05	2.446E-05	2713.	8.394E-05	7.303E-05
SE	3414.	3414.	1.908E-05	1.697E-05	3414.	5.806E-05	5.060E-05
SSE	3444.	3444.	1.562E-05	1.394E-05	3444.	4.609E-05	4.022E-05
S	4633.	4633.	1.005E-05	8.929E-06	4633.	3.632E-05	3.171E-05
SSW	975.	975.	5.390E-05	4.788E-05	975.	2.651E-04	2.276E-04
SW	632.	632.	1.243E-04	1.092E-04	632.	6.091E-04	5.186E-04
WSW	555.	555.	1.679E-04	1.466E-04	555.	9.488E-04	8.060E-04
W	518.	518.	1.799E-04	1.560E-04	518.	9.658E-04	8.185E-04
WNW	503.	503.	2.046E-04	1.763E-04	503.	1.001E-03	8.459E-04
NW	495.	495.	2.185E-04	1.894E-04	495.	9.067E-04	7.683E-04
NNW	510.	510.	2.337E-04	2.027E-04	510.	9.487E-04	8.059E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-133

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	2.824E-04	2.536E-04	610.	9.100E-04	8.050E-04
NNE	914.	914.	1.355E-04	1.224E-04	914.	3.891E-04	3.466E-04
NE	792.	792.	9.079E-05	8.273E-05	792.	3.804E-04	3.389E-04
ENE	701.	701.	1.161E-04	1.052E-04	701.	4.450E-04	3.946E-04
E	1036.	1036.	8.914E-05	8.108E-05	1036.	3.295E-04	2.937E-04
ESE	2713.	2713.	3.072E-05	2.812E-05	2713.	9.583E-05	8.640E-05
SE	3414.	3414.	2.135E-05	1.953E-05	3414.	6.660E-05	6.011E-05
SSE	3444.	3444.	1.740E-05	1.596E-05	3444.	5.275E-05	4.767E-05
S	4633.	4633.	1.130E-05	1.033E-05	4633.	4.215E-05	3.809E-05
SSW	975.	975.	5.975E-05	5.460E-05	975.	2.978E-04	2.657E-04
SW	632.	632.	1.367E-04	1.238E-04	632.	6.726E-04	5.954E-04
WSW	555.	555.	1.830E-04	1.649E-04	555.	1.044E-03	9.224E-04
W	518.	518.	1.965E-04	1.762E-04	518.	1.056E-03	9.311E-04
WNW	503.	503.	2.231E-04	1.990E-04	503.	1.088E-03	9.570E-04
NW	495.	495.	2.383E-04	2.135E-04	495.	9.911E-04	8.736E-04
NNW	510.	510.	2.563E-04	2.299E-04	510.	1.044E-03	9.221E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-135m

Downwind Direction	Unrestricted Area Bound (meters)	Mixed Mode (Vent) Release			Ground Level Release		
		Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.924E-03	1.856E-03	610.	4.403E-03	4.240E-03
NNE	914.	914.	9.071E-04	8.750E-04	914.	1.913E-03	1.843E-03
NE	792.	792.	6.745E-04	6.509E-04	792.	1.628E-03	1.568E-03
ENE	701.	701.	8.149E-04	7.862E-04	701.	2.191E-03	2.110E-03
E	1036.	1036.	5.710E-04	5.510E-04	1036.	1.368E-03	1.319E-03
ESE	2713.	2713.	1.557E-04	1.503E-04	2713.	2.479E-04	2.391E-04
SE	3414.	3414.	8.843E-05	8.536E-05	3414.	1.163E-04	1.122E-04
SSE	3444.	3444.	7.741E-05	7.472E-05	3444.	1.062E-04	1.025E-04
S	4633.	4633.	3.277E-05	3.163E-05	4633.	4.020E-05	3.879E-05
SSW	975.	975.	4.100E-04	3.957E-04	975.	1.011E-03	9.747E-04
SW	632.	632.	8.898E-04	8.587E-04	632.	2.532E-03	2.439E-03
WSW	555.	555.	1.092E-03	1.054E-03	555.	3.989E-03	3.842E-03
W	518.	518.	1.187E-03	1.145E-03	518.	4.362E-03	4.200E-03
WNW	503.	503.	1.304E-03	1.258E-03	503.	4.495E-03	4.327E-03
NW	495.	495.	1.546E-03	1.490E-03	495.	4.695E-03	4.521E-03
NNW	510.	510.	1.673E-03	1.613E-03	510.	4.688E-03	4.514E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-135

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	1.353E-03	1.307E-03	610.	3.674E-03	3.548E-03
NNE	914.	914.	6.781E-04	6.554E-04	914.	1.652E-03	1.596E-03
NE	792.	792.	4.952E-04	4.788E-04	792.	1.599E-03	1.545E-03
ENE	701.	701.	6.084E-04	5.880E-04	701.	1.833E-03	1.770E-03
E	1036.	1036.	4.753E-04	4.595E-04	1036.	1.395E-03	1.348E-03
ESE	2713.	2713.	1.700E-04	1.644E-04	2713.	4.326E-04	4.181E-04
SE	3414.	3414.	1.160E-04	1.121E-04	3414.	2.914E-04	2.816E-04
SSE	3444.	3444.	9.782E-05	9.459E-05	3444.	2.377E-04	2.297E-04
S	4633.	4633.	5.868E-05	5.674E-05	4633.	1.698E-04	1.641E-04
SSW	975.	975.	3.328E-04	3.217E-04	975.	1.253E-03	1.211E-03
SW	632.	632.	7.144E-04	6.906E-04	632.	2.708E-03	2.615E-03
WSW	555.	555.	9.205E-04	8.896E-04	555.	4.150E-03	4.007E-03
W	518.	518.	9.408E-04	9.091E-04	518.	4.151E-03	4.008E-03
WNW	503.	503.	1.018E-03	9.833E-04	503.	4.203E-03	4.058E-03
NW	495.	495.	1.139E-03	1.101E-03	495.	3.908E-03	3.773E-03
NNW	510.	510.	1.225E-03	1.183E-03	510.	4.166E-03	4.022E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-137

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	6.360E-04	6.154E-04	610.	1.202E-03	1.164E-03
NNE	914.	914.	2.578E-04	2.494E-04	914.	4.345E-04	4.205E-04
NE	792.	792.	1.950E-04	1.887E-04	792.	3.640E-04	3.522E-04
ENE	701.	701.	2.355E-04	2.279E-04	701.	4.977E-04	4.816E-04
E	1036.	1036.	1.407E-04	1.361E-04	1036.	2.400E-04	2.322E-04
ESE	2713.	2713.	2.042E-05	1.976E-05	2713.	1.931E-05	1.868E-05
SE	3414.	3414.	8.468E-06	8.195E-06	3414.	6.393E-06	6.186E-06
SSE	3444.	3444.	7.384E-06	7.146E-06	3444.	6.474E-06	6.265E-06
S	4633.	4633.	1.951E-06	1.888E-06	4633.	1.457E-06	1.410E-06
SSW	975.	975.	1.038E-04	1.004E-04	975.	1.812E-04	1.753E-04
SW	632.	632.	2.577E-04	2.493E-04	632.	5.246E-04	5.076E-04
WSW	555.	555.	2.977E-04	2.881E-04	555.	7.771E-04	7.519E-04
W	518.	518.	3.247E-04	3.143E-04	518.	8.444E-04	8.170E-04
WNW	503.	503.	3.635E-04	3.517E-04	503.	9.371E-04	9.067E-04
NW	495.	495.	4.769E-04	4.615E-04	495.	1.167E-03	1.129E-03
NNW	510.	510.	5.441E-04	5.265E-04	510.	1.222E-03	1.182E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-138

Downwind Direction	Unrestricted Area Bound	Mixed Mode (Vent) Release			Ground Level Release		
		Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	4.201E-03	4.079E-03	610.	9.169E-03	8.898E-03
NNE	914.	914.	1.982E-03	1.925E-03	914.	3.986E-03	3.869E-03
NE	792.	792.	1.504E-03	1.460E-03	792.	3.379E-03	3.280E-03
ENE	701.	701.	1.805E-03	1.753E-03	701.	4.549E-03	4.415E-03
E	1036.	1036.	1.262E-03	1.225E-03	1036.	2.830E-03	2.747E-03
ESE	2713.	2713.	3.395E-04	3.297E-04	2713.	5.079E-04	4.931E-04
SE	3414.	3414.	1.926E-04	1.871E-04	3414.	2.381E-04	2.312E-04
SSE	3444.	3444.	1.685E-04	1.636E-04	3444.	2.185E-04	2.121E-04
S	4633.	4633.	7.045E-05	6.842E-05	4633.	8.174E-05	7.937E-05
SSW	975.	975.	9.144E-04	8.880E-04	975.	2.091E-03	2.030E-03
SW	632.	632.	1.991E-03	1.934E-03	632.	5.266E-03	5.072E-03
WSW	555.	555.	2.429E-03	2.359E-03	555.	8.199E-03	7.957E-03
W	518.	518.	2.609E-03	2.534E-03	518.	8.973E-03	8.708E-03
WNW	503.	503.	2.834E-03	2.751E-03	503.	9.247E-03	8.973E-03
NW	495.	495.	3.387E-03	3.288E-03	495.	9.733E-03	9.445E-03
NNW	510.	510.	3.657E-03	3.551E-03	510.	9.712E-03	9.425E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Ar-41

Downwind	Unrestricted	Mixed Mode (Vent) Release			Ground Level Release		
Direction	Area Bound	Radius	V	VBAR	Radius	G	GBAR
	(meters)	(meters)	(mrad/yr)/(uCi/sec)		(meters)	(mrad/yr)/(uCi/sec)	
N	610.	610.	5.141E-03	4.977E-03	610.	1.283E-02	1.242E-02
NNE	914.	914.	2.568E-03	2.485E-03	914.	5.780E-03	5.595E-03
NE	792.	792.	1.935E-03	1.873E-03	792.	5.421E-03	5.248E-03
ENE	701.	701.	2.357E-03	2.282E-03	701.	6.445E-03	6.239E-03
E	1036.	1036.	1.803E-03	1.746E-03	1036.	4.745E-03	4.593E-03
ESE	2713.	2713.	6.281E-04	6.080E-04	2713.	1.352E-03	1.309E-03
SE	3414.	3414.	4.128E-04	3.996E-04	3414.	8.140E-04	7.880E-04
SSE	3444.	3444.	3.580E-04	3.466E-04	3444.	7.007E-04	6.783E-04
S	4633.	4633.	1.924E-04	1.862E-04	4633.	3.770E-04	3.650E-04
SSW	975.	975.	1.289E-03	1.247E-03	975.	4.067E-03	3.937E-03
SW	632.	632.	1.991E-03	1.934E-03	632.	9.104E-03	8.813E-03
WSW	555.	555.	2.429E-03	2.359E-03	555.	1.404E-02	1.359E-02
W	518.	518.	3.562E-03	3.448E-03	518.	1.430E-02	1.384E-02
WNW	503.	503.	3.806E-03	3.685E-03	503.	1.449E-02	1.403E-02
NW	495.	495.	4.350E-03	4.211E-03	495.	1.371E-02	1.327E-02
NNW	510.	510.	4.647E-03	4.498E-03	510.	1.439E-02	1.393E-02

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Table 8
Site Specific Potable Water Dose Factors for Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.25E+00	1.25E+00	1.25E+00	1.25E+00	1.25E+00	1.25E+00
Na-24	3.54E+01	3.54E+01	3.54E+01	3.54E+01	3.54E+01	3.54E+01	3.54E+01
Cr-51	0.00E+00	0.00E+00	5.53E-02	3.31E-02	1.22E-02	7.34E-02	1.39E+01
Mn-54	0.00E+00	9.51E+01	1.81E+01	0.00E+00	2.83E+01	0.00E+00	2.91E+02
Mn-56	0.00E+00	2.39E+00	4.24E-01	0.00E+00	3.04E+00	0.00E+00	7.64E+01
Fe-55	5.72E+01	3.95E+01	9.22E+00	0.00E+00	0.00E+00	2.21E+01	2.27E+01
Fe-59	9.03E+01	2.12E+02	8.13E+01	0.00E+00	0.00E+00	5.93E+01	7.07E+02
Co-58	0.00E+00	1.55E+01	3.47E+01	0.00E+00	0.00E+00	0.00E+00	3.14E+02
Co-60	0.00E+00	4.45E+01	9.82E+01	0.00E+00	0.00E+00	0.00E+00	8.36E+02
Ni-63	2.70E+03	1.87E+02	9.07E+01	0.00E+00	0.00E+00	0.00E+00	3.91E+01
Ni-65	1.10E+01	1.43E+00	6.51E-01	0.00E+00	0.00E+00	0.00E+00	3.62E+01
Cu-64	0.00E+00	1.73E+00	8.13E-01	0.00E+00	4.37E+00	0.00E+00	1.48E+02
Zn-65	1.01E+02	3.20E+02	1.45E+02	0.00E+00	2.14E+02	0.00E+00	2.02E+02
Zn-69	2.14E-01	4.10E-01	2.85E-02	0.00E+00	2.66E-01	0.00E+00	6.16E-02
Br-83	0.00E+00	0.00E+00	8.36E-01	0.00E+00	0.00E+00	0.00E+00	1.20E+00
Br-84	0.00E+00	0.00E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	8.51E-06
Br-85	0.00E+00	0.00E+00	4.45E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.39E+02	2.05E+02	0.00E+00	0.00E+00	0.00E+00	8.65E+01
Rb-88	0.00E+00	1.26E+00	6.68E-01	0.00E+00	0.00E+00	0.00E+00	1.74E-11
Rb-89	0.00E+00	8.34E-01	5.87E-01	0.00E+00	0.00E+00	0.00E+00	4.85E-14
Sr-89	6.41E+03	0.00E+00	1.84E+02	0.00E+00	0.00E+00	0.00E+00	1.03E+03
Sr-90	1.81E+05	0.00E+00	3.64E+03	0.00E+00	0.00E+00	0.00E+00	4.56E+03
Sr-91	1.18E+02	0.00E+00	4.76E+00	0.00E+00	0.00E+00	0.00E+00	5.62E+02
Sr-92	4.47E+01	0.00E+00	1.93E+00	0.00E+00	0.00E+00	0.00E+00	8.86E+02
Y-90	2.00E-01	0.00E+00	5.37E-03	0.00E+00	0.00E+00	0.00E+00	2.12E+03
Y-91M	1.89E-03	0.00E+00	7.32E-05	0.00E+00	0.00E+00	0.00E+00	5.55E-03
Y-91	2.93E+00	0.00E+00	7.84E-02	0.00E+00	0.00E+00	0.00E+00	1.61E+03
Y-92	1.76E-02	0.00E+00	5.14E-04	0.00E+00	0.00E+00	0.00E+00	3.08E+02
Y-93	5.58E-02	0.00E+00	1.54E-03	0.00E+00	0.00E+00	0.00E+00	1.77E+03
Zr-95	6.32E-01	2.03E-01	1.37E-01	0.00E+00	3.18E-01	0.00E+00	6.43E+02
Zr-97	3.50E-02	7.05E-03	3.22E-03	0.00E+00	1.07E-02	0.00E+00	2.18E+03
Nb-95	1.29E-01	7.20E-02	3.87E-02	0.00E+00	7.12E-02	0.00E+00	4.37E+02
Mo-99	0.00E+00	8.97E+01	1.71E+01	0.00E+00	2.03E+02	0.00E+00	2.08E+02
Tc- 99M	5.14E-03	1.45E-02	1.85E-01	0.00E+00	2.21E-01	7.12E-03	8.59E+00
Tc-101	5.28E-03	7.61E-03	7.47E-02	0.00E+00	1.37E-01	3.89E-03	2.29E-14
Ru-103	3.85E+00	0.00E+00	1.66E+00	0.00E+00	1.47E+01	0.00E+00	4.49E+02
Ru-105	3.20E-01	0.00E+00	1.26E-01	0.00E+00	4.14E+00	0.00E+00	1.96E+02
Ru-106	5.72E+01	0.00E+00	7.24E+00	0.00E+00	1.10E+02	0.00E+00	3.70E+03
Ag-110M	3.33E+00	3.08E+00	1.83E+00	0.00E+00	6.05E+00	0.00E+00	1.26E+03
Te-125M	5.58E+01	2.02E+01	7.47E+00	1.68E+01	2.27E+02	0.00E+00	2.23E+02

Table 8 (continued)
Site Specific Potable Water Dose Factors for Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	1.41E+02	5.03E+01	1.72E+01	3.60E+01	5.72E+02	0.00E+00	4.72E+02
Te-127	2.29E+00	8.22E-01	4.95E-01	1.70E+00	9.32E+00	0.00E+00	1.81E+02
Te-129M	2.39E+02	8.93E+01	3.79E+01	8.22E+01	9.99E+02	0.00E+00	1.20E+03
Te-129	6.53E-01	2.45E-01	1.59E-01	5.01E-01	2.75E+00	0.00E+00	4.93E-01
Te-131M	3.60E+01	1.76E+01	1.47E+01	2.79E+01	1.78E+02	0.00E+00	1.75E+03
Te-131	4.10E-01	1.71E-01	1.29E-01	3.37E-01	1.80E+00	0.00E+00	5.80E-02
Te-132	5.24E+01	3.39E+01	3.18E+01	3.74E+01	3.27E+02	0.00E+00	1.60E+03
I-130	1.57E+01	4.64E+01	1.83E+01	3.93E+03	7.24E+01	0.00E+00	3.99E+01
I-131	8.65E+01	1.24E+02	7.09E+01	4.06E+04	2.12E+02	0.00E+00	3.27E+01
I-132	4.22E+00	1.13E+01	3.95E+00	3.95E+02	1.80E+01	0.00E+00	2.12E+00
I-133	2.95E+01	5.14E+01	1.57E+01	7.55E+03	8.97E+01	0.00E+00	4.62E+01
I-134	2.21E+00	5.99E+00	2.14E+00	1.04E+02	9.53E+00	0.00E+00	5.22E-03
I-135	9.22E+00	2.41E+01	8.90E+00	1.59E+03	3.87E+01	0.00E+00	2.73E+01
Cs-134	1.29E+03	3.08E+03	2.52E+03	0.00E+00	9.97E+02	3.31E+02	5.39E+01
Cs-136	1.35E+02	5.35E+02	3.85E+02	0.00E+00	2.98E+02	4.08E+01	6.08E+01
Cs-137	1.66E+03	2.27E+03	1.49E+03	0.00E+00	7.70E+02	2.56E+02	4.39E+01
Cs-138	1.15E+00	2.27E+00	1.12E+00	0.00E+00	1.67E+00	1.65E-01	9.67E-06
Ba-139	2.02E+00	1.44E-03	5.91E-02	0.00E+00	1.34E-03	8.16E-04	3.58E+00
Ba-140	4.22E+02	5.31E-01	2.77E+01	0.00E+00	1.80E-01	3.04E-01	8.70E+02
Ba-141	9.80E-01	7.41E-04	3.31E-02	0.00E+00	6.89E-04	4.20E-04	4.62E-10
Ba-142	4.43E-01	4.56E-04	2.79E-02	0.00E+00	3.85E-04	2.58E-04	6.24E-19
La-140	5.20E-02	2.62E-02	6.93E-03	0.00E+00	0.00E+00	0.00E+00	1.92E+03
La-142	2.66E-03	1.21E-03	3.02E-04	0.00E+00	0.00E+00	0.00E+00	8.84E+00
Ce-141	1.95E-01	1.32E-01	1.49E-02	0.00E+00	6.12E-02	0.00E+00	5.03E+02
Ce-143	3.43E-02	2.54E+01	2.81E-03	0.00E+00	1.12E-02	0.00E+00	9.49E+02
Ce-144	1.02E+01	4.24E+00	5.45E-01	0.00E+00	2.52E+00	0.00E+00	3.43E+03
Pr-143	1.91E-01	7.68E-02	9.49E-03	0.00E+00	4.43E-02	0.00E+00	8.38E+02
Pr-144	6.26E-04	2.60E-04	3.18E-05	0.00E+00	1.47E-04	0.00E+00	9.01E-11
Nd-147	1.31E-01	1.51E-01	9.05E-03	0.00E+00	8.84E-02	0.00E+00	7.26E+02
W-187	2.14E+00	1.79E+00	6.26E-01	0.00E+00	0.00E+00	0.00E+00	5.87E+02
Np-239	2.48E-02	2.43E-03	1.34E-03	0.00E+00	7.59E-03	0.00E+00	4.99E+02

Notes:

1) Units are mrem/hr per µCi/ml.

Table 8a
Site Specific Potable Water Dose Factors for Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	8.78E-01	8.78E-01	8.78E-01	8.78E-01	8.78E-01	8.78E-01
Na-24	3.34E+01	3.34E+01	3.34E+01	3.34E+01	3.34E+01	3.34E+01	3.34E+01
Cr-51	0.00E+00	0.00E+00	5.23E-02	2.91E-02	1.15E-02	7.47E-02	8.79E+00
Mn-54	0.00E+00	8.58E+01	1.70E+01	0.00E+00	2.56E+01	0.00E+00	1.76E+02
Mn-56	0.00E+00	2.30E+00	4.08E-01	0.00E+00	2.91E+00	0.00E+00	1.51E+02
Fe-55	5.49E+01	3.90E+01	9.08E+00	0.00E+00	0.00E+00	2.47E+01	1.69E+01
Fe-59	8.53E+01	1.99E+02	7.69E+01	0.00E+00	0.00E+00	6.28E+01	4.71E+02
Co-58	0.00E+00	1.41E+01	3.26E+01	0.00E+00	0.00E+00	0.00E+00	1.95E+02
Co-60	0.00E+00	4.08E+01	9.20E+01	0.00E+00	0.00E+00	0.00E+00	5.32E+02
Ni-63	2.57E+03	1.82E+02	8.72E+01	0.00E+00	0.00E+00	0.00E+00	2.89E+01
Ni-65	1.09E+01	1.39E+00	6.34E-01	0.00E+00	0.00E+00	0.00E+00	7.54E+01
Cu-64	0.00E+00	1.67E+00	7.86E-01	0.00E+00	4.23E+00	0.00E+00	1.30E+02
Zn-65	8.37E+01	2.91E+02	1.36E+02	0.00E+00	1.86E+02	0.00E+00	1.23E+02
Zn-69	2.14E-01	4.07E-01	2.85E-02	0.00E+00	2.66E-01	0.00E+00	7.50E-01
Br-83	0.00E+00	0.00E+00	8.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.05E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	4.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.33E+02	2.03E+02	0.00E+00	0.00E+00	0.00E+00	6.41E+01
Rb-88	0.00E+00	1.24E+00	6.60E-01	0.00E+00	0.00E+00	0.00E+00	1.06E-07
Rb-89	0.00E+00	7.99E-01	5.65E-01	0.00E+00	0.00E+00	0.00E+00	1.23E-09
Sr-89	6.40E+03	0.00E+00	1.83E+02	0.00E+00	0.00E+00	0.00E+00	7.62E+02
Sr-90	1.48E+05	0.00E+00	2.97E+03	0.00E+00	0.00E+00	0.00E+00	3.39E+03
Sr-91	1.17E+02	0.00E+00	4.67E+00	0.00E+00	0.00E+00	0.00E+00	5.32E+02
Sr-92	4.43E+01	0.00E+00	1.89E+00	0.00E+00	0.00E+00	0.00E+00	1.13E+03
Y-90	1.99E-01	0.00E+00	5.36E-03	0.00E+00	0.00E+00	0.00E+00	1.64E+03
Y-91M	1.88E-03	0.00E+00	7.17E-05	0.00E+00	0.00E+00	0.00E+00	8.85E-02
Y-91	2.92E+00	0.00E+00	7.83E-02	0.00E+00	0.00E+00	0.00E+00	1.20E+03
Y-92	1.76E-02	0.00E+00	5.09E-04	0.00E+00	0.00E+00	0.00E+00	4.83E+02
Y-93	5.57E-02	0.00E+00	1.53E-03	0.00E+00	0.00E+00	0.00E+00	1.70E+03
Zr-95	5.99E-01	1.89E-01	1.30E-01	0.00E+00	2.78E-01	0.00E+00	4.36E+02
Zr-97	3.44E-02	6.82E-03	3.14E-03	0.00E+00	1.03E-02	0.00E+00	1.85E+03
Nb-95	1.19E-01	6.63E-02	3.65E-02	0.00E+00	6.42E-02	0.00E+00	2.83E+02
Mo-99	0.00E+00	8.76E+01	1.67E+01	0.00E+00	2.01E+02	0.00E+00	1.57E+02
Tc- 99M	4.83E-03	1.35E-02	1.74E-01	0.00E+00	2.01E-01	7.47E-03	8.84E+00
Tc-101	5.23E-03	7.44E-03	7.31E-02	0.00E+00	1.35E-01	4.53E-03	1.27E-09
Ru-103	3.71E+00	0.00E+00	1.58E+00	0.00E+00	1.31E+01	0.00E+00	3.10E+02
Ru-105	3.17E-01	0.00E+00	1.23E-01	0.00E+00	4.00E+00	0.00E+00	2.56E+02
Ru-106	5.70E+01	0.00E+00	7.18E+00	0.00E+00	1.10E+02	0.00E+00	2.73E+03
Ag-110M	2.98E+00	2.82E+00	1.72E+00	0.00E+00	5.38E+00	0.00E+00	7.92E+02
Te-125M	5.57E+01	2.01E+01	7.44E+00	1.56E+01	0.00E+00	0.00E+00	1.64E+02

Table 8a (continued)
Site Specific Potable Water Dose Factors for Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	1.41E+02	4.99E+01	1.67E+01	3.34E+01	5.70E+02	0.00E+00	3.50E+02
Te-127	2.30E+00	8.14E-01	4.94E-01	1.58E+00	9.30E+00	0.00E+00	1.77E+02
Te-129M	2.37E+02	8.79E+01	3.75E+01	7.65E+01	9.91E+02	0.00E+00	8.90E+02
Te-129	6.51E-01	2.43E-01	1.58E-01	4.65E-01	2.73E+00	0.00E+00	3.56E+00
Te-131M	3.55E+01	1.70E+01	1.42E+01	2.56E+01	1.77E+02	0.00E+00	1.36E+03
Te-131	4.06E-01	1.67E-01	1.27E-01	3.13E-01	1.77E+00	0.00E+00	3.33E-02
Te-132	5.07E+01	3.21E+01	3.02E+01	3.39E+01	3.08E+02	0.00E+00	1.02E+03
I-130	1.50E+01	4.33E+01	1.73E+01	3.53E+03	6.67E+01	0.00E+00	3.33E+01
I-131	8.50E+01	1.19E+02	6.40E+01	3.47E+04	2.05E+02	0.00E+00	2.35E+01
I-132	4.06E+00	1.06E+01	3.81E+00	3.58E+02	1.67E+01	0.00E+00	4.62E+00
I-133	2.92E+01	4.96E+01	1.51E+01	6.92E+03	8.69E+01	0.00E+00	3.75E+01
I-134	2.12E+00	5.63E+00	2.02E+00	9.38E+01	8.87E+00	0.00E+00	7.41E-02
I-135	8.87E+00	2.28E+01	8.46E+00	1.47E+03	3.60E+01	0.00E+00	2.53E+01
Cs-134	1.22E+03	2.86E+03	1.33E+03	0.00E+00	9.10E+02	3.47E+02	3.56E+01
Cs-136	1.25E+02	4.91E+02	3.30E+02	0.00E+00	2.67E+02	4.22E+01	3.95E+01
Cs-137	1.63E+03	2.17E+03	7.54E+02	0.00E+00	7.37E+02	2.86E+02	3.08E+01
Cs-138	1.13E+00	2.17E+00	1.08E+00	0.00E+00	1.60E+00	1.86E-01	9.83E-04
Ba-139	2.02E+00	1.42E-03	5.89E-02	0.00E+00	1.34E-03	9.80E-04	1.80E+01
Ba-140	4.13E+02	5.06E-01	2.66E+01	0.00E+00	1.72E-01	3.40E-01	6.37E+02
Ba-141	9.75E-01	7.28E-04	3.26E-02	0.00E+00	6.76E-04	4.99E-04	2.08E-06
Ba-142	4.35E-01	4.35E-04	2.67E-02	0.00E+00	3.68E-04	2.89E-04	1.33E-12
La-140	5.06E-02	2.49E-02	6.61E-03	0.00E+00	0.00E+00	0.00E+00	1.43E+03
La-142	2.60E-03	1.16E-03	2.88E-04	0.00E+00	0.00E+00	0.00E+00	3.52E+01
Ce-141	1.93E-01	1.29E-01	1.48E-02	0.00E+00	6.08E-02	0.00E+00	3.69E+02
Ce-143	3.42E-02	2.49E+01	2.78E-03	0.00E+00	1.11E-02	0.00E+00	7.47E+02
Ce-144	1.01E+01	4.19E+00	5.44E-01	0.00E+00	2.50E+00	0.00E+00	2.54E+03
Pr-143	1.90E-01	7.60E-02	9.48E-03	0.00E+00	4.42E-02	0.00E+00	6.26E+02
Pr-144	6.25E-04	2.56E-04	3.17E-05	0.00E+00	1.47E-04	0.00E+00	6.89E-07
Nd-147	1.36E-01	1.48E-01	8.88E-03	0.00E+00	8.71E-02	0.00E+00	5.35E+02
W-187	2.12E+00	1.73E+00	6.06E-01	0.00E+00	0.00E+00	0.00E+00	4.68E+02
Np-239	2.56E-02	2.41E-03	1.34E-03	0.00E+00	7.57E-03	0.00E+00	3.88E+02

Notes:

1) Units are mrem/hr per µCi/ml.

Table 8b
Site Specific Potable Water Dose Factors for Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00
Na-24	8.43E+01	8.43E+01	8.43E+01	8.43E+01	8.43E+01	8.43E+01	8.43E+01
Cr-51	0.00E+00	0.00E+00	1.29E-01	7.18E-02	1.96E-02	1.31E-01	6.86E+00
Mn-54	0.00E+00	1.56E+02	4.14E+01	0.00E+00	4.36E+01	0.00E+00	1.31E+02
Mn-56	0.00E+00	4.85E+00	1.10E+00	0.00E+00	5.87E+00	0.00E+00	7.03E+02
Fe-55	1.67E+02	8.87E+01	2.75E+01	0.00E+00	0.00E+00	5.01E+01	1.64E+01
Fe-59	2.40E+02	3.88E+02	1.93E+02	0.00E+00	0.00E+00	1.13E+02	4.04E+02
Co-58	0.00E+00	2.62E+01	8.01E+01	0.00E+00	0.00E+00	0.00E+00	1.53E+02
Co-60	0.00E+00	7.69E+01	2.27E+02	0.00E+00	0.00E+00	0.00E+00	4.26E+02
Ni-63	7.82E+03	4.19E+02	2.66E+02	0.00E+00	0.00E+00	0.00E+00	2.82E+01
Ni-65	3.23E+01	3.04E+00	1.77E+00	0.00E+00	0.00E+00	0.00E+00	3.72E+02
Cu-64	0.00E+00	3.56E+00	2.15E+00	0.00E+00	8.60E+00	0.00E+00	1.67E+02
Zn-65	1.99E+02	5.31E+02	3.30E+02	0.00E+00	3.34E+02	0.00E+00	9.32E+01
Zn-69	6.37E-01	9.20E-01	8.50E-02	0.00E+00	5.58E-01	0.00E+00	5.80E+01
Br-83	0.00E+00	0.00E+00	2.49E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.88E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.33E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	9.74E+02	5.99E+02	0.00E+00	0.00E+00	0.00E+00	6.26E+01
Rb-88	0.00E+00	2.76E+00	1.92E+00	0.00E+00	0.00E+00	0.00E+00	1.35E-01
Rb-89	0.00E+00	1.70E+00	1.51E+00	0.00E+00	0.00E+00	0.00E+00	1.48E-02
Sr-89	1.92E+04	0.00E+00	5.48E+02	0.00E+00	0.00E+00	0.00E+00	7.43E+02
Sr-90	3.72E+05	0.00E+00	7.49E+03	0.00E+00	0.00E+00	0.00E+00	3.33E+03
Sr-91	3.49E+02	0.00E+00	1.32E+01	0.00E+00	0.00E+00	0.00E+00	7.70E+02
Sr-92	1.31E+02	0.00E+00	5.26E+00	0.00E+00	0.00E+00	0.00E+00	2.49E+03
Y-90	5.97E-01	0.00E+00	1.60E-02	0.00E+00	0.00E+00	0.00E+00	1.70E+03
Y-91M	5.55E-03	0.00E+00	2.02E-04	0.00E+00	0.00E+00	0.00E+00	1.09E+01
Y-91	8.75E+00	0.00E+00	2.34E-01	0.00E+00	0.00E+00	0.00E+00	1.17E+03
Y-92	5.23E-02	0.00E+00	1.50E-03	0.00E+00	0.00E+00	0.00E+00	1.51E+03
Y-93	1.66E-01	0.00E+00	4.55E-03	0.00E+00	0.00E+00	0.00E+00	2.47E+03
Zr-95	1.69E+00	3.71E-01	3.30E-01	0.00E+00	5.31E-01	0.00E+00	3.87E+02
Zr-97	1.02E-01	1.47E-02	8.66E-03	0.00E+00	2.11E-02	0.00E+00	2.22E+03
Nb-95	3.27E-01	1.27E-01	9.10E-02	0.00E+00	1.20E-01	0.00E+00	2.35E+02
Mo-99	0.00E+00	1.93E+02	4.78E+01	0.00E+00	4.13E+02	0.00E+00	1.60E+02
Tc- 99M	1.34E-02	2.63E-02	4.36E-01	0.00E+00	3.82E-01	1.34E-02	1.50E+01
Tc-101	1.56E-02	1.63E-02	2.06E-01	0.00E+00	2.78E-01	8.60E-03	5.17E-02
Ru-103	1.06E+01	0.00E+00	4.08E+00	0.00E+00	2.67E+01	0.00E+00	2.75E+02
Ru-105	9.38E-01	0.00E+00	3.40E-01	0.00E+00	8.24E+00	0.00E+00	6.12E+02
Ru-106	1.70E+02	0.00E+00	2.12E+01	0.00E+00	2.30E+02	0.00E+00	2.65E+03
Ag-110M	7.83E+00	5.29E+00	4.23E+00	0.00E+00	9.85E+00	0.00E+00	6.29E+02
Te-125M	1.66E+02	4.49E+01	2.21E+01	4.65E+01	0.00E+00	0.00E+00	1.60E+02

Table 8b (continued)
Site Specific Potable Water Dose Factors for Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	4.20E+02	1.13E+02	4.99E+01	1.00E+02	1.20E+03	0.00E+00	3.40E+02
Te-127	6.85E+00	1.85E+00	1.47E+00	4.74E+00	1.95E+01	0.00E+00	2.67E+02
Te-129M	7.08E+02	1.98E+02	1.10E+02	2.28E+02	2.08E+03	0.00E+00	8.63E+02
Te-129	1.95E+00	5.44E-01	4.62E-01	1.39E+00	5.70E+00	0.00E+00	1.21E+02
Te-131M	1.05E+02	3.62E+01	3.85E+01	7.44E+01	3.50E+02	0.00E+00	1.47E+03
Te-131	1.21E+00	3.68E-01	3.59E-01	9.23E-01	3.65E+00	0.00E+00	6.34E+00
Te-132	1.47E+02	6.50E+01	7.85E+01	9.46E+01	6.03E+02	0.00E+00	6.54E+02
I-130	4.24E+01	8.58E+01	4.42E+01	9.45E+03	1.28E+02	0.00E+00	4.01E+01
I-131	2.50E+02	2.51E+02	1.43E+02	8.31E+04	4.13E+02	0.00E+00	2.24E+01
I-132	1.16E+01	2.14E+01	9.83E+00	9.91E+02	3.27E+01	0.00E+00	2.51E+01
I-133	8.60E+01	1.06E+02	4.03E+01	1.98E+04	1.77E+02	0.00E+00	4.29E+01
I-134	6.09E+00	1.13E+01	5.20E+00	2.60E+02	1.73E+01	0.00E+00	7.50E+00
I-135	2.54E+01	4.58E+01	2.17E+01	4.06E+03	7.02E+01	0.00E+00	3.49E+01
Cs-134	3.40E+03	5.58E+03	1.18E+03	0.00E+00	1.73E+03	6.21E+02	3.01E+01
Cs-136	3.42E+02	9.39E+02	6.08E+02	0.00E+00	5.00E+02	7.46E+01	3.30E+01
Cs-137	4.75E+03	4.55E+03	6.72E+02	0.00E+00	1.48E+03	5.33E+02	2.85E+01
Cs-138	3.31E+00	4.61E+00	2.92E+00	0.00E+00	3.24E+00	3.49E-01	2.12E+00
Ba-139	6.02E+00	3.21E-03	1.74E-01	0.00E+00	2.81E-03	1.89E-03	3.47E+02
Ba-140	1.21E+03	1.06E+00	7.05E+01	0.00E+00	3.44E-01	6.31E-01	6.12E+02
Ba-141	2.91E+00	1.63E-03	9.46E-02	0.00E+00	1.41E-03	9.56E-03	1.66E+00
Ba-142	1.27E+00	9.14E-04	7.09E-02	0.00E+00	7.40E-04	5.38E-04	1.66E-02
La-140	1.47E-01	5.13E-02	1.73E-02	0.00E+00	0.00E+00	0.00E+00	1.43E+03
La-142	7.62E-03	2.43E-03	7.60E-04	0.00E+00	0.00E+00	0.00E+00	4.81E+02
Ce-141	5.77E-01	2.88E-01	4.27E-02	0.00E+00	1.26E-01	0.00E+00	3.59E+02
Ce-143	1.02E-01	5.51E+01	7.98E-03	0.00E+00	2.31E-02	0.00E+00	8.07E+02
Ce-144	3.02E+01	9.48E+00	1.61E+00	0.00E+00	5.25E+00	0.00E+00	2.47E+03
Pr-143	5.71E-01	1.72E-01	2.83E-02	0.00E+00	9.29E-02	0.00E+00	6.16E+02
Pr-144	1.88E-03	5.80E-04	9.43E-05	0.00E+00	3.07E-04	0.00E+00	1.25E+00
Nd-147	4.06E-01	3.28E-01	2.54E-02	0.00E+00	1.80E-01	0.00E+00	5.20E+02
W-187	6.24E+00	3.69E+00	1.66E+00	0.00E+00	0.00E+00	0.00E+00	5.19E+02
Np-239	7.63E-02	5.48E-03	3.85E-03	0.00E+00	1.58E-02	0.00E+00	4.06E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 8c
Site Specific Potable Water Dose Factors for Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.66E+00	1.66E+00	1.66E+00	1.66E+00	1.66E+00	1.66E+00
Na-24	9.50E+01	9.50E+01	9.50E+01	9.50E+01	9.50E+01	9.50E+01	9.50E+01
Cr-51	0.00E+00	0.00E+00	1.33E-01	8.65E-02	1.89E-02	1.68E-01	3.87E+00
Mn-54	0.00E+00	1.87E+02	4.24E+01	0.00E+00	4.15E+01	0.00E+00	6.88E+01
Mn-56	0.00E+00	7.69E+00	1.33E+00	0.00E+00	6.61E+00	0.00E+00	6.99E+02
Fe-55	1.31E+02	8.45E+01	2.26E+01	0.00E+00	0.00E+00	4.13E+01	1.07E+01
Fe-59	2.90E+02	5.06E+02	1.99E+02	0.00E+00	0.00E+00	1.50E+02	2.42E+02
Co-58	0.00E+00	3.39E+01	8.45E+01	0.00E+00	0.00E+00	0.00E+00	8.44E+01
Co-60	0.00E+00	1.02E+02	2.40E+02	0.00E+00	0.00E+00	0.00E+00	2.42E+02
Ni-63	5.96E+03	3.69E+02	2.07E+02	0.00E+00	0.00E+00	0.00E+00	1.83E+01
Ni-65	4.42E+01	5.00E+00	2.28E+00	0.00E+00	0.00E+00	0.00E+00	3.81E+02
Cu-64	0.00E+00	5.73E+00	2.65E+00	0.00E+00	9.69E+00	0.00E+00	1.18E+02
Zn-65	1.73E+02	5.93E+02	2.74E+02	0.00E+00	2.88E+02	0.00E+00	5.01E+02
Zn-69	8.77E-01	1.58E+00	1.18E-01	0.00E+00	6.56E-01	0.00E+00	1.29E+02
Br-83	0.00E+00	0.00E+00	3.41E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.59E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.82E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.60E+03	7.90E+02	0.00E+00	0.00E+00	0.00E+00	4.09E+01
Rb-88	0.00E+00	4.68E+00	2.57E+00	0.00E+00	0.00E+00	0.00E+00	4.56E+00
Rb-89	0.00E+00	2.69E+00	1.85E+00	0.00E+00	0.00E+00	0.00E+00	9.16E-01
Sr-89	2.36E+04	0.00E+00	6.77E+02	0.00E+00	0.00E+00	0.00E+00	4.85E+02
Sr-90	2.66E+05	0.00E+00	5.40E+03	0.00E+00	0.00E+00	0.00E+00	2.17E+03
Sr-91	4.70E+02	0.00E+00	1.70E+01	0.00E+00	0.00E+00	0.00E+00	5.57E+02
Sr-92	1.81E+02	0.00E+00	6.71E+00	0.00E+00	0.00E+00	0.00E+00	1.95E+03
Y-90	8.17E-01	0.00E+00	2.19E-02	0.00E+00	0.00E+00	0.00E+00	1.13E+03
Y-91M	7.62E-03	0.00E+00	2.60E-04	0.00E+00	0.00E+00	0.00E+00	2.54E+01
Y-91	1.06E+01	0.00E+00	2.83E-01	0.00E+00	0.00E+00	0.00E+00	7.62E+02
Y-92	7.19E-02	0.00E+00	2.02E-03	0.00E+00	0.00E+00	0.00E+00	1.37E+03
Y-93	2.29E-01	0.00E+00	6.23E-03	0.00E+00	0.00E+00	0.00E+00	1.81E+03
Zr-95	1.94E+00	4.72E-01	3.35E-01	0.00E+00	5.09E-01	0.00E+00	2.35E+02
Zr-97	1.39E-01	2.39E-02	1.09E-02	0.00E+00	2.41E-02	0.00E+00	1.52E+03
Nb-95	3.95E-01	1.63E-01	9.41E-02	0.00E+00	1.17E-01	0.00E+00	1.37E+02
Mo-99	0.00E+00	3.20E+02	6.24E+01	0.00E+00	4.78E+02	0.00E+00	1.05E+02
Tc- 99M	1.81E-02	3.72E-02	4.80E-01	0.00E+00	4.01E-01	1.95E-02	1.08E+01
Tc-101	2.13E-02	2.69E-02	2.66E-01	0.00E+00	3.20E-01	1.47E-02	4.57E+00
Ru-103	1.39E+01	0.00E+00	4.66E+00	0.00E+00	2.90E+01	0.00E+00	1.69E+02
Ru-105	1.28E+00	0.00E+00	4.31E-01	0.00E+00	9.41E+00	0.00E+00	5.09E+02
Ru-106	2.27E+02	0.00E+00	2.83E+01	0.00E+00	2.68E+02	0.00E+00	1.72E+03
Ag-110M	9.37E+00	6.84E+00	4.52E+00	0.00E+00	9.78E+00	0.00E+00	3.55E+02
Te-125M	2.19E+02	7.33E+01	2.96E+01	7.37E+01	0.00E+00	0.00E+00	1.04E+02

Table 8c (continued)
Site Specific Potable Water Dose Factors for Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	5.50E+02	1.82E+02	6.66E+01	1.59E+02	1.35E+03	0.00E+00	2.22E+02
Te-127	9.41E+00	3.15E+00	2.02E+00	7.66E+00	2.29E+01	0.00E+00	1.98E+02
Te-129M	9.41E+02	3.23E+02	1.45E+02	3.61E+02	2.35E+03	0.00E+00	5.61E+02
Te-129	2.67E+00	9.21E-01	6.24E-01	2.24E+00	6.65E+00	0.00E+00	2.13E+02
Te-131M	1.43E+02	5.76E+01	4.75E+01	1.17E+02	3.96E+02	0.00E+00	9.69E+02
Te-131	1.66E+00	6.11E-01	4.65E-01	1.48E+00	4.23E+00	0.00E+00	6.69E+01
Te-132	1.96E+02	9.69E+01	9.04E+01	1.43E+02	6.06E+02	0.00E+00	3.58E+02
I-130	5.64E+01	1.24E+02	4.98E+01	1.39E+04	1.36E+02	0.00E+00	2.66E+01
I-131	3.38E+02	3.98E+02	1.75E+02	1.31E+05	4.65E+02	0.00E+00	1.42E+01
I-132	1.56E+01	3.17E+01	1.13E+01	1.49E+03	3.54E+01	0.00E+00	2.57E+01
I-133	1.18E+02	1.71E+02	5.01E+01	3.11E+04	2.01E+02	0.00E+00	2.90E+01
I-134	8.17E+00	1.67E+01	5.95E+00	3.90E+02	1.87E+01	0.00E+00	1.73E+01
I-135	3.42E+01	6.81E+01	2.48E+01	6.10E+03	7.59E+01	0.00E+00	2.46E+01
Cs-134	3.55E+03	6.61E+03	6.68E+02	0.00E+00	1.70E+03	6.98E+02	1.80E+01
Cs-136	4.32E+02	1.27E+03	4.74E+02	0.00E+00	5.06E+02	1.03E+02	1.93E+01
Cs-137	4.91E+03	5.75E+03	4.07E+02	0.00E+00	1.54E+03	6.24E+02	1.80E+01
Cs-138	4.52E+00	7.35E+00	3.56E+00	0.00E+00	3.67E+00	5.73E-01	1.18E+01
Ba-139	8.29E+00	5.49E-03	2.40E-01	0.00E+00	3.30E-03	3.33E-03	5.25E+02
Ba-140	1.61E+03	1.61E+00	8.29E+01	0.00E+00	3.82E-01	9.88E-01	3.95E+02
Ba-141	4.00E+00	2.74E-03	1.26E-01	0.00E+00	1.65E-03	1.66E-03	4.88E+01
Ba-142	1.73E+00	1.44E-03	8.52E-02	0.00E+00	8.29E-04	8.71E-04	7.14E+00
La-140	1.98E-01	7.82E-02	2.01E-02	0.00E+00	0.00E+00	0.00E+00	9.19E+02
La-142	1.03E-02	3.80E-03	9.09E-04	0.00E+00	0.00E+00	0.00E+00	6.45E+02
Ce-141	7.40E-01	4.51E-01	5.31E-02	0.00E+00	1.39E-01	0.00E+00	2.33E+02
Ce-143	1.39E-01	9.24E+01	1.05E-02	0.00E+00	2.69E-02	0.00E+00	5.39E+02
Ce-144	2.80E+01	1.15E+01	1.57E+00	0.00E+00	4.64E+00	0.00E+00	1.61E+03
Pr-143	7.65E-01	2.86E-01	3.79E-02	0.00E+00	1.06E-01	0.00E+00	4.03E+02
Pr-144	2.58E-03	9.97E-04	1.30E-04	0.00E+00	3.61E-04	0.00E+00	4.64E+01
Nd-147	5.20E-01	5.34E-01	3.27E-02	0.00E+00	2.06E-01	0.00E+00	3.39E+02
W-187	8.49E+00	5.91E+00	2.04E+00	0.00E+00	0.00E+00	0.00E+00	3.47E+02
Np-239	1.04E-01	9.34E-03	5.28E-03	0.00E+00	1.86E-02	0.00E+00	2.70E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 9
Site Specific Fish Ingestion Dose Factors for Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.29E-01	1.29E-01	1.29E-01	1.29E-01	1.29E-01	1.29E-01
Na-24	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02
Cr-51	0.00E+00	0.00E+00	1.27E+00	7.61E-01	2.81E-01	1.69E+00	3.20E+02
Mn-54	0.00E+00	4.38E+03	8.35E+02	0.00E+00	1.30E+03	0.00E+00	1.34E+04
Mn-56	0.00E+00	1.10E+02	1.95E+01	0.00E+00	1.40E+02	0.00E+00	3.51E+03
Fe-55	6.58E+02	4.55E+02	1.06E+02	0.00E+00	0.00E+00	2.54E+02	2.61E+02
Fe-59	1.04E+03	2.44E+03	9.36E+02	0.00E+00	0.00E+00	6.82E+02	8.14E+03
Co-58	0.00E+00	8.92E+01	2.00E+02	0.00E+00	0.00E+00	0.00E+00	1.81E+03
Co-60	0.00E+00	2.56E+02	5.65E+02	0.00E+00	0.00E+00	0.00E+00	4.81E+03
Ni-63	3.11E+04	2.16E+03	1.04E+03	0.00E+00	0.00E+00	0.00E+00	4.50E+02
Ni-65	1.26E+02	1.64E+01	7.49E+00	0.00E+00	0.00E+00	0.00E+00	4.17E+02
Cu-64	0.00E+00	9.97E+00	4.68E+00	0.00E+00	2.51E+01	0.00E+00	8.50E+02
Zn-65	2.32E+04	7.37E+04	3.33E+04	0.00E+00	4.93E+04	0.00E+00	4.64E+04
Zn-69	4.93E+01	9.43E+01	6.56E+00	0.00E+00	6.13E+01	0.00E+00	1.42E+01
Br-83	0.00E+00	0.00E+00	4.04E+01	0.00E+00	0.00E+00	0.00E+00	5.82E+01
Br-84	0.00E+00	0.00E+00	5.24E+01	0.00E+00	0.00E+00	0.00E+00	4.11E-04
Br-85	0.00E+00	0.00E+00	2.15E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.01E+05	4.71E+04	0.00E+00	0.00E+00	0.00E+00	1.99E+04
Rb-88	0.00E+00	2.90E+02	1.54E+02	0.00E+00	0.00E+00	0.00E+00	4.00E-09
Rb-89	0.00E+00	1.92E+02	1.35E+02	0.00E+00	0.00E+00	0.00E+00	1.12E-11
Sr-89	2.21E+04	0.00E+00	6.35E+02	0.00E+00	0.00E+00	0.00E+00	3.55E+03
Sr-90	6.26E+05	0.00E+00	1.26E+04	0.00E+00	0.00E+00	0.00E+00	1.57E+04
Sr-91	4.07E+02	0.00E+00	1.64E+01	0.00E+00	0.00E+00	0.00E+00	1.94E+03
Sr-92	1.54E+02	0.00E+00	6.68E+00	0.00E+00	0.00E+00	0.00E+00	3.06E+03
Y-90	5.76E-01	0.00E+00	1.54E-02	0.00E+00	0.00E+00	0.00E+00	6.10E+03
Y-91M	5.44E-03	0.00E+00	2.11E-04	0.00E+00	0.00E+00	0.00E+00	1.60E-02
Y-91	8.44E+00	0.00E+00	2.26E-01	0.00E+00	0.00E+00	0.00E+00	4.64E+03
Y-92	5.06E-02	0.00E+00	1.48E-03	0.00E+00	0.00E+00	0.00E+00	8.86E+02
Y-93	1.60E-01	0.00E+00	4.43E-03	0.00E+00	0.00E+00	0.00E+00	5.09E+03
Zr-95	2.40E-01	7.70E-02	5.21E-02	0.00E+00	1.21E-01	0.00E+00	2.44E+02
Zr-97	1.33E-02	2.68E-03	1.22E-03	0.00E+00	4.04E-03	0.00E+00	8.30E+02
Nb-95	4.47E+02	2.48E+02	1.34E+02	0.00E+00	2.46E+02	0.00E+00	1.51E+06
Mo-99	0.00E+00	1.03E+02	1.96E+01	0.00E+00	2.34E+02	0.00E+00	2.39E+02
Tc- 99M	8.87E-03	2.51E-02	3.19E-01	0.00E+00	3.81E-01	1.23E-02	1.48E+01
Tc-101	9.12E-03	1.31E-02	1.29E-01	0.00E+00	2.37E-01	6.72E-03	3.95E-14
Ru-103	4.43E+00	0.00E+00	1.91E+00	0.00E+00	1.69E+01	0.00E+00	5.17E+02
Ru-105	3.69E-01	0.00E+00	1.46E-01	0.00E+00	4.76E+00	0.00E+00	2.26E+02
Ru-106	6.58E+01	0.00E+00	8.33E+00	0.00E+00	1.27E+02	0.00E+00	4.26E+03
Ag-110M	8.81E-01	8.15E-01	4.84E-01	0.00E+00	1.60E+00	0.00E+00	3.33E+02
Te-125M	2.57E+03	9.30E+02	3.44E+02	7.72E+02	1.04E+04	0.00E+00	1.02E+04

Table 9 (continued)
Site Specific Fish Ingestion Dose Factors for Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	6.48E+03	2.32E+03	7.90E+02	1.66E+03	2.63E+04	0.00E+00	2.17E+04
Te-127	1.05E+02	3.78E+01	2.28E+01	7.80E+01	4.29E+02	0.00E+00	8.31E+03
Te-129M	1.10E+04	4.11E+03	1.74E+03	3.78E+03	4.60E+04	0.00E+00	5.54E+04
Te-129	3.01E+01	1.13E+01	7.33E+00	2.31E+01	1.26E+02	0.00E+00	2.27E+01
Te-131M	1.66E+03	8.10E+02	6.75E+02	1.28E+03	8.21E+03	0.00E+00	8.04E+04
Te-131	1.89E+01	7.88E+00	5.96E+00	1.55E+01	8.26E+01	0.00E+00	2.67E+00
Te-132	2.41E+03	1.56E+03	1.47E+03	1.72E+03	1.50E+04	0.00E+00	7.38E+04
I-130	2.71E+01	8.01E+01	3.16E+01	6.79E+03	1.25E+02	0.00E+00	6.89E+01
I-131	1.49E+02	2.14E+02	1.22E+02	7.00E+04	3.66E+02	0.00E+00	5.64E+01
I-132	7.29E+00	1.95E+01	6.82E+00	6.82E+02	3.11E+01	0.00E+00	3.66E+00
I-133	5.10E+01	8.87E+01	2.70E+01	1.30E+04	1.55E+02	0.00E+00	7.97E+01
I-134	3.81E+00	1.03E+01	3.70E+00	1.79E+02	1.64E+01	0.00E+00	9.01E-03
I-135	1.59E+01	4.17E+01	1.54E+01	2.75E+03	6.68E+01	0.00E+00	4.70E+01
Cs-134	2.98E+05	7.09E+05	5.79E+05	0.00E+00	2.29E+05	7.61E+04	1.24E+04
Cs-136	3.12E+04	1.23E+05	8.86E+04	0.00E+00	6.85E+04	9.38E+03	1.40E+04
Cs-137	3.82E+05	5.22E+05	3.42E+05	0.00E+00	1.77E+05	5.89E+04	1.01E+04
Cs-138	2.64E+02	5.22E+02	2.59E+02	0.00E+00	3.84E+02	3.79E+01	2.23E-03
Ba-139	9.29E-01	6.62E-04	2.72E-02	0.00E+00	6.19E-04	3.75E-04	1.65E+00
Ba-140	1.94E+02	2.44E-01	1.27E+01	0.00E+00	8.30E-02	1.40E-01	4.00E+02
Ba-141	4.51E-01	3.41E-04	1.52E-02	0.00E+00	3.17E-04	1.93E-04	2.13E-10
Ba-142	2.04E-01	2.10E-04	1.28E-02	0.00E+00	1.77E-04	1.19E-04	2.87E-19
La-140	1.50E-01	7.54E-02	1.99E-02	0.00E+00	0.00E+00	0.00E+00	5.54E+03
La-142	7.66E-03	3.48E-03	8.68E-04	0.00E+00	0.00E+00	0.00E+00	2.54E+01
Ce-141	2.24E-02	1.52E-02	1.72E-03	0.00E+00	7.04E-03	0.00E+00	5.79E+01
Ce-143	3.95E-03	2.92E+00	3.23E-04	0.00E+00	1.29E-03	0.00E+00	1.09E+02
Ce-144	1.17E+00	4.88E-01	6.27E-02	0.00E+00	2.90E-01	0.00E+00	3.95E+02
Pr-143	5.51E-01	2.21E-01	2.73E-02	0.00E+00	1.27E-01	0.00E+00	2.41E+03
Pr-144	1.80E-03	7.48E-04	9.16E-05	0.00E+00	4.22E-04	0.00E+00	2.59E-10
Nd-147	3.76E-01	4.35E-01	2.60E-02	0.00E+00	2.54E-01	0.00E+00	2.09E+03
W-187	2.96E+02	2.47E+02	8.65E+01	0.00E+00	0.00E+00	0.00E+00	8.10E+04
Np-239	2.85E-02	2.80E-03	1.54E-03	0.00E+00	8.74E-03	0.00E+00	5.75E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 9a
Site Specific Fish Ingestion Dose Factors for Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	9.92E-02	9.92E-02	9.92E-02	9.92E-02	9.92E-02	9.92E-02
Na-24	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02
Cr-51	0.00E+00	0.00E+00	1.31E+00	7.30E-01	2.88E-01	1.88E+00	2.21E+02
Mn-54	0.00E+00	4.30E+03	8.54E+02	0.00E+00	1.28E+03	0.00E+00	8.83E+03
Mn-56	0.00E+00	1.15E+02	2.05E+01	0.00E+00	1.46E+02	0.00E+00	7.59E+03
Fe-55	6.89E+02	4.89E+02	1.14E+02	0.00E+00	0.00E+00	3.10E+02	2.12E+02
Fe-59	1.07E+03	2.50E+03	9.65E+02	0.00E+00	0.00E+00	7.88E+02	5.91E+03
Co-58	0.00E+00	8.86E+01	2.04E+02	0.00E+00	0.00E+00	0.00E+00	1.22E+03
Co-60	0.00E+00	2.56E+02	5.77E+02	0.00E+00	0.00E+00	0.00E+00	3.34E+03
Ni-63	3.23E+04	2.28E+03	1.09E+03	0.00E+00	0.00E+00	0.00E+00	3.63E+02
Ni-65	1.37E+02	1.75E+01	7.95E+00	0.00E+00	0.00E+00	0.00E+00	9.47E+02
Cu-64	0.00E+00	1.05E+01	4.93E+00	0.00E+00	2.65E+01	0.00E+00	8.14E+02
Zn-65	2.10E+04	7.30E+04	3.40E+04	0.00E+00	4.67E+04	0.00E+00	3.09E+04
Zn-69	5.36E+01	1.02E+02	7.15E+00	0.00E+00	6.68E+01	0.00E+00	1.88E+02
Br-83	0.00E+00	0.00E+00	4.40E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.34E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.09E+05	5.11E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
Rb-88	0.00E+00	3.11E+02	1.66E+02	0.00E+00	0.00E+00	0.00E+00	2.66E-05
Rb-89	0.00E+00	2.01E+02	1.42E+02	0.00E+00	0.00E+00	0.00E+00	3.08E-07
Sr-89	2.41E+04	0.00E+00	6.89E+02	0.00E+00	0.00E+00	0.00E+00	2.87E+03
Sr-90	5.58E+05	0.00E+00	1.12E+04	0.00E+00	0.00E+00	0.00E+00	1.27E+04
Sr-91	4.42E+02	0.00E+00	1.76E+01	0.00E+00	0.00E+00	0.00E+00	2.00E+03
Sr-92	1.67E+02	0.00E+00	7.11E+00	0.00E+00	0.00E+00	0.00E+00	4.25E+03
Y-90	6.25E-01	0.00E+00	1.68E-02	0.00E+00	0.00E+00	0.00E+00	5.15E+03
Y-91M	5.88E-03	0.00E+00	2.25E-04	0.00E+00	0.00E+00	0.00E+00	2.78E-01
Y-91	9.17E+00	0.00E+00	2.46E-01	0.00E+00	0.00E+00	0.00E+00	3.76E+03
Y-92	5.52E-02	0.00E+00	1.60E-03	0.00E+00	0.00E+00	0.00E+00	1.51E+03
Y-93	1.75E-01	0.00E+00	4.79E-03	0.00E+00	0.00E+00	0.00E+00	5.34E+03
Zr-95	2.48E-01	7.82E-02	5.38E-02	0.00E+00	1.15E-01	0.00E+00	1.81E+02
Zr-97	1.43E-02	2.82E-03	1.30E-03	0.00E+00	4.28E-03	0.00E+00	7.64E+02
Nb-95	4.50E+02	2.50E+02	1.37E+02	0.00E+00	2.42E+02	0.00E+00	1.07E+06
Mo-99	0.00E+00	1.10E+02	2.10E+01	0.00E+00	2.52E+02	0.00E+00	1.97E+02
Tc- 99M	9.08E-03	2.53E-02	3.28E-01	0.00E+00	3.78E-01	1.41E-02	1.66E+01
Tc-101	9.85E-03	1.40E-02	1.38E-01	0.00E+00	2.53E-01	8.54E-03	2.39E-09
Ru-103	4.65E+00	0.00E+00	1.99E+00	0.00E+00	1.64E+01	0.00E+00	3.89E+02
Ru-105	3.98E-01	0.00E+00	1.54E-01	0.00E+00	5.02E+00	0.00E+00	3.21E+02
Ru-106	7.15E+01	0.00E+00	9.01E+00	0.00E+00	1.38E+02	0.00E+00	3.43E+03
Ag-110M	8.60E-01	8.14E-01	4.95E-01	0.00E+00	1.55E+00	0.00E+00	2.29E+02
Te-125M	2.79E+03	1.01E+03	3.74E+02	7.81E+02	0.00E+00	0.00E+00	8.24E+03

Table 9a (continued)
Site Specific Fish Ingestion Dose Factors for Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	7.06E+03	2.50E+03	8.39E+02	1.68E+03	2.86E+04	0.00E+00	1.76E+04
Te-127	1.15E+02	4.09E+01	2.48E+01	7.95E+01	4.67E+02	0.00E+00	8.90E+03
Te-129M	1.19E+04	4.41E+03	1.88E+03	3.84E+03	4.98E+04	0.00E+00	4.47E+04
Te-129	3.27E+01	1.22E+01	7.95E+00	2.33E+01	1.37E+02	0.00E+00	1.79E+02
Te-131M	1.78E+03	8.54E+02	7.12E+02	1.28E+03	8.90E+03	0.00E+00	6.85E+04
Te-131	2.04E+01	8.39E+00	6.36E+00	1.57E+01	8.90E+01	0.00E+00	1.67E+00
Te-132	2.55E+03	1.61E+03	1.52E+03	1.70E+03	1.55E+04	0.00E+00	5.11E+04
I-130	2.82E+01	8.15E+01	3.26E+01	6.65E+03	1.26E+02	0.00E+00	6.27E+01
I-131	1.60E+02	2.24E+02	1.20E+02	6.54E+04	3.86E+02	0.00E+00	4.43E+01
I-132	7.63E+00	2.00E+01	7.17E+00	6.73E+02	3.15E+01	0.00E+00	8.70E+00
I-133	5.50E+01	9.33E+01	2.85E+01	1.30E+04	1.64E+02	0.00E+00	7.06E+01
I-134	3.99E+00	1.06E+01	3.80E+00	1.76E+02	1.67E+01	0.00E+00	1.40E-01
I-135	1.67E+01	4.30E+01	1.59E+01	2.76E+03	6.79E+01	0.00E+00	4.76E+01
Cs-134	3.05E+05	7.19E+05	3.33E+05	0.00E+00	2.28E+05	8.72E+04	8.94E+03
Cs-136	3.13E+04	1.23E+05	8.28E+04	0.00E+00	6.71E+04	1.06E+04	9.92E+03
Cs-137	4.09E+05	5.44E+05	1.89E+05	0.00E+00	1.85E+05	7.19E+04	7.73E+03
Cs-138	2.83E+02	5.44E+02	2.72E+02	0.00E+00	4.01E+02	4.67E+01	2.47E-01
Ba-139	1.01E+00	7.14E-04	2.95E-02	0.00E+00	6.73E-04	4.92E-04	9.05E+00
Ba-140	2.07E+02	2.54E-01	1.34E+01	0.00E+00	8.61E-02	1.71E-01	3.20E+02
Ba-141	4.90E-01	3.66E-04	1.63E-02	0.00E+00	3.39E-04	2.50E-04	1.04E-06
Ba-142	2.18E-01	2.18E-04	1.34E-02	0.00E+00	1.85E-04	1.45E-04	6.70E-13
La-140	1.59E-01	7.80E-02	2.07E-02	0.00E+00	0.00E+00	0.00E+00	4.48E+03
La-142	8.16E-03	3.63E-03	9.03E-04	0.00E+00	0.00E+00	0.00E+00	1.10E+02
Ce-141	2.43E-02	1.62E-02	1.86E-03	0.00E+00	7.62E-03	0.00E+00	4.63E+01
Ce-143	4.29E-03	3.12E+00	3.48E-04	0.00E+00	1.40E-03	0.00E+00	9.38E+01
Ce-144	1.27E+00	5.25E-01	6.82E-02	0.00E+00	3.14E-01	0.00E+00	3.19E+02
Pr-143	5.97E-01	2.38E-01	2.97E-02	0.00E+00	1.39E-01	0.00E+00	1.97E+03
Pr-144	1.96E-03	8.03E-04	9.94E-05	0.00E+00	4.61E-04	0.00E+00	2.16E-06
Nd-147	4.28E-01	4.65E-01	2.79E-02	0.00E+00	2.73E-01	0.00E+00	1.68E+03
W-187	3.20E+02	2.60E+02	9.13E+01	0.00E+00	0.00E+00	0.00E+00	7.05E+04
Np-239	3.21E-02	3.03E-03	1.68E-03	0.00E+00	9.50E-03	0.00E+00	4.87E+02

Notes:

1) Units are mrem/hr per µCi/ml.

Table 9b
Site Specific Fish Ingestion Dose Factors for Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	8.21E-02	8.21E-02	8.21E-02	8.21E-02	8.21E-02	8.21E-02
Na-24	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02
Cr-51	0.00E+00	0.00E+00	1.40E+00	7.77E-01	2.12E-01	1.42E+00	7.43E+01
Mn-54	0.00E+00	3.37E+03	8.97E+02	0.00E+00	9.44E+02	0.00E+00	2.83E+03
Mn-56	0.00E+00	1.05E+02	2.37E+01	0.00E+00	1.27E+02	0.00E+00	1.52E+04
Fe-55	9.05E+02	4.80E+02	1.49E+02	0.00E+00	0.00E+00	2.71E+02	8.89E+01
Fe-59	1.30E+03	2.10E+03	1.05E+03	0.00E+00	0.00E+00	6.09E+02	2.19E+03
Co-58	0.00E+00	7.08E+01	2.17E+02	0.00E+00	0.00E+00	0.00E+00	4.13E+02
Co-60	0.00E+00	2.08E+02	6.14E+02	0.00E+00	0.00E+00	0.00E+00	1.15E+03
Ni-63	4.23E+04	2.27E+03	1.44E+03	0.00E+00	0.00E+00	0.00E+00	1.53E+02
Ni-65	1.75E+02	1.64E+01	9.60E+00	0.00E+00	0.00E+00	0.00E+00	2.01E+03
Cu-64	0.00E+00	9.64E+00	5.82E+00	0.00E+00	2.33E+01	0.00E+00	4.52E+02
Zn-65	2.16E+04	5.74E+04	3.57E+04	0.00E+00	3.62E+04	0.00E+00	1.01E+04
Zn-69	6.89E+01	9.96E+01	9.20E+00	0.00E+00	6.04E+01	0.00E+00	6.28E+03
Br-83	0.00E+00	0.00E+00	5.65E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	6.54E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	3.01E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.05E+05	6.48E+04	0.00E+00	0.00E+00	0.00E+00	6.78E+03
Rb-88	0.00E+00	2.99E+02	2.08E+02	0.00E+00	0.00E+00	0.00E+00	1.47E+01
Rb-89	0.00E+00	1.84E+02	1.64E+02	0.00E+00	0.00E+00	0.00E+00	1.60E+00
Sr-89	3.11E+04	0.00E+00	8.90E+02	0.00E+00	0.00E+00	0.00E+00	1.21E+03
Sr-90	6.04E+05	0.00E+00	1.22E+04	0.00E+00	0.00E+00	0.00E+00	5.40E+03
Sr-91	5.66E+02	0.00E+00	2.14E+01	0.00E+00	0.00E+00	0.00E+00	1.25E+03
Sr-92	2.13E+02	0.00E+00	8.54E+00	0.00E+00	0.00E+00	0.00E+00	4.04E+03
Y-90	8.08E-01	0.00E+00	2.16E-02	0.00E+00	0.00E+00	0.00E+00	2.30E+03
Y-91M	7.51E-03	0.00E+00	2.73E-04	0.00E+00	0.00E+00	0.00E+00	1.47E+01
Y-91	1.18E+01	0.00E+00	3.17E-01	0.00E+00	0.00E+00	0.00E+00	1.58E+03
Y-92	7.08E-02	0.00E+00	2.03E-03	0.00E+00	0.00E+00	0.00E+00	2.05E+03
Y-93	2.24E-01	0.00E+00	6.16E-03	0.00E+00	0.00E+00	0.00E+00	3.34E+03
Zr-95	3.01E-01	6.62E-02	5.89E-02	0.00E+00	9.47E-02	0.00E+00	6.90E+01
Zr-97	1.81E-02	2.62E-03	1.55E-03	0.00E+00	3.76E-03	0.00E+00	3.97E+02
Nb-95	5.31E+02	2.07E+02	1.48E+02	0.00E+00	1.94E+02	0.00E+00	3.82E+05
Mo-99	0.00E+00	1.05E+02	2.59E+01	0.00E+00	2.23E+02	0.00E+00	8.65E+01
Tc- 99M	1.09E-02	2.14E-02	3.54E-01	0.00E+00	3.10E-01	1.08E-02	1.22E+01
Tc-101	1.26E-02	1.32E-02	1.68E-01	0.00E+00	2.25E-01	6.99E-03	4.20E-02
Ru-103	5.75E+00	0.00E+00	2.21E+00	0.00E+00	1.45E+01	0.00E+00	1.49E+02
Ru-105	5.07E-01	0.00E+00	1.84E-01	0.00E+00	4.46E+00	0.00E+00	3.31E+02
Ru-106	9.20E+01	0.00E+00	1.15E+01	0.00E+00	1.24E+02	0.00E+00	1.43E+03
Ag-110M	9.75E-01	6.59E-01	5.26E-01	0.00E+00	1.23E+00	0.00E+00	7.83E+01
Te-125M	3.59E+03	9.72E+02	4.78E+02	1.01E+03	0.00E+00	0.00E+00	3.46E+03

Table 9b (continued)
Site Specific Fish Ingestion Dose Factors for Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	9.09E+03	2.45E+03	1.08E+03	2.17E+03	2.59E+04	0.00E+00	7.36E+03
Te-127	1.48E+02	4.00E+01	3.18E+01	1.03E+02	4.22E+02	0.00E+00	5.79E+03
Te-129M	1.53E+04	4.28E+03	2.38E+03	4.94E+03	4.50E+04	0.00E+00	1.87E+04
Te-129	4.22E+01	1.18E+01	1.00E+01	3.01E+01	1.23E+02	0.00E+00	2.62E+03
Te-131M	2.27E+03	7.83E+02	8.34E+02	1.61E+03	7.58E+03	0.00E+00	3.18E+04
Te-131	2.61E+01	7.96E+00	7.77E+00	2.00E+01	7.90E+01	0.00E+00	1.37E+02
Te-132	3.18E+03	1.41E+03	1.70E+03	2.05E+03	1.31E+04	0.00E+00	1.42E+04
I-130	3.45E+01	6.96E+01	3.59E+01	7.67E+03	1.04E+02	0.00E+00	3.26E+01
I-131	2.03E+02	2.04E+02	1.16E+02	6.75E+04	3.35E+02	0.00E+00	1.82E+01
I-132	9.44E+00	1.73E+01	7.98E+00	8.05E+02	2.65E+01	0.00E+00	2.04E+01
I-133	6.99E+01	8.64E+01	3.27E+01	1.60E+04	1.44E+02	0.00E+00	3.48E+01
I-134	4.94E+00	9.18E+00	4.22E+00	2.11E+02	1.40E+01	0.00E+00	6.09E+00
I-135	2.06E+01	3.72E+01	1.76E+01	3.29E+03	5.70E+01	0.00E+00	2.83E+01
Cs-134	3.68E+05	6.04E+05	1.27E+05	0.00E+00	1.87E+05	6.72E+04	3.26E+03
Cs-136	3.70E+04	1.02E+05	6.58E+04	0.00E+00	5.41E+04	8.07E+03	3.57E+03
Cs-137	5.14E+05	4.92E+05	7.27E+04	0.00E+00	1.60E+05	5.77E+04	3.08E+03
Cs-138	3.59E+02	4.99E+02	3.16E+02	0.00E+00	3.51E+02	3.78E+01	2.30E+02
Ba-139	1.30E+00	6.95E-04	3.78E-02	0.00E+00	6.07E-04	4.09E-04	7.52E+01
Ba-140	2.61E+02	2.29E-01	1.53E+01	0.00E+00	7.46E-02	1.37E-01	1.32E+02
Ba-141	6.29E-01	3.52E-04	2.05E-02	0.00E+00	3.05E-04	2.07E-03	3.59E-01
Ba-142	2.75E-01	1.98E-04	1.54E-02	0.00E+00	1.60E-04	1.16E-04	3.59E-03
La-140	1.99E-01	6.94E-02	2.34E-02	0.00E+00	0.00E+00	0.00E+00	1.94E+03
La-142	1.03E-02	3.28E-03	1.03E-03	0.00E+00	0.00E+00	0.00E+00	6.51E+02
Ce-141	3.12E-02	1.56E-02	2.31E-03	0.00E+00	6.83E-03	0.00E+00	1.94E+01
Ce-143	5.50E-03	2.98E+00	4.32E-04	0.00E+00	1.25E-03	0.00E+00	4.37E+01
Ce-144	1.64E+00	5.13E-01	8.73E-02	0.00E+00	2.84E-01	0.00E+00	1.34E+02
Pr-143	7.73E-01	2.32E-01	3.83E-02	0.00E+00	1.26E-01	0.00E+00	8.34E+02
Pr-144	2.54E-03	7.85E-04	1.28E-04	0.00E+00	4.15E-04	0.00E+00	1.69E+00
Nd-147	5.49E-01	4.44E-01	3.44E-02	0.00E+00	2.44E-01	0.00E+00	7.04E+02
W-187	4.05E+02	2.40E+02	1.08E+02	0.00E+00	0.00E+00	0.00E+00	3.37E+04
Np-239	4.13E-02	2.97E-03	2.08E-03	0.00E+00	8.57E-03	0.00E+00	2.19E+02

Notes:

1) Units are mrem/hr per µCi/ml.

2) The infant age group is assumed to receive no dose through the fish ingestion pathway, therefore no dose factors are supplied.

Table 10
Ground Plane Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.20E+07	1.20E+07	1.20E+07	1.20E+07	1.20E+07	1.20E+07	1.20E+07
Cr-51	4.65E+06	4.65E+06	4.65E+06	4.65E+06	4.65E+06	4.65E+06	4.65E+06
Mn-54	1.38E+09	1.38E+09	1.38E+09	1.38E+09	1.38E+09	1.38E+09	1.38E+09
Mn-56	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05	9.03E+05
Fe-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08
Co-58	3.80E+08	3.80E+08	3.80E+08	3.80E+08	3.80E+08	3.80E+08	3.80E+08
Co-60	2.45E+10	2.45E+10	2.45E+10	2.45E+10	2.45E+10	2.45E+10	2.45E+10
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-65	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05	2.97E+05
Cu-64	6.05E+05	6.05E+05	6.05E+05	6.05E+05	6.05E+05	6.05E+05	6.05E+05
Zn-65	7.46E+08	7.46E+08	7.46E+08	7.46E+08	7.46E+08	7.46E+08	7.46E+08
Zn-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03
Br-84	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05	2.03E+05
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	9.01E+06	9.01E+06	9.01E+06	9.01E+06	9.01E+06	9.01E+06	9.01E+06
Rb-88	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04
Rb-89	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05	1.23E+05
Sr-89	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-91	2.14E+06	2.14E+06	2.14E+06	2.14E+06	2.14E+06	2.14E+06	2.14E+06
Sr-92	7.76E+05	7.76E+05	7.76E+05	7.76E+05	7.76E+05	7.76E+05	7.76E+05
Y-90	4.50E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03	4.50E+03
Y-91M	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05
Y-91	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06
Y-92	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05	1.80E+05
Y-93	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05	1.83E+05
Zr-95	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08
Zr-97	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06	2.96E+06
Nb-95	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08
Mo-99	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06
Tc- 99M	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05	1.84E+05
Tc-101	2.03E+04	2.03E+04	2.03E+04	2.03E+04	2.03E+04	2.03E+04	2.03E+04
Ru-103	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08	1.08E+08
Ru-105	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05	6.36E+05
Ru-106	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08	4.22E+08
Ag-110M	3.45E+09	3.45E+09	3.45E+09	3.45E+09	3.45E+09	3.45E+09	3.45E+09

Table 10 (Continued)
Ground Plane Dose Factors (same for all age groups)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.56E+06	1.56E+06	1.56E+06	1.56E+06	1.56E+06	1.56E+06	1.56E+06
Te-127M	9.16E+04	9.16E+04	9.16E+04	9.16E+04	9.16E+04	9.16E+04	9.16E+04
Te-127	2.99E+03	2.99E+03	2.99E+03	2.99E+03	2.99E+03	2.99E+03	2.99E+03
Te-129M	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07	1.98E+07
Te-129	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04	2.62E+04
Te-131M	8.02E+06	8.02E+06	8.02E+06	8.02E+06	8.02E+06	8.02E+06	8.02E+06
Te-131	2.92E+04	2.92E+04	2.92E+04	2.92E+04	2.92E+04	2.92E+04	2.92E+04
Te-132	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06
I-130	5.50E+06	5.50E+06	5.50E+06	5.50E+06	5.50E+06	5.50E+06	5.50E+06
I-131	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07
I-132	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06	1.25E+06
I-133	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06
I-134	4.46E+05	4.46E+05	4.46E+05	4.46E+05	4.46E+05	4.46E+05	4.46E+05
I-135	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06
Cs-134	6.94E+09	6.94E+09	6.94E+09	6.94E+09	6.94E+09	6.94E+09	6.94E+09
Cs-136	1.50E+08	1.50E+08	1.50E+08	1.50E+08	1.50E+08	1.50E+08	1.50E+08
Cs-137	1.76E+10	1.76E+10	1.76E+10	1.76E+10	1.76E+10	1.76E+10	1.76E+10
Cs-138	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05	3.59E+05
Ba-139	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05
Ba-140	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07
Ba-141	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04	4.17E+04
Ba-142	4.44E+04	4.44E+04	4.44E+04	4.44E+04	4.44E+04	4.44E+04	4.44E+04
La-140	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07
La-142	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05	7.60E+05
Ce-141	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07
Ce-143	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06	2.31E+06
Ce-144	6.96E+07	6.96E+07	6.96E+07	6.96E+07	6.96E+07	6.96E+07	6.96E+07
Pr-143	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-144	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03
Nd-147	8.48E+06	8.48E+06	8.48E+06	8.48E+06	8.48E+06	8.48E+06	8.48E+06
W-187	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06	2.35E+06
Np-239	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06	1.71E+06

Notes:

1) Units are m^2 mrem/yr per µCi/sec.

2) All age groups are assumed to receive the same dose.

Table 11
Adult Inhalation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	7.18E+02	7.18E+02	7.18E+02	7.18E+02	7.18E+02	7.18E+02
Na-24	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04
Cr-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
Mn-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04
Mn-56	0.00E+00	1.24E+00	1.83E-01	0.00E+00	1.30E+00	9.44E+03	2.02E+04
Fe-55	2.46E+04	1.70E+04	3.94E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03
Fe-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05
Co-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05
Co-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05
Ni-63	4.32E+05	3.14E+04	1.45E+04	0.00E+00	0.00E+00	1.78E+05	1.34E+04
Ni-65	1.54E+00	2.10E-01	9.12E-02	0.00E+00	0.00E+00	5.60E+03	1.23E+04
Cu-64	0.00E+00	1.46E+00	6.15E-01	0.00E+00	4.62E+00	6.78E+03	4.90E+04
Zn-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.34E+04
Zn-69	3.38E-02	6.51E-02	4.52E-03	0.00E+00	4.22E-02	9.20E+02	1.63E+01
Br-83	0.00E+00	0.00E+00	2.41E+02	0.00E+00	0.00E+00	0.00E+00	2.32E+02
Br-84	0.00E+00	0.00E+00	3.13E+02	0.00E+00	0.00E+00	0.00E+00	1.64E-03
Br-85	0.00E+00	0.00E+00	1.28E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.35E+05	5.90E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+04
Rb-88	0.00E+00	3.87E+02	1.93E+02	0.00E+00	0.00E+00	0.00E+00	3.34E-09
Rb-89	0.00E+00	2.56E+02	1.70E+02	0.00E+00	0.00E+00	0.00E+00	9.28E-12
Sr-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05
Sr-90	2.87E+07	0.00E+00	5.77E+05	0.00E+00	0.00E+00	9.60E+06	7.22E+05
Sr-91	6.19E+01	0.00E+00	2.50E+00	0.00E+00	0.00E+00	3.65E+04	1.91E+05
Sr-92	6.74E+00	0.00E+00	2.91E-01	0.00E+00	0.00E+00	1.65E+04	4.30E+04
Y-90	2.09E+03	0.00E+00	5.61E+01	0.00E+00	0.00E+00	1.70E+05	5.06E+05
Y-91M	2.61E-01	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.92E+03	1.33E+00
Y-91	4.62E+05	0.00E+00	1.24E+04	0.00E+00	0.00E+00	1.70E+06	3.85E+05
Y-92	1.03E+01	0.00E+00	3.02E-01	0.00E+00	0.00E+00	1.57E+04	7.35E+04
Y-93	9.44E+01	0.00E+00	2.61E+00	0.00E+00	0.00E+00	4.85E+04	4.22E+05
Zr-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05
Zr-97	9.68E+01	1.96E+01	9.04E+00	0.00E+00	2.97E+01	7.87E+04	5.23E+05
Nb-95	1.41E+04	7.82E+03	4.21E+03	0.00E+00	7.74E+03	5.05E+05	1.04E+05
Mo-99	0.00E+00	1.21E+02	2.30E+01	0.00E+00	2.91E+02	9.12E+04	2.48E+05
Tc- 99M	1.03E-03	2.91E-03	3.70E-02	0.00E+00	4.42E-02	7.64E+02	4.16E+03
Tc-101	4.18E-05	6.02E-05	5.90E-04	0.00E+00	1.08E-03	3.99E+02	1.09E-11
Ru-103	1.53E+03	0.00E+00	6.58E+02	0.00E+00	5.83E+03	5.05E+05	1.10E+05
Ru-105	7.90E-01	0.00E+00	3.11E-01	0.00E+00	1.02E+00	1.10E+04	4.82E+04
Ru-106	6.91E+04	0.00E+00	8.72E+03	0.00E+00	1.34E+05	9.36E+06	9.12E+05
Ag-110M	1.08E+04	1.00E+04	5.94E+03	0.00E+00	1.97E+04	4.63E+06	3.02E+05

Table 11 (Continued)
Adult Inhalation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.42E+03	1.58E+03	4.67E+02	1.05E+03	1.24E+04	3.14E+05	7.06E+04
Te-127M	1.26E+04	5.77E+03	1.57E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05
Te-127	1.40E+00	6.42E-01	3.10E-01	1.06E+00	5.10E+00	6.51E+03	5.74E+04
Te-129M	9.76E+03	4.67E+03	1.58E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05
Te-129	4.98E-02	2.39E-02	1.24E-02	3.90E-02	1.87E-01	1.94E+03	1.57E+02
Te-131M	6.99E+01	4.36E+01	2.90E+01	5.50E+01	3.09E+02	1.46E+05	5.56E+05
Te-131	1.11E-02	5.95E-03	3.59E-03	9.36E-03	4.37E-02	1.39E+03	1.84E+01
Te-132	2.60E+02	2.15E+02	1.62E+02	1.90E+02	1.46E+03	2.88E+05	5.10E+05
I-130	4.58E+03	1.34E+04	5.28E+03	1.14E+06	2.09E+04	0.00E+00	7.69E+03
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03
I-132	1.16E+03	3.26E+03	1.16E+03	1.14E+05	5.18E+03	0.00E+00	4.06E+02
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.58E+04	0.00E+00	8.88E+03
I-134	6.44E+02	1.73E+03	6.15E+02	2.98E+04	2.75E+03	0.00E+00	1.01E+00
I-135	2.68E+03	6.98E+03	2.57E+03	4.48E+05	1.11E+04	0.00E+00	5.25E+03
Cs-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04
Cs-136	3.90E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04
Cs-137	4.78E+05	6.21E+05	4.28E+05	0.00E+00	2.22E+05	7.52E+04	8.40E+03
Cs-138	3.31E+02	6.21E+02	3.24E+02	0.00E+00	4.80E+02	4.86E+01	1.86E-03
Ba-139	9.36E-01	6.66E-04	2.74E-02	0.00E+00	6.22E-04	3.76E+03	8.96E+02
Ba-140	3.90E+04	4.90E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
Ba-141	1.00E-01	7.53E-05	3.36E-03	0.00E+00	7.00E-05	1.94E+03	1.16E-07
Ba-142	2.63E-02	2.70E-05	1.66E-03	0.00E+00	2.29E-05	1.19E+03	1.57E-16
La-140	3.44E+02	1.74E+02	4.58E+01	0.00E+00	0.00E+00	1.36E+05	4.58E+05
La-142	6.83E-01	3.10E-01	7.72E-02	0.00E+00	0.00E+00	6.33E+03	2.11E+03
Ce-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.26E+03	3.62E+05	1.20E+05
Ce-143	1.86E+02	1.38E+02	1.53E+01	0.00E+00	6.08E+01	7.98E+04	2.26E+05
Ce-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05
Pr-143	9.36E+03	3.75E+03	4.64E+02	0.00E+00	2.16E+03	2.81E+05	2.00E+05
Pr-144	3.01E-02	1.25E-02	1.53E-03	0.00E+00	7.05E-03	1.02E+03	2.15E-08
Nd-147	5.27E+03	6.10E+03	3.65E+02	0.00E+00	3.56E+03	2.21E+05	1.73E+05
W-187	8.48E+00	7.08E+00	2.48E+00	0.00E+00	0.00E+00	2.90E+04	1.55E+05
Np-239	2.30E+02	2.03E+02	1.24E+01	0.00E+00	7.00E+01	3.76E+04	1.19E+05

Notes:

1) Units are mrem/yr per $\mu Ci/m^3$.

Table 11a
Teen Inhalation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	7.25E+02	7.25E+02	7.25E+02	7.25E+02	7.25E+02	7.25E+02
Na-24	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04
Cr-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
Mn-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04
Mn-56	0.00E+00	1.70E+00	2.52E-01	0.00E+00	1.79E+00	1.52E+04	5.74E+04
Fe-55	3.34E+04	2.38E+04	5.54E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
Fe-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
Co-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04
Co-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05
Ni-63	5.80E+05	4.34E+04	1.98E+04	0.00E+00	0.00E+00	3.07E+05	1.42E+04
Ni-65	2.18E+00	2.93E-01	1.27E-01	0.00E+00	0.00E+00	9.36E+03	3.67E+04
Cu-64	0.00E+00	2.03E+00	8.48E-01	0.00E+00	6.41E+00	1.11E+04	6.14E+04
Zn-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.66E+04
Zn-69	4.83E-02	9.20E-02	6.46E-03	0.00E+00	6.02E-02	1.58E+03	2.85E+02
Br-83	0.00E+00	0.00E+00	3.44E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.33E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.83E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.40E+04	0.00E+00	0.00E+00	0.00E+00	1.77E+04
Rb-88	0.00E+00	5.46E+02	2.72E+02	0.00E+00	0.00E+00	0.00E+00	2.92E-05
Rb-89	0.00E+00	3.52E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	3.38E-07
Sr-89	4.34E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05
Sr-90	3.31E+07	0.00E+00	6.66E+05	0.00E+00	0.00E+00	1.65E+07	7.65E+05
Sr-91	8.80E+01	0.00E+00	3.51E+00	0.00E+00	0.00E+00	6.07E+04	2.59E+05
Sr-92	9.52E+00	0.00E+00	4.06E-01	0.00E+00	0.00E+00	2.74E+04	1.19E+05
Y-90	2.98E+03	0.00E+00	8.00E+01	0.00E+00	0.00E+00	2.93E+05	5.59E+05
Y-91M	3.70E-01	0.00E+00	1.42E-02	0.00E+00	0.00E+00	3.20E+03	3.02E+01
Y-91	6.61E+05	0.00E+00	1.77E+04	0.00E+00	0.00E+00	2.94E+06	4.09E+05
Y-92	1.47E+01	0.00E+00	4.29E-01	0.00E+00	0.00E+00	2.68E+04	1.65E+05
Y-93	1.35E+02	0.00E+00	3.72E+00	0.00E+00	0.00E+00	8.32E+04	5.79E+05
Zr-95	1.46E+05	4.58E+04	3.15E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05
Zr-97	1.38E+02	2.72E+01	1.26E+01	0.00E+00	4.12E+01	1.30E+05	6.30E+05
Nb-95	1.86E+04	1.03E+04	5.66E+03	0.00E+00	1.00E+04	7.51E+05	9.68E+04
Mo-99	0.00E+00	1.69E+02	3.22E+01	0.00E+00	4.11E+02	1.54E+05	2.69E+05
Tc- 99M	1.38E-03	3.86E-03	4.99E-02	0.00E+00	5.76E-02	1.15E+03	6.13E+03
Tc-101	5.92E-05	8.40E-05	8.24E-04	0.00E+00	1.52E-03	6.67E+02	8.72E-07
Ru-103	2.10E+03	0.00E+00	8.96E+02	0.00E+00	7.43E+03	7.83E+05	1.09E+05
Ru-105	1.12E+00	0.00E+00	4.34E-01	0.00E+00	1.41E+00	1.82E+04	9.04E+04
Ru-106	9.84E+04	0.00E+00	1.24E+04	0.00E+00	1.90E+05	1.61E+07	9.60E+05
Ag-110M	1.38E+04	1.31E+04	7.99E+03	0.00E+00	2.50E+04	6.75E+06	2.73E+05

Table 11a (Continued)
Teen Inhalation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	4.88E+03	2.24E+03	6.67E+02	1.40E+03	0.00E+00	5.36E+05	7.50E+04
Te-127M	1.80E+04	8.16E+03	2.18E+03	4.38E+03	6.54E+04	1.66E+06	1.59E+05
Te-127	2.01E+00	9.12E-01	4.42E-01	1.42E+00	7.28E+00	1.12E+04	8.08E+04
Te-129M	1.39E+04	6.58E+03	2.25E+03	4.58E+03	5.19E+04	1.98E+06	4.05E+05
Te-129	7.10E-02	3.38E-02	1.76E-02	5.18E-02	2.66E-01	3.30E+03	1.62E+03
Te-131M	9.84E+01	6.01E+01	4.02E+01	7.25E+01	4.39E+02	2.38E+05	6.21E+05
Te-131	1.58E-02	8.32E-03	5.04E-03	1.24E-02	6.18E-02	2.34E+03	1.51E+01
Te-132	3.60E+02	2.90E+02	2.19E+02	2.46E+02	1.95E+03	4.49E+05	4.63E+05
I-130	6.24E+03	1.79E+04	7.17E+03	1.49E+06	2.75E+04	0.00E+00	9.12E+03
I-131	3.54E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03
I-132	1.59E+03	4.38E+03	1.58E+03	1.51E+05	6.92E+03	0.00E+00	1.27E+03
I-133	1.22E+04	2.05E+04	6.22E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
I-134	8.88E+02	2.32E+03	8.40E+02	3.95E+04	3.66E+03	0.00E+00	2.04E+01
I-135	3.70E+03	9.44E+03	3.49E+03	6.21E+05	1.49E+04	0.00E+00	6.95E+03
Cs-134	5.02E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03
Cs-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04
Cs-137	6.70E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
Cs-138	4.66E+02	8.56E+02	4.46E+02	0.00E+00	6.62E+02	7.87E+01	2.70E-01
Ba-139	1.34E+00	9.44E-04	3.90E-02	0.00E+00	8.88E-04	6.46E+03	6.45E+03
Ba-140	5.47E+04	6.70E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05
Ba-141	1.42E-01	1.06E-04	4.74E-03	0.00E+00	9.84E-05	3.29E+03	7.46E-04
Ba-142	3.70E-02	3.70E-05	2.27E-03	0.00E+00	3.14E-05	1.91E+03	4.79E-10
La-140	4.79E+02	2.36E+02	6.26E+01	0.00E+00	0.00E+00	2.14E+05	4.87E+05
La-142	9.60E-01	4.25E-01	1.06E-01	0.00E+00	0.00E+00	1.02E+04	1.20E+04
Ce-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05
Ce-143	2.66E+02	1.94E+02	2.16E+01	0.00E+00	8.64E+01	1.30E+05	2.55E+05
Ce-144	4.89E+06	2.02E+06	2.62E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05
Pr-143	1.34E+04	5.31E+03	6.62E+02	0.00E+00	3.09E+03	4.83E+05	2.14E+05
Pr-144	4.30E-02	1.76E-02	2.18E-03	0.00E+00	1.01E-02	1.75E+03	2.35E-04
Nd-147	7.86E+03	8.56E+03	5.13E+02	0.00E+00	5.02E+03	3.72E+05	1.82E+05
W-187	1.20E+01	9.76E+00	3.43E+00	0.00E+00	0.00E+00	4.74E+04	1.77E+05
Np-239	3.38E+02	2.88E+02	1.77E+01	0.00E+00	1.00E+02	6.49E+04	1.32E+05

Notes:

1) Units are mrem/yr per $\mu Ci/m^3$.

Table 11b
Child Inhalation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	6.40E+02	6.40E+02	6.40E+02	6.40E+02	6.40E+02	6.40E+02
Na-24	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04
Cr-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03
Mn-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04
Mn-56	0.00E+00	1.66E+00	3.12E-01	0.00E+00	1.67E+00	1.31E+04	1.23E+05
Fe-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
Fe-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04
Co-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04
Co-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04
Ni-63	8.21E+05	4.63E+04	2.80E+04	0.00E+00	0.00E+00	2.75E+05	6.33E+03
Ni-65	2.99E+00	2.96E-01	1.64E-01	0.00E+00	0.00E+00	8.18E+03	8.40E+04
Cu-64	0.00E+00	1.99E+00	1.07E+00	0.00E+00	6.03E+00	9.58E+03	3.67E+04
Zn-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.95E+05	1.63E+04
Zn-69	6.70E-02	9.66E-02	8.92E-03	0.00E+00	5.85E-02	1.42E+03	1.02E+04
Br-83	0.00E+00	0.00E+00	4.74E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.48E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.98E+05	1.14E+05	0.00E+00	0.00E+00	0.00E+00	7.99E+03
Rb-88	0.00E+00	5.62E+02	3.66E+02	0.00E+00	0.00E+00	0.00E+00	1.72E+01
Rb-89	0.00E+00	3.45E+02	2.90E+02	0.00E+00	0.00E+00	0.00E+00	1.89E+00
Sr-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05
Sr-90	3.85E+07	0.00E+00	7.66E+05	0.00E+00	0.00E+00	1.48E+07	3.43E+05
Sr-91	1.21E+02	0.00E+00	4.59E+00	0.00E+00	0.00E+00	5.33E+04	1.74E+05
Sr-92	1.31E+01	0.00E+00	5.25E-01	0.00E+00	0.00E+00	2.40E+04	2.42E+05
Y-90	4.11E+03	0.00E+00	1.11E+02	0.00E+00	0.00E+00	2.62E+05	2.68E+05
Y-91M	5.07E-01	0.00E+00	1.84E-02	0.00E+00	0.00E+00	2.81E+03	1.72E+03
Y-91	9.14E+05	0.00E+00	2.44E+04	0.00E+00	0.00E+00	2.63E+06	1.84E+05
Y-92	2.04E+01	0.00E+00	5.81E-01	0.00E+00	0.00E+00	2.39E+04	2.39E+05
Y-93	1.86E+02	0.00E+00	5.11E+00	0.00E+00	0.00E+00	7.44E+04	3.89E+05
Zr-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04
Zr-97	1.88E+02	2.72E+01	1.60E+01	0.00E+00	3.89E+01	1.13E+05	3.51E+05
Nb-95	2.35E+04	9.18E+03	6.55E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04
Mo-99	0.00E+00	1.72E+02	4.26E+01	0.00E+00	3.92E+02	1.35E+05	1.27E+05
Tc- 99M	1.78E-03	3.48E-03	5.77E-02	0.00E+00	5.07E-02	9.51E+02	4.81E+03
Tc-101	8.10E-05	8.51E-05	1.08E-03	0.00E+00	1.45E-03	5.85E+02	1.63E+01
Ru-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.03E+03	6.62E+05	4.48E+04
Ru-105	1.53E+00	0.00E+00	5.55E-01	0.00E+00	1.34E+00	1.59E+04	9.95E+04
Ru-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05
Ag-110M	1.69E+04	1.14E+04	9.14E+03	0.00E+00	2.12E+04	5.48E+06	1.00E+05

Table 11b (Continued)
Child Inhalation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	6.73E+03	2.33E+03	9.14E+02	1.92E+03	0.00E+00	4.77E+05	3.38E+04
Te-127M	2.49E+04	8.55E+03	3.02E+03	6.07E+03	6.36E+04	1.48E+06	7.14E+04
Te-127	2.77E+00	9.51E-01	6.11E-01	1.96E+00	7.07E+00	1.00E+04	5.62E+04
Te-129M	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05
Te-129	9.77E-02	3.50E-02	2.38E-02	7.14E-02	2.57E-01	2.93E+03	2.55E+04
Te-131M	1.34E+02	5.92E+01	5.07E+01	9.77E+01	4.00E+02	2.06E+05	3.08E+05
Te-131	2.17E-02	8.44E-03	6.59E-03	1.70E-02	5.88E-02	2.05E+03	1.33E+03
Te-132	4.81E+02	2.72E+02	2.63E+02	3.17E+02	1.77E+03	3.77E+05	1.38E+05
I-130	8.18E+03	1.64E+04	8.44E+03	1.85E+06	2.45E+04	0.00E+00	5.11E+03
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03
I-132	2.12E+03	4.07E+03	1.88E+03	1.94E+05	6.25E+03	0.00E+00	3.20E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03
I-134	1.17E+03	2.16E+03	9.95E+02	5.07E+04	3.30E+03	0.00E+00	9.55E+02
I-135	4.92E+03	8.73E+03	4.14E+03	7.92E+05	1.34E+04	0.00E+00	4.44E+03
Cs-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.30E+05	1.21E+05	3.85E+03
Cs-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03
Cs-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03
Cs-138	6.33E+02	8.40E+02	5.55E+02	0.00E+00	6.22E+02	6.81E+01	2.70E+02
Ba-139	1.84E+00	9.84E-04	5.37E-02	0.00E+00	8.62E-04	5.77E+03	5.77E+04
Ba-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
Ba-141	1.96E-01	1.09E-04	6.36E-03	0.00E+00	9.47E-05	2.92E+03	2.75E+02
Ba-142	5.00E-02	3.60E-05	2.79E-03	0.00E+00	2.91E-05	1.64E+03	2.74E+00
La-140	6.44E+02	2.25E+02	7.55E+01	0.00E+00	0.00E+00	1.83E+05	2.26E+05
La-142	1.30E+00	4.11E-01	1.29E-01	0.00E+00	0.00E+00	8.70E+03	7.59E+04
Ce-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04
Ce-143	3.66E+02	1.99E+02	2.87E+01	0.00E+00	8.36E+01	1.15E+05	1.27E+05
Ce-144	6.77E+06	2.12E+06	3.61E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05
Pr-143	1.85E+04	5.55E+03	9.14E+02	0.00E+00	3.00E+03	4.33E+05	9.73E+04
Pr-144	5.96E-02	1.85E-02	3.00E-03	0.00E+00	9.77E-03	1.57E+03	1.97E+02
Nd-147	1.08E+04	8.73E+03	6.81E+02	0.00E+00	4.81E+03	3.28E+05	8.21E+04
W-187	1.63E+01	9.66E+00	4.33E+00	0.00E+00	0.00E+00	4.11E+04	9.10E+04
Np-239	4.66E+02	3.01E+02	2.35E+01	0.00E+00	9.73E+01	5.81E+04	6.40E+04

Notes:

1) Units are mrem/yr per $\mu Ci/m^3$.

Table 11c
Infant Inhalation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02
Na-24	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04
Cr-51	0.00E+00	0.00E+00	8.95E+01	5.75E+01	1.32E+01	1.28E+04	3.57E+02
Mn-54	0.00E+00	2.53E+04	4.98E+03	0.00E+00	4.98E+03	1.00E+06	7.06E+03
Mn-56	0.00E+00	1.54E+00	2.21E-01	0.00E+00	1.10E+00	1.25E+04	7.17E+04
Fe-55	1.97E+04	1.17E+04	3.33E+03	0.00E+00	0.00E+00	8.69E+04	1.09E+03
Fe-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04
Co-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04
Co-60	0.00E+00	8.02E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04
Ni-63	3.39E+05	2.04E+04	1.16E+04	0.00E+00	0.00E+00	2.09E+05	2.42E+03
Ni-65	2.39E+00	2.84E-01	1.23E-01	0.00E+00	0.00E+00	8.12E+03	5.01E+04
Cu-64	0.00E+00	1.88E+00	7.74E-01	0.00E+00	3.98E+00	9.30E+03	1.50E+04
Zn-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04
Zn-69	5.39E-02	9.67E-02	7.18E-03	0.00E+00	4.02E-02	1.47E+03	1.32E+04
Br-83	0.00E+00	0.00E+00	3.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.82E+04	0.00E+00	0.00E+00	0.00E+00	3.04E+03
Rb-88	0.00E+00	5.57E+02	2.87E+02	0.00E+00	0.00E+00	0.00E+00	3.39E+02
Rb-89	0.00E+00	3.21E+02	2.06E+02	0.00E+00	0.00E+00	0.00E+00	6.82E+01
Sr-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04
Sr-90	1.55E+07	0.00E+00	3.12E+05	0.00E+00	0.00E+00	1.12E+07	1.31E+05
Sr-91	9.56E+01	0.00E+00	3.46E+00	0.00E+00	0.00E+00	5.26E+04	7.34E+04
Sr-92	1.05E+01	0.00E+00	3.91E-01	0.00E+00	0.00E+00	2.38E+04	1.40E+05
Y-90	3.29E+03	0.00E+00	8.82E+01	0.00E+00	0.00E+00	2.69E+05	1.04E+05
Y-91M	4.07E-01	0.00E+00	1.39E-02	0.00E+00	0.00E+00	2.79E+03	2.35E+03
Y-91	5.88E+05	0.00E+00	1.57E+04	0.00E+00	0.00E+00	2.45E+06	7.03E+04
Y-92	1.64E+01	0.00E+00	4.61E-01	0.00E+00	0.00E+00	2.45E+04	1.27E+05
Y-93	1.50E+02	0.00E+00	4.07E+00	0.00E+00	0.00E+00	7.64E+04	1.67E+05
Zr-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04
Zr-97	1.50E+02	2.56E+01	1.17E+01	0.00E+00	2.59E+01	1.10E+05	1.40E+05
Nb-95	1.57E+04	6.43E+03	3.78E+03	0.00E+00	4.72E+03	4.79E+05	1.27E+04
Mo-99	0.00E+00	1.65E+02	3.23E+01	0.00E+00	2.65E+02	1.35E+05	4.87E+04
Tc- 99M	1.40E-03	2.88E-03	3.72E-02	0.00E+00	3.11E-02	8.11E+02	2.03E+03
Tc-101	6.51E-05	8.23E-05	8.12E-04	0.00E+00	9.79E-04	5.84E+02	8.44E+02
Ru-103	2.02E+03	0.00E+00	6.79E+02	0.00E+00	4.24E+03	5.52E+05	1.61E+04
Ru-105	1.22E+00	0.00E+00	4.10E-01	0.00E+00	8.99E-01	1.57E+04	4.84E+04
Ru-106	8.68E+04	0.00E+00	1.09E+04	0.00E+00	1.07E+05	1.16E+07	1.64E+05
Ag-110M	9.98E+03	7.22E+03	5.00E+03	0.00E+00	1.09E+04	3.67E+06	3.30E+04

Table 11c (Continued)
Infant Inhalation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	4.76E+03	1.99E+03	6.58E+02	1.62E+03	0.00E+00	4.47E+05	1.29E+04
Te-127M	1.67E+04	6.90E+03	2.07E+03	4.87E+03	3.75E+04	1.31E+06	2.73E+04
Te-127	2.23E+00	9.53E-01	4.89E-01	1.85E+00	4.86E+00	1.03E+04	2.44E+04
Te-129M	1.41E+04	6.09E+03	2.23E+03	5.47E+03	3.18E+04	1.68E+06	6.90E+04
Te-129	7.88E-02	3.47E-02	1.88E-02	6.75E-02	1.75E-01	3.00E+03	2.63E+04
Te-131M	1.07E+02	5.50E+01	3.63E+01	8.93E+01	2.65E+02	1.99E+05	1.19E+05
Te-131	1.74E-02	8.22E-03	5.00E-03	1.58E-02	3.99E-02	2.06E+03	8.22E+03
Te-132	3.72E+02	2.37E+02	1.76E+02	2.79E+02	1.03E+03	3.40E+05	4.41E+04
I-130	6.36E+03	1.39E+04	5.57E+03	1.60E+06	1.53E+04	0.00E+00	1.99E+03
I-131	3.79E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03
I-132	1.69E+03	3.54E+03	1.26E+03	1.69E+05	3.95E+03	0.00E+00	1.90E+03
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	0.00E+00	2.16E+03
I-134	9.21E+02	1.88E+03	6.65E+02	4.45E+04	2.09E+03	0.00E+00	1.29E+03
I-135	3.86E+03	7.60E+03	2.77E+03	6.96E+05	8.47E+03	0.00E+00	1.83E+03
Cs-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03
Cs-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03
Cs-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03
Cs-138	5.05E+02	7.81E+02	3.98E+02	0.00E+00	4.10E+02	6.54E+01	8.76E+02
Ba-139	1.48E+00	9.84E-04	4.30E-02	0.00E+00	5.92E-04	5.95E+03	5.10E+04
Ba-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04
Ba-141	1.57E-01	1.08E-04	4.97E-03	0.00E+00	6.50E-05	2.97E+03	4.75E+03
Ba-142	3.98E-02	3.30E-05	1.96E-03	0.00E+00	1.90E-05	1.55E+03	6.93E+02
La-140	5.05E+02	2.00E+02	5.15E+01	0.00E+00	0.00E+00	1.68E+05	8.48E+04
La-142	1.03E+00	3.77E-01	9.04E-02	0.00E+00	0.00E+00	8.22E+03	5.95E+04
Ce-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04
Ce-143	2.93E+02	1.93E+02	2.21E+01	0.00E+00	5.64E+01	1.16E+05	4.97E+04
Ce-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.84E+06	1.48E+05
Pr-143	1.40E+04	5.24E+03	6.99E+02	0.00E+00	1.97E+03	4.33E+05	3.72E+04
Pr-144	4.79E-02	1.85E-02	2.41E-03	0.00E+00	6.72E-03	1.61E+03	4.28E+03
Nd-147	7.94E+03	8.13E+03	5.00E+02	0.00E+00	3.15E+03	3.22E+05	3.12E+04
W-187	1.30E+01	9.02E+00	3.12E+00	0.00E+00	0.00E+00	3.96E+04	3.56E+04
Np-239	3.71E+02	2.98E+02	1.88E+01	0.00E+00	6.62E+01	5.95E+04	2.49E+04

Notes:

1) Units are mrem/yr per $\mu Ci/m^3$.

Table 12
Adult Vegetation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03
Na-24	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05
Cr-51	0.00E+00	0.00E+00	4.64E+04	2.77E+04	1.02E+04	6.15E+04	1.17E+07
Mn-54	0.00E+00	3.13E+08	5.97E+07	0.00E+00	9.31E+07	0.00E+00	9.58E+08
Mn-56	0.00E+00	1.54E+01	2.73E+00	0.00E+00	1.95E+01	0.00E+00	4.91E+02
Fe-55	2.10E+08	1.45E+08	3.38E+07	0.00E+00	0.00E+00	8.08E+07	8.31E+07
Fe-59	1.26E+08	2.96E+08	1.13E+08	0.00E+00	0.00E+00	8.27E+07	9.87E+08
Co-58	0.00E+00	3.08E+07	6.90E+07	0.00E+00	0.00E+00	0.00E+00	6.24E+08
Co-60	0.00E+00	1.67E+08	3.69E+08	0.00E+00	0.00E+00	0.00E+00	3.14E+09
Ni-63	1.04E+10	7.21E+08	3.49E+08	0.00E+00	0.00E+00	0.00E+00	1.50E+08
Ni-65	5.97E+01	7.75E+00	3.54E+00	0.00E+00	0.00E+00	0.00E+00	1.97E+02
Cu-64	0.00E+00	9.09E+03	4.27E+03	0.00E+00	2.29E+04	0.00E+00	7.75E+05
Zn-65	3.17E+08	1.01E+09	4.56E+08	0.00E+00	6.75E+08	0.00E+00	6.36E+08
Zn-69	4.95E-06	9.48E-06	6.59E-07	0.00E+00	6.16E-06	0.00E+00	1.42E-06
Br-83	0.00E+00	0.00E+00	3.00E+00	0.00E+00	0.00E+00	0.00E+00	4.32E+00
Br-84	0.00E+00	0.00E+00	2.20E-11	0.00E+00	0.00E+00	0.00E+00	1.72E-16
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.20E+08	1.03E+08	0.00E+00	0.00E+00	0.00E+00	4.34E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	9.95E+09	0.00E+00	2.86E+08	0.00E+00	0.00E+00	0.00E+00	1.60E+09
Sr-90	6.95E+11	0.00E+00	1.40E+10	0.00E+00	0.00E+00	0.00E+00	1.75E+10
Sr-91	3.01E+05	0.00E+00	1.22E+04	0.00E+00	0.00E+00	0.00E+00	1.43E+06
Sr-92	4.12E+02	0.00E+00	1.78E+01	0.00E+00	0.00E+00	0.00E+00	8.17E+03
Y-90	1.33E+04	0.00E+00	3.57E+02	0.00E+00	0.00E+00	0.00E+00	1.41E+08
Y-91M	4.93E-09	0.00E+00	1.91E-10	0.00E+00	0.00E+00	0.00E+00	1.45E-08
Y-91	5.12E+06	0.00E+00	1.37E+05	0.00E+00	0.00E+00	0.00E+00	2.82E+09
Y-92	8.95E-01	0.00E+00	2.62E-02	0.00E+00	0.00E+00	0.00E+00	1.57E+04
Y-93	1.67E+02	0.00E+00	4.62E+00	0.00E+00	0.00E+00	0.00E+00	5.31E+06
Zr-95	1.18E+06	3.77E+05	2.55E+05	0.00E+00	5.92E+05	0.00E+00	1.20E+09
Zr-97	3.35E+02	6.77E+01	3.09E+01	0.00E+00	1.02E+02	0.00E+00	2.10E+07
Nb-95	1.43E+05	7.95E+04	4.27E+04	0.00E+00	7.86E+04	0.00E+00	4.83E+08
Mo-99	0.00E+00	6.14E+06	1.17E+06	0.00E+00	1.39E+07	0.00E+00	1.42E+07
Tc- 99M	3.06E+00	8.64E+00	1.10E+02	0.00E+00	1.31E+02	4.23E+00	5.11E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	4.77E+06	0.00E+00	2.05E+06	0.00E+00	1.82E+07	0.00E+00	5.57E+08
Ru-105	5.27E+01	0.00E+00	2.08E+01	0.00E+00	6.81E+02	0.00E+00	3.23E+04
Ru-106	1.93E+08	0.00E+00	2.44E+07	0.00E+00	3.72E+08	0.00E+00	1.25E+10
Ag-110M	1.05E+07	9.75E+06	5.79E+06	0.00E+00	1.92E+07	0.00E+00	3.98E+09

Table 12 (Continued)
Adult Vegetation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	9.67E+07	3.50E+07	1.30E+07	2.91E+07	3.93E+08	0.00E+00	3.86E+08
Te-127M	3.49E+08	1.25E+08	4.26E+07	8.92E+07	1.42E+09	0.00E+00	1.17E+09
Te-127	5.68E+03	2.04E+03	1.23E+03	4.21E+03	2.31E+04	0.00E+00	4.48E+05
Te-129M	2.51E+08	9.37E+07	3.97E+07	8.62E+07	1.05E+09	0.00E+00	1.26E+09
Te-129	7.14E-04	2.68E-04	1.74E-04	5.48E-04	3.00E-03	0.00E+00	5.39E-04
Te-131M	9.09E+05	4.45E+05	3.71E+05	7.04E+05	4.50E+06	0.00E+00	4.41E+07
Te-131	1.26E-15	5.26E-16	3.97E-16	1.03E-15	5.51E-15	0.00E+00	1.78E-16
Te-132	4.28E+06	2.77E+06	2.60E+06	3.06E+06	2.67E+07	0.00E+00	1.31E+08
I-130	3.89E+05	1.15E+06	4.52E+05	9.72E+07	1.79E+06	0.00E+00	9.87E+05
I-131	8.07E+07	1.15E+08	6.62E+07	3.78E+10	1.98E+08	0.00E+00	3.05E+07
I-132	5.58E+01	1.49E+02	5.22E+01	5.22E+03	2.38E+02	0.00E+00	2.80E+01
I-133	2.08E+06	3.62E+06	1.10E+06	5.32E+08	6.31E+06	0.00E+00	3.25E+06
I-134	8.55E-05	2.32E-04	8.31E-05	4.02E-03	3.69E-04	0.00E+00	2.02E-07
I-135	3.87E+04	1.01E+05	3.74E+04	6.68E+06	1.62E+05	0.00E+00	1.14E+05
Cs-134	4.67E+09	1.11E+10	9.08E+09	0.00E+00	3.59E+09	1.19E+09	1.94E+08
Cs-136	4.25E+07	1.68E+08	1.21E+08	0.00E+00	9.33E+07	1.28E+07	1.90E+07
Cs-137	6.36E+09	8.70E+09	5.70E+09	0.00E+00	2.95E+09	9.81E+08	1.68E+08
Cs-138	3.32E-11	6.56E-11	3.25E-11	0.00E+00	4.82E-11	4.76E-12	2.80E-16
Ba-139	2.71E-02	1.93E-05	7.92E-04	0.00E+00	1.80E-05	1.09E-05	4.80E-02
Ba-140	1.29E+08	1.61E+05	8.42E+06	0.00E+00	5.49E+04	9.24E+04	2.65E+08
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	1.98E+03	9.97E+02	2.63E+02	0.00E+00	0.00E+00	0.00E+00	7.32E+07
La-142	1.94E-04	8.83E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	6.45E-01
Ce-141	1.97E+05	1.33E+05	1.51E+04	0.00E+00	6.19E+04	0.00E+00	5.09E+08
Ce-143	9.94E+02	7.35E+05	8.13E+01	0.00E+00	3.24E+02	0.00E+00	2.75E+07
Ce-144	3.29E+07	1.38E+07	1.77E+06	0.00E+00	8.16E+06	0.00E+00	1.11E+10
Pr-143	6.27E+04	2.51E+04	3.11E+03	0.00E+00	1.45E+04	0.00E+00	2.75E+08
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	3.37E+04	3.90E+04	2.33E+03	0.00E+00	2.28E+04	0.00E+00	1.87E+08
W-187	3.79E+04	3.17E+04	1.11E+04	0.00E+00	0.00E+00	0.00E+00	1.04E+07
Np-239	1.42E+03	1.40E+02	7.72E+01	0.00E+00	4.37E+02	0.00E+00	2.87E+07

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 12a
Teen Vegetation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.47E+03	1.47E+03	1.47E+03	1.47E+03	1.47E+03	1.47E+03
Na-24	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05
Cr-51	0.00E+00	0.00E+00	6.16E+04	3.42E+04	1.35E+04	8.79E+04	1.03E+07
Mn-54	0.00E+00	4.54E+08	9.01E+07	0.00E+00	1.36E+08	0.00E+00	9.32E+08
Mn-56	0.00E+00	1.39E+01	2.47E+00	0.00E+00	1.76E+01	0.00E+00	9.13E+02
Fe-55	3.26E+08	2.31E+08	5.39E+07	0.00E+00	0.00E+00	1.47E+08	1.00E+08
Fe-59	1.79E+08	4.18E+08	1.61E+08	0.00E+00	0.00E+00	1.32E+08	9.89E+08
Co-58	0.00E+00	4.37E+07	1.01E+08	0.00E+00	0.00E+00	0.00E+00	6.02E+08
Co-60	0.00E+00	2.49E+08	5.60E+08	0.00E+00	0.00E+00	0.00E+00	3.24E+09
Ni-63	1.61E+10	1.13E+09	5.45E+08	0.00E+00	0.00E+00	0.00E+00	1.81E+08
Ni-65	5.55E+01	7.10E+00	3.23E+00	0.00E+00	0.00E+00	0.00E+00	3.85E+02
Cu-64	0.00E+00	8.24E+03	3.87E+03	0.00E+00	2.08E+04	0.00E+00	6.39E+05
Zn-65	4.24E+08	1.47E+09	6.86E+08	0.00E+00	9.41E+08	0.00E+00	6.23E+08
Zn-69	4.64E-06	8.84E-06	6.19E-07	0.00E+00	5.78E-06	0.00E+00	1.63E-05
Br-83	0.00E+00	0.00E+00	2.81E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.00E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.75E+08	1.29E+08	0.00E+00	0.00E+00	0.00E+00	4.06E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.51E+10	0.00E+00	4.33E+08	0.00E+00	0.00E+00	0.00E+00	1.80E+09
Sr-90	9.22E+11	0.00E+00	1.84E+10	0.00E+00	0.00E+00	0.00E+00	2.11E+10
Sr-91	2.81E+05	0.00E+00	1.12E+04	0.00E+00	0.00E+00	0.00E+00	1.27E+06
Sr-92	3.84E+02	0.00E+00	1.64E+01	0.00E+00	0.00E+00	0.00E+00	9.78E+03
Y-90	1.24E+04	0.00E+00	3.35E+02	0.00E+00	0.00E+00	0.00E+00	1.02E+08
Y-91M	4.59E-09	0.00E+00	1.75E-10	0.00E+00	0.00E+00	0.00E+00	2.17E-07
Y-91	7.84E+06	0.00E+00	2.10E+05	0.00E+00	0.00E+00	0.00E+00	3.21E+09
Y-92	8.41E-01	0.00E+00	2.43E-02	0.00E+00	0.00E+00	0.00E+00	2.31E+04
Y-93	1.57E+02	0.00E+00	4.30E+00	0.00E+00	0.00E+00	0.00E+00	4.80E+06
Zr-95	1.72E+06	5.44E+05	3.74E+05	0.00E+00	7.99E+05	0.00E+00	1.26E+09
Zr-97	3.10E+02	6.14E+01	2.83E+01	0.00E+00	9.31E+01	0.00E+00	1.66E+07
Nb-95	1.93E+05	1.07E+05	5.90E+04	0.00E+00	1.04E+05	0.00E+00	4.58E+08
Mo-99	0.00E+00	5.63E+06	1.07E+06	0.00E+00	1.29E+07	0.00E+00	1.01E+07
Tc- 99M	2.70E+00	7.52E+00	9.75E+01	0.00E+00	1.12E+02	4.17E+00	4.94E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	6.82E+06	0.00E+00	2.91E+06	0.00E+00	2.40E+07	0.00E+00	5.69E+08
Ru-105	4.90E+01	0.00E+00	1.90E+01	0.00E+00	6.18E+02	0.00E+00	3.95E+04
Ru-106	3.09E+08	0.00E+00	3.90E+07	0.00E+00	5.97E+08	0.00E+00	1.48E+10
Ag-110M	1.52E+07	1.44E+07	8.73E+06	0.00E+00	2.74E+07	0.00E+00	4.03E+09

Table 12a (Continued)
Teen Vegetation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.49E+08	5.35E+07	1.99E+07	4.15E+07	0.00E+00	0.00E+00	4.38E+08
Te-127M	5.51E+08	1.96E+08	6.56E+07	1.31E+08	2.24E+09	0.00E+00	1.37E+09
Te-127	5.36E+03	1.90E+03	1.15E+03	3.70E+03	2.17E+04	0.00E+00	4.14E+05
Te-129M	3.61E+08	1.34E+08	5.72E+07	1.17E+08	1.51E+09	0.00E+00	1.36E+09
Te-129	6.68E-04	2.49E-04	1.63E-04	4.77E-04	2.80E-03	0.00E+00	3.65E-03
Te-131M	8.42E+05	4.04E+05	3.37E+05	6.07E+05	4.21E+06	0.00E+00	3.24E+07
Te-131	1.17E-15	4.82E-16	3.66E-16	9.01E-16	5.11E-15	0.00E+00	9.60E-17
Te-132	3.89E+06	2.46E+06	2.32E+06	2.60E+06	2.36E+07	0.00E+00	7.81E+07
I-130	3.47E+05	1.01E+06	4.01E+05	8.20E+07	1.55E+06	0.00E+00	7.73E+05
I-131	7.68E+07	1.08E+08	5.78E+07	3.14E+10	1.85E+08	0.00E+00	2.13E+07
I-132	5.03E+01	1.32E+02	4.72E+01	4.43E+03	2.07E+02	0.00E+00	5.73E+01
I-133	1.93E+06	3.28E+06	1.00E+06	4.58E+08	5.75E+06	0.00E+00	2.48E+06
I-134	7.73E-05	2.05E-04	7.36E-05	3.41E-03	3.23E-04	0.00E+00	2.70E-06
I-135	3.49E+04	8.99E+04	3.33E+04	5.78E+06	1.42E+05	0.00E+00	9.97E+04
Cs-134	7.10E+09	1.67E+10	7.75E+09	0.00E+00	5.31E+09	2.03E+09	2.08E+08
Cs-136	4.35E+07	1.71E+08	1.15E+08	0.00E+00	9.31E+07	1.47E+07	1.38E+07
Cs-137	1.01E+10	1.35E+10	4.69E+09	0.00E+00	4.59E+09	1.78E+09	1.92E+08
Cs-138	3.07E-11	5.89E-11	2.94E-11	0.00E+00	4.35E-11	5.06E-12	2.67E-14
Ba-139	2.55E-02	1.79E-05	7.42E-04	0.00E+00	1.69E-05	1.23E-05	2.27E-01
Ba-140	1.38E+08	1.69E+05	8.90E+06	0.00E+00	5.74E+04	1.14E+05	2.13E+08
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	1.81E+03	8.88E+02	2.36E+02	0.00E+00	0.00E+00	0.00E+00	5.10E+07
La-142	1.78E-04	7.92E-05	1.97E-05	0.00E+00	0.00E+00	0.00E+00	2.41E+00
Ce-141	2.83E+05	1.89E+05	2.17E+04	0.00E+00	8.89E+04	0.00E+00	5.40E+08
Ce-143	9.29E+02	6.76E+05	7.55E+01	0.00E+00	3.03E+02	0.00E+00	2.03E+07
Ce-144	5.27E+07	2.18E+07	2.83E+06	0.00E+00	1.30E+07	0.00E+00	1.33E+10
Pr-143	7.01E+04	2.80E+04	3.49E+03	0.00E+00	1.63E+04	0.00E+00	2.31E+08
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	3.67E+04	4.00E+04	2.39E+03	0.00E+00	2.35E+04	0.00E+00	1.44E+08
W-187	3.53E+04	2.87E+04	1.01E+04	0.00E+00	0.00E+00	0.00E+00	7.78E+06
Np-239	1.38E+03	1.30E+02	7.24E+01	0.00E+00	4.09E+02	0.00E+00	2.10E+07

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per µCi/m^3.

Table 12b
Child Vegetation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03
Na-24	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05
Cr-51	0.00E+00	0.00E+00	1.17E+05	6.49E+04	1.77E+04	1.18E+05	6.20E+06
Mn-54	0.00E+00	6.65E+08	1.77E+08	0.00E+00	1.86E+08	0.00E+00	5.58E+08
Mn-56	0.00E+00	1.82E+01	4.10E+00	0.00E+00	2.20E+01	0.00E+00	2.63E+03
Fe-55	8.01E+08	4.25E+08	1.32E+08	0.00E+00	0.00E+00	2.40E+08	7.87E+07
Fe-59	3.97E+08	6.42E+08	3.20E+08	0.00E+00	0.00E+00	1.86E+08	6.69E+08
Co-58	0.00E+00	6.45E+07	1.97E+08	0.00E+00	0.00E+00	0.00E+00	3.76E+08
Co-60	0.00E+00	3.78E+08	1.12E+09	0.00E+00	0.00E+00	0.00E+00	2.10E+09
Ni-63	3.95E+10	2.11E+09	1.34E+09	0.00E+00	0.00E+00	0.00E+00	1.42E+08
Ni-65	1.02E+02	9.59E+00	5.60E+00	0.00E+00	0.00E+00	0.00E+00	1.18E+03
Cu-64	0.00E+00	1.09E+04	6.56E+03	0.00E+00	2.62E+04	0.00E+00	5.10E+05
Zn-65	8.12E+08	2.16E+09	1.35E+09	0.00E+00	1.36E+09	0.00E+00	3.80E+08
Zn-69	8.56E-06	1.24E-05	1.14E-06	0.00E+00	7.50E-06	0.00E+00	7.80E-04
Br-83	0.00E+00	0.00E+00	5.18E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.39E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.54E+08	2.79E+08	0.00E+00	0.00E+00	0.00E+00	2.92E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.59E+10	0.00E+00	1.03E+09	0.00E+00	0.00E+00	0.00E+00	1.39E+09
Sr-90	1.87E+12	0.00E+00	3.77E+10	0.00E+00	0.00E+00	0.00E+00	1.67E+10
Sr-91	5.17E+05	0.00E+00	1.95E+04	0.00E+00	0.00E+00	0.00E+00	1.14E+06
Sr-92	7.04E+02	0.00E+00	2.82E+01	0.00E+00	0.00E+00	0.00E+00	1.33E+04
Y-90	2.31E+04	0.00E+00	6.18E+02	0.00E+00	0.00E+00	0.00E+00	6.57E+07
Y-91M	8.42E-09	0.00E+00	3.06E-10	0.00E+00	0.00E+00	0.00E+00	1.65E-05
Y-91	1.87E+07	0.00E+00	4.99E+05	0.00E+00	0.00E+00	0.00E+00	2.49E+09
Y-92	1.55E+00	0.00E+00	4.43E-02	0.00E+00	0.00E+00	0.00E+00	4.47E+04
Y-93	2.89E+02	0.00E+00	7.94E+00	0.00E+00	0.00E+00	0.00E+00	4.31E+06
Zr-95	3.86E+06	8.50E+05	7.56E+05	0.00E+00	1.22E+06	0.00E+00	8.86E+08
Zr-97	5.67E+02	8.19E+01	4.83E+01	0.00E+00	1.18E+02	0.00E+00	1.24E+07
Nb-95	4.12E+05	1.61E+05	1.15E+05	0.00E+00	1.51E+05	0.00E+00	2.97E+08
Mo-99	0.00E+00	7.69E+06	1.90E+06	0.00E+00	1.64E+07	0.00E+00	6.36E+06
Tc- 99M	4.64E+00	9.10E+00	1.51E+02	0.00E+00	1.32E+02	4.62E+00	5.18E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.53E+07	0.00E+00	5.89E+06	0.00E+00	3.86E+07	0.00E+00	3.96E+08
Ru-105	8.97E+01	0.00E+00	3.25E+01	0.00E+00	7.89E+02	0.00E+00	5.86E+04
Ru-106	7.45E+08	0.00E+00	9.30E+07	0.00E+00	1.01E+09	0.00E+00	1.16E+10
Ag-110M	3.21E+07	2.17E+07	1.74E+07	0.00E+00	4.04E+07	0.00E+00	2.58E+09

Table 12b (Continued)
Child Vegetation Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.51E+08	9.52E+07	4.68E+07	9.86E+07	0.00E+00	0.00E+00	3.39E+08
Te-127M	1.32E+09	3.56E+08	1.57E+08	3.16E+08	3.77E+09	0.00E+00	1.07E+09
Te-127	9.89E+03	2.67E+03	2.12E+03	6.84E+03	2.81E+04	0.00E+00	3.86E+05
Te-129M	8.40E+08	2.35E+08	1.30E+08	2.71E+08	2.47E+09	0.00E+00	1.02E+09
Te-129	1.24E-03	3.45E-04	2.94E-04	8.83E-04	3.62E-03	0.00E+00	7.70E-02
Te-131M	1.54E+06	5.32E+05	5.66E+05	1.09E+06	5.15E+06	0.00E+00	2.16E+07
Te-131	2.15E-15	6.57E-16	6.41E-16	1.65E-15	6.51E-15	0.00E+00	1.13E-14
Te-132	6.97E+06	3.09E+06	3.73E+06	4.49E+06	2.86E+07	0.00E+00	3.11E+07
I-130	6.10E+05	1.23E+06	6.35E+05	1.36E+08	1.84E+06	0.00E+00	5.76E+05
I-131	1.43E+08	1.44E+08	8.17E+07	4.75E+10	2.36E+08	0.00E+00	1.28E+07
I-132	8.93E+01	1.64E+02	7.54E+01	7.61E+03	2.51E+02	0.00E+00	1.93E+02
I-133	3.52E+06	4.36E+06	1.65E+06	8.09E+08	7.26E+06	0.00E+00	1.76E+06
I-134	1.37E-04	2.55E-04	1.17E-04	5.86E-03	3.90E-04	0.00E+00	1.69E-04
I-135	6.20E+04	1.12E+05	5.28E+04	9.89E+06	1.71E+05	0.00E+00	8.51E+04
Cs-134	1.60E+10	2.63E+10	5.55E+09	0.00E+00	8.16E+09	2.93E+09	1.42E+08
Cs-136	8.18E+07	2.25E+08	1.46E+08	0.00E+00	1.20E+08	1.79E+07	7.90E+06
Cs-137	2.39E+10	2.29E+10	3.38E+09	0.00E+00	7.46E+09	2.68E+09	1.43E+08
Cs-138	5.58E-11	7.75E-11	4.92E-11	0.00E+00	5.45E-11	5.87E-12	3.57E-11
Ba-139	4.69E-02	2.51E-05	1.36E-03	0.00E+00	2.19E-05	1.47E-05	2.71E+00
Ba-140	2.77E+08	2.43E+05	1.62E+07	0.00E+00	7.90E+04	1.45E+05	1.40E+08
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	3.25E+03	1.13E+03	3.82E+02	0.00E+00	0.00E+00	0.00E+00	3.16E+07
La-142	3.23E-04	1.03E-04	3.22E-05	0.00E+00	0.00E+00	0.00E+00	2.04E+01
Ce-141	6.55E+05	3.27E+05	4.85E+04	0.00E+00	1.43E+05	0.00E+00	4.08E+08
Ce-143	1.71E+03	9.28E+05	1.34E+02	0.00E+00	3.89E+02	0.00E+00	1.36E+07
Ce-144	1.27E+08	3.98E+07	6.78E+06	0.00E+00	2.21E+07	0.00E+00	1.04E+10
Pr-143	1.46E+05	4.38E+04	7.24E+03	0.00E+00	2.37E+04	0.00E+00	1.57E+08
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	7.27E+04	5.89E+04	4.56E+03	0.00E+00	3.23E+04	0.00E+00	9.33E+07
W-187	6.41E+04	3.80E+04	1.70E+04	0.00E+00	0.00E+00	0.00E+00	5.34E+06
Np-239	2.55E+03	1.83E+02	1.29E+02	0.00E+00	5.30E+02	0.00E+00	1.36E+07

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

3) The infant age group is assumed to receive no due through the vegetation ingestion pathway therefore no dose factors are supplied.

Table 13
Adult Grass-Cow-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02
Na-24	2.46E+06	2.46E+06	2.46E+06	2.46E+06	2.46E+06	2.46E+06	2.46E+06
Cr-51	0.00E+00	0.00E+00	2.86E+04	1.71E+04	6.29E+03	3.79E+04	7.18E+06
Mn-54	0.00E+00	8.41E+06	1.61E+06	0.00E+00	2.50E+06	0.00E+00	2.58E+07
Mn-56	0.00E+00	4.13E-03	7.32E-04	0.00E+00	5.24E-03	0.00E+00	1.32E-01
Fe-55	2.51E+07	1.74E+07	4.05E+06	0.00E+00	0.00E+00	9.68E+06	9.95E+06
Fe-59	2.97E+07	6.98E+07	2.67E+07	0.00E+00	0.00E+00	1.95E+07	2.33E+08
Co-58	0.00E+00	4.72E+06	1.06E+07	0.00E+00	0.00E+00	0.00E+00	9.56E+07
Co-60	0.00E+00	1.64E+07	3.62E+07	0.00E+00	0.00E+00	0.00E+00	3.08E+08
Ni-63	6.73E+09	4.66E+08	2.26E+08	0.00E+00	0.00E+00	0.00E+00	9.73E+07
Ni-65	3.70E-01	4.81E-02	2.19E-02	0.00E+00	0.00E+00	0.00E+00	1.22E+00
Cu-64	0.00E+00	2.36E+04	1.11E+04	0.00E+00	5.95E+04	0.00E+00	2.01E+06
Zn-65	1.37E+09	4.36E+09	1.97E+09	0.00E+00	2.92E+09	0.00E+00	2.75E+09
Zn-69	2.01E-12	3.84E-12	2.67E-13	0.00E+00	2.50E-12	0.00E+00	5.78E-13
Br-83	0.00E+00	0.00E+00	9.65E-02	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.60E+09	1.21E+09	0.00E+00	0.00E+00	0.00E+00	5.12E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.45E+09	0.00E+00	4.16E+07	0.00E+00	0.00E+00	0.00E+00	2.33E+08
Sr-90	5.38E+10	0.00E+00	1.08E+09	0.00E+00	0.00E+00	0.00E+00	1.35E+09
Sr-91	2.87E+04	0.00E+00	1.16E+03	0.00E+00	0.00E+00	0.00E+00	1.37E+05
Sr-92	4.84E-01	0.00E+00	2.09E-02	0.00E+00	0.00E+00	0.00E+00	9.58E+00
Y-90	7.10E+01	0.00E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	7.52E+05
Y-91M	6.42E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E-19
Y-91	8.59E+03	0.00E+00	2.30E+02	0.00E+00	0.00E+00	0.00E+00	4.73E+06
Y-92	5.57E-05	0.00E+00	1.63E-06	0.00E+00	0.00E+00	0.00E+00	9.75E-01
Y-93	2.22E-01	0.00E+00	6.12E-03	0.00E+00	0.00E+00	0.00E+00	7.03E+03
Zr-95	9.44E+02	3.03E+02	2.05E+02	0.00E+00	4.75E+02	0.00E+00	9.59E+05
Zr-97	4.32E-01	8.72E-02	3.99E-02	0.00E+00	1.32E-01	0.00E+00	2.70E+04
Nb-95	8.26E+04	4.60E+04	2.47E+04	0.00E+00	4.54E+04	0.00E+00	2.79E+08
Mo-99	0.00E+00	2.47E+07	4.70E+06	0.00E+00	5.60E+07	0.00E+00	5.73E+07
Tc- 99M	3.31E+00	9.35E+00	1.19E+02	0.00E+00	1.42E+02	4.58E+00	5.53E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.02E+03	0.00E+00	4.39E+02	0.00E+00	3.88E+03	0.00E+00	1.19E+05
Ru-105	8.51E-04	0.00E+00	3.36E-04	0.00E+00	1.10E-02	0.00E+00	5.20E-01
Ru-106	2.04E+04	0.00E+00	2.58E+03	0.00E+00	3.94E+04	0.00E+00	1.32E+06
Ag-110M	5.82E+07	5.39E+07	3.20E+07	0.00E+00	1.06E+08	0.00E+00	2.20E+10

Table 13 (Continued)
Adult Grass-Cow-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.63E+07	5.91E+06	2.18E+06	4.90E+06	6.63E+07	0.00E+00	6.51E+07
Te-127M	4.58E+07	1.64E+07	5.58E+06	1.17E+07	1.86E+08	0.00E+00	1.54E+08
Te-127	6.66E+02	2.39E+02	1.44E+02	4.94E+02	2.71E+03	0.00E+00	5.26E+04
Te-129M	6.02E+07	2.24E+07	9.52E+06	2.07E+07	2.51E+08	0.00E+00	3.03E+08
Te-129	2.83E-10	1.06E-10	6.88E-11	2.17E-10	1.19E-09	0.00E+00	2.13E-10
Te-131M	3.61E+05	1.76E+05	1.47E+05	2.79E+05	1.79E+06	0.00E+00	1.75E+07
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.39E+06	1.55E+06	1.45E+06	1.71E+06	1.49E+07	0.00E+00	7.32E+07
I-130	4.18E+05	1.23E+06	4.86E+05	1.04E+08	1.92E+06	0.00E+00	1.06E+06
I-131	2.96E+08	4.23E+08	2.43E+08	1.39E+11	7.26E+08	0.00E+00	1.12E+08
I-132	1.65E-01	4.40E-01	1.54E-01	1.54E+01	7.02E-01	0.00E+00	8.27E-02
I-133	3.88E+06	6.74E+06	2.06E+06	9.91E+08	1.18E+07	0.00E+00	6.06E+06
I-134	1.89E-12	5.13E-12	1.83E-12	8.89E-11	8.16E-12	0.00E+00	4.47E-15
I-135	1.29E+04	3.38E+04	1.25E+04	2.23E+06	5.42E+04	0.00E+00	3.82E+04
Cs-134	5.65E+09	1.35E+10	1.10E+10	0.00E+00	4.35E+09	1.45E+09	2.35E+08
Cs-136	2.63E+08	1.04E+09	7.46E+08	0.00E+00	5.77E+08	7.91E+07	1.18E+08
Cs-137	7.38E+09	1.01E+10	6.61E+09	0.00E+00	3.43E+09	1.14E+09	1.95E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	4.43E-08	3.16E-11	1.30E-09	0.00E+00	2.95E-11	1.79E-11	7.86E-08
Ba-140	2.69E+07	3.38E+04	1.76E+06	0.00E+00	1.15E+04	1.93E+04	5.54E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	4.52E+00	2.28E+00	6.02E-01	0.00E+00	0.00E+00	0.00E+00	1.67E+05
La-142	1.89E-11	8.59E-12	2.14E-12	0.00E+00	0.00E+00	0.00E+00	6.28E-08
Ce-141	4.84E+03	3.28E+03	3.72E+02	0.00E+00	1.52E+03	0.00E+00	1.25E+07
Ce-143	4.15E+01	3.07E+04	3.39E+00	0.00E+00	1.35E+01	0.00E+00	1.15E+06
Ce-144	3.58E+05	1.50E+05	1.92E+04	0.00E+00	8.87E+04	0.00E+00	1.21E+08
Pr-143	1.58E+02	6.34E+01	7.83E+00	0.00E+00	3.66E+01	0.00E+00	6.92E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	9.48E+01	1.10E+02	6.56E+00	0.00E+00	6.41E+01	0.00E+00	5.26E+05
W-187	6.51E+03	5.44E+03	1.90E+03	0.00E+00	0.00E+00	0.00E+00	1.78E+06
Np-239	3.67E+00	3.61E-01	1.99E-01	0.00E+00	1.12E+00	0.00E+00	7.40E+04

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per µCi/m^3.

Table 13a
Teen Grass-Cow-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	5.66E+02	5.66E+02	5.66E+02	5.66E+02	5.66E+02	5.66E+02
Na-24	4.29E+06	4.29E+06	4.29E+06	4.29E+06	4.29E+06	4.29E+06	4.29E+06
Cr-51	0.00E+00	0.00E+00	4.99E+04	2.77E+04	1.09E+04	7.12E+04	8.38E+06
Mn-54	0.00E+00	1.40E+07	2.78E+06	0.00E+00	4.18E+06	0.00E+00	2.87E+07
Mn-56	0.00E+00	7.32E-03	1.30E-03	0.00E+00	9.27E-03	0.00E+00	4.82E-01
Fe-55	4.45E+07	3.16E+07	7.36E+06	0.00E+00	0.00E+00	2.00E+07	1.37E+07
Fe-59	5.18E+07	1.21E+08	4.67E+07	0.00E+00	0.00E+00	3.81E+07	2.86E+08
Co-58	0.00E+00	7.94E+06	1.83E+07	0.00E+00	0.00E+00	0.00E+00	1.09E+08
Co-60	0.00E+00	2.78E+07	6.26E+07	0.00E+00	0.00E+00	0.00E+00	3.62E+08
Ni-63	1.18E+10	8.35E+08	4.01E+08	0.00E+00	0.00E+00	0.00E+00	1.33E+08
Ni-65	6.78E-01	8.66E-02	3.94E-02	0.00E+00	0.00E+00	0.00E+00	4.70E+00
Cu-64	0.00E+00	4.21E+04	1.98E+04	0.00E+00	1.06E+05	0.00E+00	3.26E+06
Zn-65	2.11E+09	7.31E+09	3.41E+09	0.00E+00	4.68E+09	0.00E+00	3.10E+09
Zn-69	3.70E-12	7.05E-12	4.94E-13	0.00E+00	4.61E-12	0.00E+00	1.30E-11
Br-83	0.00E+00	0.00E+00	1.78E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.73E+09	2.22E+09	0.00E+00	0.00E+00	0.00E+00	7.01E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.67E+09	0.00E+00	7.66E+07	0.00E+00	0.00E+00	0.00E+00	3.18E+08
Sr-90	8.13E+10	0.00E+00	1.63E+09	0.00E+00	0.00E+00	0.00E+00	1.86E+09
Sr-91	5.27E+04	0.00E+00	2.10E+03	0.00E+00	0.00E+00	0.00E+00	2.39E+05
Sr-92	8.85E-01	0.00E+00	3.77E-02	0.00E+00	0.00E+00	0.00E+00	2.26E+01
Y-90	1.30E+02	0.00E+00	3.51E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+06
Y-91M	1.18E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.55E-18
Y-91	1.58E+04	0.00E+00	4.24E+02	0.00E+00	0.00E+00	0.00E+00	6.48E+06
Y-92	1.03E-04	0.00E+00	2.98E-06	0.00E+00	0.00E+00	0.00E+00	2.82E+00
Y-93	4.09E-01	0.00E+00	1.12E-02	0.00E+00	0.00E+00	0.00E+00	1.25E+04
Zr-95	1.65E+03	5.21E+02	3.58E+02	0.00E+00	7.65E+02	0.00E+00	1.20E+06
Zr-97	7.87E-01	1.56E-01	7.17E-02	0.00E+00	2.36E-01	0.00E+00	4.22E+04
Nb-95	1.41E+05	7.82E+04	4.30E+04	0.00E+00	7.58E+04	0.00E+00	3.34E+08
Mo-99	0.00E+00	4.46E+07	8.51E+06	0.00E+00	1.02E+08	0.00E+00	8.00E+07
Tc- 99M	5.74E+00	1.60E+01	2.07E+02	0.00E+00	2.39E+02	8.89E+00	1.05E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.81E+03	0.00E+00	7.74E+02	0.00E+00	6.38E+03	0.00E+00	1.51E+05
Ru-105	1.55E-03	0.00E+00	6.03E-04	0.00E+00	1.96E-02	0.00E+00	1.25E+00
Ru-106	3.75E+04	0.00E+00	4.73E+03	0.00E+00	7.24E+04	0.00E+00	1.80E+06
Ag-110M	9.63E+07	9.11E+07	5.54E+07	0.00E+00	1.74E+08	0.00E+00	2.56E+10

Table 13a (Continued)
Teen Grass-Cow-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.01E+07	1.08E+07	4.02E+06	8.40E+06	0.00E+00	0.00E+00	8.87E+07
Te-127M	8.44E+07	2.99E+07	1.00E+07	2.01E+07	3.42E+08	0.00E+00	2.10E+08
Te-127	1.24E+03	4.38E+02	2.66E+02	8.52E+02	5.00E+03	0.00E+00	9.54E+04
Te-129M	1.10E+08	4.09E+07	1.74E+07	3.55E+07	4.61E+08	0.00E+00	4.13E+08
Te-129	5.20E-10	1.94E-10	1.27E-10	3.72E-10	2.18E-09	0.00E+00	2.84E-09
Te-131M	6.57E+05	3.15E+05	2.63E+05	4.74E+05	3.28E+06	0.00E+00	2.53E+07
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	4.27E+06	2.71E+06	2.55E+06	2.85E+06	2.60E+07	0.00E+00	8.57E+07
I-130	7.35E+05	2.13E+06	8.49E+05	1.73E+08	3.27E+06	0.00E+00	1.63E+06
I-131	5.37E+08	7.52E+08	4.04E+08	2.19E+11	1.29E+09	0.00E+00	1.49E+08
I-132	2.92E-01	7.64E-01	2.74E-01	2.57E+01	1.20E+00	0.00E+00	3.33E-01
I-133	7.08E+06	1.20E+07	3.66E+06	1.68E+09	2.11E+07	0.00E+00	9.09E+06
I-134	3.35E-12	8.89E-12	3.19E-12	1.48E-10	1.40E-11	0.00E+00	1.17E-13
I-135	2.29E+04	5.91E+04	2.19E+04	3.80E+06	9.33E+04	0.00E+00	6.54E+04
Cs-134	9.82E+09	2.31E+10	1.07E+10	0.00E+00	7.34E+09	2.80E+09	2.87E+08
Cs-136	4.47E+08	1.76E+09	1.18E+09	0.00E+00	9.58E+08	1.51E+08	1.42E+08
Cs-137	1.34E+10	1.78E+10	6.20E+09	0.00E+00	6.06E+09	2.35E+09	2.53E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	8.20E-08	5.77E-11	2.39E-09	0.00E+00	5.44E-11	3.98E-11	7.31E-07
Ba-140	4.85E+07	5.95E+04	3.13E+06	0.00E+00	2.02E+04	4.00E+04	7.49E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	8.12E+00	3.99E+00	1.06E+00	0.00E+00	0.00E+00	0.00E+00	2.29E+05
La-142	3.41E-11	1.51E-11	3.77E-12	0.00E+00	0.00E+00	0.00E+00	4.61E-07
Ce-141	8.88E+03	5.93E+03	6.81E+02	0.00E+00	2.79E+03	0.00E+00	1.70E+07
Ce-143	7.62E+01	5.55E+04	6.20E+00	0.00E+00	2.49E+01	0.00E+00	1.67E+06
Ce-144	6.58E+05	2.72E+05	3.54E+04	0.00E+00	1.63E+05	0.00E+00	1.66E+08
Pr-143	2.90E+02	1.16E+02	1.44E+01	0.00E+00	6.74E+01	0.00E+00	9.55E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.82E+02	1.98E+02	1.19E+01	0.00E+00	1.17E+02	0.00E+00	7.16E+05
W-187	1.19E+04	9.71E+03	3.40E+03	0.00E+00	0.00E+00	0.00E+00	2.63E+06
Np-239	7.00E+00	6.60E-01	3.67E-01	0.00E+00	2.07E+00	0.00E+00	1.06E+05

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per µCi/m^3.

Table 13b
Child Grass-Cow-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	8.97E+02	8.97E+02	8.97E+02	8.97E+02	8.97E+02	8.97E+02
Na-24	8.93E+06	8.93E+06	8.93E+06	8.93E+06	8.93E+06	8.93E+06	8.93E+06
Cr-51	0.00E+00	0.00E+00	1.02E+05	5.65E+04	1.54E+04	1.03E+05	5.39E+06
Mn-54	0.00E+00	2.10E+07	5.59E+06	0.00E+00	5.88E+06	0.00E+00	1.76E+07
Mn-56	0.00E+00	1.28E-02	2.88E-03	0.00E+00	1.54E-02	0.00E+00	1.85E+00
Fe-55	1.12E+08	5.93E+07	1.84E+07	0.00E+00	0.00E+00	3.35E+07	1.10E+07
Fe-59	1.20E+08	1.94E+08	9.69E+07	0.00E+00	0.00E+00	5.64E+07	2.02E+08
Co-58	0.00E+00	1.21E+07	3.71E+07	0.00E+00	0.00E+00	0.00E+00	7.08E+07
Co-60	0.00E+00	4.32E+07	1.27E+08	0.00E+00	0.00E+00	0.00E+00	2.39E+08
Ni-63	2.96E+10	1.59E+09	1.01E+09	0.00E+00	0.00E+00	0.00E+00	1.07E+08
Ni-65	1.66E+00	1.56E-01	9.11E-02	0.00E+00	0.00E+00	0.00E+00	1.91E+01
Cu-64	0.00E+00	7.39E+04	4.47E+04	0.00E+00	1.79E+05	0.00E+00	3.47E+06
Zn-65	4.13E+09	1.10E+10	6.85E+09	0.00E+00	6.94E+09	0.00E+00	1.93E+09
Zn-69	9.10E-12	1.32E-11	1.22E-12	0.00E+00	7.98E-12	0.00E+00	8.29E-10
Br-83	0.00E+00	0.00E+00	4.37E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	8.78E+09	5.40E+09	0.00E+00	0.00E+00	0.00E+00	5.65E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	6.62E+09	0.00E+00	1.89E+08	0.00E+00	0.00E+00	0.00E+00	2.56E+08
Sr-90	1.68E+11	0.00E+00	3.38E+09	0.00E+00	0.00E+00	0.00E+00	1.51E+09
Sr-91	1.29E+05	0.00E+00	4.88E+03	0.00E+00	0.00E+00	0.00E+00	2.86E+05
Sr-92	2.16E+00	0.00E+00	8.67E-02	0.00E+00	0.00E+00	0.00E+00	4.09E+01
Y-90	3.23E+02	0.00E+00	8.64E+00	0.00E+00	0.00E+00	0.00E+00	9.19E+05
Y-91M	2.87E-19	0.00E+00	1.04E-20	0.00E+00	0.00E+00	0.00E+00	5.62E-16
Y-91	3.90E+04	0.00E+00	1.04E+03	0.00E+00	0.00E+00	0.00E+00	5.20E+06
Y-92	2.53E-04	0.00E+00	7.23E-06	0.00E+00	0.00E+00	0.00E+00	7.30E+00
Y-93	1.00E+00	0.00E+00	2.75E-02	0.00E+00	0.00E+00	0.00E+00	1.50E+04
Zr-95	3.83E+03	8.43E+02	7.50E+02	0.00E+00	1.21E+03	0.00E+00	8.79E+05
Zr-97	1.91E+00	2.77E-01	1.63E-01	0.00E+00	3.97E-01	0.00E+00	4.19E+04
Nb-95	3.18E+05	1.24E+05	8.85E+04	0.00E+00	1.16E+05	0.00E+00	2.29E+08
Mo-99	0.00E+00	8.12E+07	2.01E+07	0.00E+00	1.73E+08	0.00E+00	6.72E+07
Tc- 99M	1.32E+01	2.58E+01	4.28E+02	0.00E+00	3.75E+02	1.31E+01	1.47E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	4.28E+03	0.00E+00	1.65E+03	0.00E+00	1.08E+04	0.00E+00	1.11E+05
Ru-105	3.79E-03	0.00E+00	1.38E-03	0.00E+00	3.33E-02	0.00E+00	2.48E+00
Ru-106	9.24E+04	0.00E+00	1.15E+04	0.00E+00	1.25E+05	0.00E+00	1.44E+06
Ag-110M	2.09E+08	1.41E+08	1.13E+08	0.00E+00	2.63E+08	0.00E+00	1.68E+10

Table 13b (Continued)
Child Grass-Cow-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	7.38E+07	2.00E+07	9.84E+06	2.07E+07	0.00E+00	0.00E+00	7.12E+07
Te-127M	2.08E+08	5.60E+07	2.47E+07	4.97E+07	5.93E+08	0.00E+00	1.68E+08
Te-127	3.04E+03	8.19E+02	6.51E+02	2.10E+03	8.64E+03	0.00E+00	1.19E+05
Te-129M	2.71E+08	7.58E+07	4.21E+07	8.75E+07	7.97E+08	0.00E+00	3.31E+08
Te-129	1.28E-09	3.58E-10	3.05E-10	9.16E-10	3.75E-09	0.00E+00	7.99E-08
Te-131M	1.60E+06	5.53E+05	5.88E+05	1.14E+06	5.35E+06	0.00E+00	2.24E+07
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	1.02E+07	4.52E+06	5.46E+06	6.58E+06	4.19E+07	0.00E+00	4.55E+07
I-130	1.72E+06	3.47E+06	1.79E+06	3.82E+08	5.19E+06	0.00E+00	1.62E+06
I-131	1.30E+09	1.31E+09	7.45E+08	4.33E+11	2.15E+09	0.00E+00	1.17E+08
I-132	6.91E-01	1.27E+00	5.84E-01	5.89E+01	1.94E+00	0.00E+00	1.49E+00
I-133	1.72E+07	2.13E+07	8.05E+06	3.95E+09	3.55E+07	0.00E+00	8.57E+06
I-134	7.94E-12	1.47E-11	6.79E-12	3.39E-10	2.26E-11	0.00E+00	9.78E-12
I-135	5.43E+04	9.78E+04	4.62E+04	8.66E+06	1.50E+05	0.00E+00	7.45E+04
Cs-134	2.26E+10	3.72E+10	7.84E+09	0.00E+00	1.15E+10	4.13E+09	2.00E+08
Cs-136	1.01E+09	2.77E+09	1.80E+09	0.00E+00	1.48E+09	2.20E+08	9.75E+07
Cs-137	3.22E+10	3.09E+10	4.55E+09	0.00E+00	1.01E+10	3.62E+09	1.93E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	2.01E-07	1.08E-10	5.84E-09	0.00E+00	9.39E-11	6.33E-11	1.16E-05
Ba-140	1.17E+08	1.03E+05	6.84E+06	0.00E+00	3.34E+04	6.12E+04	5.94E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	1.95E+01	6.80E+00	2.29E+00	0.00E+00	0.00E+00	0.00E+00	1.90E+05
La-142	8.24E-11	2.63E-11	8.22E-12	0.00E+00	0.00E+00	0.00E+00	5.20E-06
Ce-141	2.19E+04	1.09E+04	1.62E+03	0.00E+00	4.78E+03	0.00E+00	1.36E+07
Ce-143	1.87E+02	1.01E+05	1.47E+01	0.00E+00	4.26E+01	0.00E+00	1.49E+06
Ce-144	1.62E+06	5.09E+05	8.66E+04	0.00E+00	2.82E+05	0.00E+00	1.33E+08
Pr-143	7.18E+02	2.16E+02	3.57E+01	0.00E+00	1.17E+02	0.00E+00	7.75E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	4.48E+02	3.63E+02	2.81E+01	0.00E+00	1.99E+02	0.00E+00	5.75E+05
W-187	2.89E+04	1.71E+04	7.67E+03	0.00E+00	0.00E+00	0.00E+00	2.40E+06
Np-239	1.72E+01	1.24E+00	8.69E-01	0.00E+00	3.58E+00	0.00E+00	9.15E+04

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 13c
Infant Grass-Cow-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.36E+03	1.36E+03	1.36E+03	1.36E+03	1.36E+03	1.36E+03
Na-24	1.56E+07	1.56E+07	1.56E+07	1.56E+07	1.56E+07	1.56E+07	1.56E+07
Cr-51	0.00E+00	0.00E+00	1.61E+05	1.05E+05	2.30E+04	2.05E+05	4.70E+06
Mn-54	0.00E+00	3.90E+07	8.84E+06	0.00E+00	8.64E+06	0.00E+00	1.43E+07
Mn-56	0.00E+00	3.13E-02	5.39E-03	0.00E+00	2.69E-02	0.00E+00	2.84E+00
Fe-55	1.35E+08	8.73E+07	2.33E+07	0.00E+00	0.00E+00	4.27E+07	1.11E+07
Fe-59	2.24E+08	3.92E+08	1.54E+08	0.00E+00	0.00E+00	1.16E+08	1.87E+08
Co-58	0.00E+00	2.43E+07	6.05E+07	0.00E+00	0.00E+00	0.00E+00	6.04E+07
Co-60	0.00E+00	8.82E+07	2.08E+08	0.00E+00	0.00E+00	0.00E+00	2.10E+08
Ni-63	3.49E+10	2.16E+09	1.21E+09	0.00E+00	0.00E+00	0.00E+00	1.07E+08
Ni-65	3.51E+00	3.97E-01	1.81E-01	0.00E+00	0.00E+00	0.00E+00	3.02E+01
Cu-64	0.00E+00	1.84E+05	8.51E+04	0.00E+00	3.11E+05	0.00E+00	3.77E+06
Zn-65	5.55E+09	1.90E+10	8.78E+09	0.00E+00	9.23E+09	0.00E+00	1.61E+10
Zn-69	1.94E-11	3.49E-11	2.60E-12	0.00E+00	1.45E-11	0.00E+00	2.85E-09
Br-83	0.00E+00	0.00E+00	9.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.23E+10	1.10E+10	0.00E+00	0.00E+00	0.00E+00	5.70E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.26E+10	0.00E+00	3.61E+08	0.00E+00	0.00E+00	0.00E+00	2.59E+08
Sr-90	1.86E+11	0.00E+00	3.77E+09	0.00E+00	0.00E+00	0.00E+00	1.52E+09
Sr-91	2.70E+05	0.00E+00	9.76E+03	0.00E+00	0.00E+00	0.00E+00	3.19E+05
Sr-92	4.60E+00	0.00E+00	1.71E-01	0.00E+00	0.00E+00	0.00E+00	4.96E+01
Y-90	6.82E+02	0.00E+00	1.83E+01	0.00E+00	0.00E+00	0.00E+00	9.42E+05
Y-91M	6.09E-19	0.00E+00	2.07E-20	0.00E+00	0.00E+00	0.00E+00	2.03E-15
Y-91	7.33E+04	0.00E+00	1.95E+03	0.00E+00	0.00E+00	0.00E+00	5.25E+06
Y-92	5.37E-04	0.00E+00	1.51E-05	0.00E+00	0.00E+00	0.00E+00	1.02E+01
Y-93	2.14E+00	0.00E+00	5.83E-02	0.00E+00	0.00E+00	0.00E+00	1.69E+04
Zr-95	6.81E+03	1.66E+03	1.18E+03	0.00E+00	1.79E+03	0.00E+00	8.26E+05
Zr-97	4.05E+00	6.96E-01	3.18E-01	0.00E+00	7.01E-01	0.00E+00	4.44E+04
Nb-95	5.94E+05	2.45E+05	1.41E+05	0.00E+00	1.75E+05	0.00E+00	2.07E+08
Mo-99	0.00E+00	2.08E+08	4.05E+07	0.00E+00	3.10E+08	0.00E+00	6.84E+07
Tc- 99M	2.74E+01	5.65E+01	7.27E+02	0.00E+00	6.08E+02	2.95E+01	1.64E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	8.67E+03	0.00E+00	2.90E+03	0.00E+00	1.80E+04	0.00E+00	1.05E+05
Ru-105	8.00E-03	0.00E+00	2.69E-03	0.00E+00	5.88E-02	0.00E+00	3.18E+00
Ru-106	1.90E+05	0.00E+00	2.38E+04	0.00E+00	2.25E+05	0.00E+00	1.44E+06
Ag-110M	3.86E+08	2.82E+08	1.86E+08	0.00E+00	4.03E+08	0.00E+00	1.46E+10

Table 13c (Continued)
Infant Grass-Cow-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.51E+08	5.04E+07	2.04E+07	5.08E+07	0.00E+00	0.00E+00	7.19E+07
Te-127M	4.21E+08	1.40E+08	5.10E+07	1.22E+08	1.04E+09	0.00E+00	1.70E+08
Te-127	6.45E+03	2.16E+03	1.39E+03	5.25E+03	1.57E+04	0.00E+00	1.35E+05
Te-129M	5.57E+08	1.91E+08	8.58E+07	2.14E+08	1.39E+09	0.00E+00	3.33E+08
Te-129	2.72E-09	9.38E-10	6.35E-10	2.28E-09	6.77E-09	0.00E+00	2.17E-07
Te-131M	3.37E+06	1.36E+06	1.12E+06	2.75E+06	9.35E+06	0.00E+00	2.29E+07
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.10E+07	1.04E+07	9.71E+06	1.54E+07	6.51E+07	0.00E+00	3.85E+07
I-130	3.53E+06	7.77E+06	3.12E+06	8.71E+08	8.53E+06	0.00E+00	1.67E+06
I-131	2.72E+09	3.20E+09	1.41E+09	1.05E+12	3.74E+09	0.00E+00	1.14E+08
I-132	1.43E+00	2.91E+00	1.04E+00	1.36E+02	3.25E+00	0.00E+00	2.36E+00
I-133	3.63E+07	5.29E+07	1.55E+07	9.62E+09	6.22E+07	0.00E+00	8.95E+06
I-134	1.65E-11	3.37E-11	1.20E-11	7.87E-10	3.77E-11	0.00E+00	3.49E-11
I-135	1.13E+05	2.25E+05	8.19E+04	2.01E+07	2.50E+05	0.00E+00	8.13E+04
Cs-134	3.65E+10	6.80E+10	6.87E+09	0.00E+00	1.75E+10	7.18E+09	1.85E+08
Cs-136	1.97E+09	5.80E+09	2.16E+09	0.00E+00	2.31E+09	4.72E+08	8.80E+07
Cs-137	5.15E+10	6.02E+10	4.27E+09	0.00E+00	1.62E+10	6.55E+09	1.88E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	4.29E-07	2.84E-10	1.24E-08	0.00E+00	1.71E-10	1.72E-10	2.72E-05
Ba-140	2.41E+08	2.41E+05	1.24E+07	0.00E+00	5.72E+04	1.48E+05	5.92E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	4.06E+01	1.60E+01	4.12E+00	0.00E+00	0.00E+00	0.00E+00	1.88E+05
La-142	1.73E-10	6.35E-11	1.52E-11	0.00E+00	0.00E+00	0.00E+00	1.08E-05
Ce-141	4.34E+04	2.64E+04	3.11E+03	0.00E+00	8.15E+03	0.00E+00	1.37E+07
Ce-143	3.96E+02	2.63E+05	3.00E+01	0.00E+00	7.65E+01	0.00E+00	1.53E+06
Ce-144	2.33E+06	9.52E+05	1.30E+05	0.00E+00	3.85E+05	0.00E+00	1.33E+08
Pr-143	1.49E+03	5.56E+02	7.37E+01	0.00E+00	2.07E+02	0.00E+00	7.84E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	8.88E+02	9.12E+02	5.59E+01	0.00E+00	3.51E+02	0.00E+00	5.78E+05
W-187	6.08E+04	4.23E+04	1.46E+04	0.00E+00	0.00E+00	0.00E+00	2.48E+06
Np-239	3.64E+01	3.26E+00	1.84E+00	0.00E+00	6.50E+00	0.00E+00	9.42E+04

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per µCi/m^3.

Table 14
Adult Grass-Goat-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	8.88E+02	8.88E+02	8.88E+02	8.88E+02	8.88E+02	8.88E+02
Na-24	2.95E+05	2.95E+05	2.95E+05	2.95E+05	2.95E+05	2.95E+05	2.95E+05
Cr-51	0.00E+00	0.00E+00	3.43E+03	2.05E+03	7.55E+02	4.55E+03	8.62E+05
Mn-54	0.00E+00	1.01E+06	1.93E+05	0.00E+00	3.00E+05	0.00E+00	3.09E+06
Mn-56	0.00E+00	4.95E-04	8.79E-05	0.00E+00	6.29E-04	0.00E+00	1.58E-02
Fe-55	3.26E+05	2.26E+05	5.26E+04	0.00E+00	0.00E+00	1.26E+05	1.29E+05
Fe-59	3.86E+05	9.07E+05	3.48E+05	0.00E+00	0.00E+00	2.53E+05	3.02E+06
Co-58	0.00E+00	5.66E+05	1.27E+06	0.00E+00	0.00E+00	0.00E+00	1.15E+07
Co-60	0.00E+00	1.97E+06	4.34E+06	0.00E+00	0.00E+00	0.00E+00	3.70E+07
Ni-63	8.07E+08	5.60E+07	2.71E+07	0.00E+00	0.00E+00	0.00E+00	1.17E+07
Ni-65	4.44E-02	5.77E-03	2.63E-03	0.00E+00	0.00E+00	0.00E+00	1.46E-01
Cu-64	0.00E+00	2.63E+03	1.23E+03	0.00E+00	6.63E+03	0.00E+00	2.24E+05
Zn-65	1.65E+08	5.24E+08	2.37E+08	0.00E+00	3.50E+08	0.00E+00	3.30E+08
Zn-69	2.41E-13	4.61E-13	3.21E-14	0.00E+00	3.00E-13	0.00E+00	6.93E-14
Br-83	0.00E+00	0.00E+00	1.16E-02	0.00E+00	0.00E+00	0.00E+00	1.67E-02
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	3.12E+08	1.45E+08	0.00E+00	0.00E+00	0.00E+00	6.15E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.05E+09	0.00E+00	8.74E+07	0.00E+00	0.00E+00	0.00E+00	4.88E+08
Sr-90	1.13E+11	0.00E+00	2.27E+09	0.00E+00	0.00E+00	0.00E+00	2.84E+09
Sr-91	6.03E+04	0.00E+00	2.44E+03	0.00E+00	0.00E+00	0.00E+00	2.87E+05
Sr-92	1.02E+00	0.00E+00	4.39E-02	0.00E+00	0.00E+00	0.00E+00	2.01E+01
Y-90	8.52E+00	0.00E+00	2.28E-01	0.00E+00	0.00E+00	0.00E+00	9.03E+04
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.26E-20
Y-91	1.03E+03	0.00E+00	2.76E+01	0.00E+00	0.00E+00	0.00E+00	5.67E+05
Y-92	6.68E-06	0.00E+00	1.95E-07	0.00E+00	0.00E+00	0.00E+00	1.17E-01
Y-93	2.66E-02	0.00E+00	7.34E-04	0.00E+00	0.00E+00	0.00E+00	8.43E+02
Zr-95	1.13E+02	3.63E+01	2.46E+01	0.00E+00	5.70E+01	0.00E+00	1.15E+05
Zr-97	5.19E-02	1.05E-02	4.79E-03	0.00E+00	1.58E-02	0.00E+00	3.24E+03
Nb-95	9.92E+03	5.52E+03	2.97E+03	0.00E+00	5.45E+03	0.00E+00	3.35E+07
Mo-99	0.00E+00	2.97E+06	5.65E+05	0.00E+00	6.72E+06	0.00E+00	6.88E+06
Tc- 99M	3.97E-01	1.12E+00	1.43E+01	0.00E+00	1.70E+01	5.50E-01	6.64E+02
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.22E+02	0.00E+00	5.26E+01	0.00E+00	4.66E+02	0.00E+00	1.43E+04
Ru-105	1.02E-04	0.00E+00	4.03E-05	0.00E+00	1.32E-03	0.00E+00	6.25E-02
Ru-106	2.45E+03	0.00E+00	3.10E+02	0.00E+00	4.73E+03	0.00E+00	1.58E+05
Ag-110M	6.99E+06	6.46E+06	3.84E+06	0.00E+00	1.27E+07	0.00E+00	2.64E+09

Table 14 (Continued)
Adult Grass-Goat-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.96E+06	7.09E+05	2.62E+05	5.88E+05	7.95E+06	0.00E+00	7.81E+06
Te-127M	5.49E+06	1.96E+06	6.69E+05	1.40E+06	2.23E+07	0.00E+00	1.84E+07
Te-127	8.00E+01	2.87E+01	1.73E+01	5.92E+01	3.26E+02	0.00E+00	6.31E+03
Te-129M	7.22E+06	2.69E+06	1.14E+06	2.48E+06	3.01E+07	0.00E+00	3.64E+07
Te-129	3.39E-11	1.27E-11	8.26E-12	2.60E-11	1.43E-10	0.00E+00	2.56E-11
Te-131M	4.33E+04	2.12E+04	1.76E+04	3.35E+04	2.14E+05	0.00E+00	2.10E+06
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.87E+05	1.86E+05	1.74E+05	2.05E+05	1.79E+06	0.00E+00	8.78E+06
I-130	5.01E+05	1.48E+06	5.84E+05	1.25E+08	2.31E+06	0.00E+00	1.27E+06
I-131	3.55E+08	5.08E+08	2.91E+08	1.67E+11	8.71E+08	0.00E+00	1.34E+08
I-132	1.98E-01	5.29E-01	1.85E-01	1.85E+01	8.42E-01	0.00E+00	9.93E-02
I-133	4.65E+06	8.09E+06	2.47E+06	1.19E+09	1.41E+07	0.00E+00	7.27E+06
I-134	2.27E-12	6.15E-12	2.20E-12	1.07E-10	9.79E-12	0.00E+00	5.36E-15
I-135	1.55E+04	4.06E+04	1.50E+04	2.68E+06	6.51E+04	0.00E+00	4.58E+04
Cs-134	1.70E+10	4.04E+10	3.30E+10	0.00E+00	1.31E+10	4.34E+09	7.06E+08
Cs-136	7.88E+08	3.11E+09	2.24E+09	0.00E+00	1.73E+09	2.37E+08	3.53E+08
Cs-137	2.21E+10	3.03E+10	1.98E+10	0.00E+00	1.03E+10	3.42E+09	5.86E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	5.32E-09	3.79E-12	1.56E-10	0.00E+00	3.54E-12	2.15E-12	9.44E-09
Ba-140	3.23E+06	4.05E+03	2.11E+05	0.00E+00	1.38E+03	2.32E+03	6.64E+06
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	5.43E-01	2.74E-01	7.23E-02	0.00E+00	0.00E+00	0.00E+00	2.01E+04
La-142	2.27E-12	1.03E-12	2.57E-13	0.00E+00	0.00E+00	0.00E+00	7.53E-09
Ce-141	5.81E+02	3.93E+02	4.46E+01	0.00E+00	1.83E+02	0.00E+00	1.50E+06
Ce-143	4.98E+00	3.68E+03	4.07E-01	0.00E+00	1.62E+00	0.00E+00	1.38E+05
Ce-144	4.29E+04	1.79E+04	2.30E+03	0.00E+00	1.06E+04	0.00E+00	1.45E+07
Pr-143	1.90E+01	7.60E+00	9.40E-01	0.00E+00	4.39E+00	0.00E+00	8.31E+04
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.14E+01	1.32E+01	7.87E-01	0.00E+00	7.69E+00	0.00E+00	6.31E+04
W-187	7.82E+02	6.53E+02	2.28E+02	0.00E+00	0.00E+00	0.00E+00	2.14E+05
Np-239	4.40E-01	4.33E-02	2.39E-02	0.00E+00	1.35E-01	0.00E+00	8.88E+03

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 14a
Teen Grass-Goat-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.16E+03	1.16E+03	1.16E+03	1.16E+03	1.16E+03	1.16E+03
Na-24	5.15E+05	5.15E+05	5.15E+05	5.15E+05	5.15E+05	5.15E+05	5.15E+05
Cr-51	0.00E+00	0.00E+00	5.99E+03	3.33E+03	1.31E+03	8.55E+03	1.01E+06
Mn-54	0.00E+00	1.68E+06	3.34E+05	0.00E+00	5.02E+05	0.00E+00	3.45E+06
Mn-56	0.00E+00	8.78E-04	1.56E-04	0.00E+00	1.11E-03	0.00E+00	5.78E-02
Fe-55	5.79E+05	4.11E+05	9.57E+04	0.00E+00	0.00E+00	2.60E+05	1.78E+05
Fe-59	6.74E+05	1.57E+06	6.07E+05	0.00E+00	0.00E+00	4.96E+05	3.72E+06
Co-58	0.00E+00	9.53E+05	2.20E+06	0.00E+00	0.00E+00	0.00E+00	1.31E+07
Co-60	0.00E+00	3.34E+06	7.52E+06	0.00E+00	0.00E+00	0.00E+00	4.35E+07
Ni-63	1.42E+09	1.00E+08	4.81E+07	0.00E+00	0.00E+00	0.00E+00	1.59E+07
Ni-65	8.13E-02	1.04E-02	4.73E-03	0.00E+00	0.00E+00	0.00E+00	5.63E-01
Cu-64	0.00E+00	4.69E+03	2.20E+03	0.00E+00	1.19E+04	0.00E+00	3.64E+05
Zn-65	2.53E+08	8.78E+08	4.09E+08	0.00E+00	5.62E+08	0.00E+00	3.72E+08
Zn-69	4.44E-13	8.46E-13	5.92E-14	0.00E+00	5.53E-13	0.00E+00	1.56E-12
Br-83	0.00E+00	0.00E+00	2.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.68E+08	2.67E+08	0.00E+00	0.00E+00	0.00E+00	8.41E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	5.61E+09	0.00E+00	1.61E+08	0.00E+00	0.00E+00	0.00E+00	6.69E+08
Sr-90	1.71E+11	0.00E+00	3.41E+09	0.00E+00	0.00E+00	0.00E+00	3.90E+09
Sr-91	1.11E+05	0.00E+00	4.41E+03	0.00E+00	0.00E+00	0.00E+00	5.02E+05
Sr-92	1.86E+00	0.00E+00	7.92E-02	0.00E+00	0.00E+00	0.00E+00	4.74E+01
Y-90	1.56E+01	0.00E+00	4.21E-01	0.00E+00	0.00E+00	0.00E+00	1.29E+05
Y-91M	1.41E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.66E-19
Y-91	1.90E+03	0.00E+00	5.08E+01	0.00E+00	0.00E+00	0.00E+00	7.77E+05
Y-92	1.23E-05	0.00E+00	3.57E-07	0.00E+00	0.00E+00	0.00E+00	3.39E-01
Y-93	4.90E-02	0.00E+00	1.34E-03	0.00E+00	0.00E+00	0.00E+00	1.50E+03
Zr-95	1.98E+02	6.25E+01	4.30E+01	0.00E+00	9.18E+01	0.00E+00	1.44E+05
Zr-97	9.44E-02	1.87E-02	8.61E-03	0.00E+00	2.83E-02	0.00E+00	5.06E+03
Nb-95	1.69E+04	9.38E+03	5.16E+03	0.00E+00	9.09E+03	0.00E+00	4.01E+07
Mo-99	0.00E+00	5.36E+06	1.02E+06	0.00E+00	1.23E+07	0.00E+00	9.59E+06
Tc- 99M	6.89E-01	1.92E+00	2.49E+01	0.00E+00	2.86E+01	1.07E+00	1.26E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	2.17E+02	0.00E+00	9.29E+01	0.00E+00	7.66E+02	0.00E+00	1.81E+04
Ru-105	1.86E-04	0.00E+00	7.24E-05	0.00E+00	2.35E-03	0.00E+00	1.51E-01
Ru-106	4.50E+03	0.00E+00	5.67E+02	0.00E+00	8.68E+03	0.00E+00	2.16E+05
Ag-110M	1.16E+07	1.09E+07	6.65E+06	0.00E+00	2.09E+07	0.00E+00	3.07E+09

Table 14a (Continued)
Teen Grass-Goat-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.61E+06	1.30E+06	4.82E+05	1.01E+06	0.00E+00	0.00E+00	1.06E+07
Te-127M	1.01E+07	3.59E+06	1.20E+06	2.41E+06	4.10E+07	0.00E+00	2.52E+07
Te-127	1.48E+02	5.25E+01	3.19E+01	1.02E+02	6.00E+02	0.00E+00	1.14E+04
Te-129M	1.32E+07	4.90E+06	2.09E+06	4.26E+06	5.53E+07	0.00E+00	4.96E+07
Te-129	6.24E-11	2.33E-11	1.52E-11	4.46E-11	2.62E-10	0.00E+00	3.41E-10
Te-131M	7.88E+04	3.78E+04	3.15E+04	5.68E+04	3.94E+05	0.00E+00	3.03E+06
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	5.13E+05	3.25E+05	3.06E+05	3.42E+05	3.12E+06	0.00E+00	1.03E+07
I-130	8.82E+05	2.55E+06	1.02E+06	2.08E+08	3.93E+06	0.00E+00	1.96E+06
I-131	6.45E+08	9.02E+08	4.85E+08	2.63E+11	1.55E+09	0.00E+00	1.78E+08
I-132	3.50E-01	9.17E-01	3.29E-01	3.09E+01	1.44E+00	0.00E+00	3.99E-01
I-133	8.50E+06	1.44E+07	4.40E+06	2.01E+09	2.53E+07	0.00E+00	1.09E+07
I-134	4.03E-12	1.07E-11	3.83E-12	1.78E-10	1.68E-11	0.00E+00	1.41E-13
I-135	2.75E+04	7.09E+04	2.63E+04	4.56E+06	1.12E+05	0.00E+00	7.85E+04
Cs-134	2.94E+10	6.93E+10	3.22E+10	0.00E+00	2.20E+10	8.41E+09	8.62E+08
Cs-136	1.34E+09	5.28E+09	3.54E+09	0.00E+00	2.87E+09	4.53E+08	4.25E+08
Cs-137	4.02E+10	5.34E+10	1.86E+10	0.00E+00	1.82E+10	7.06E+09	7.60E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	9.84E-09	6.92E-12	2.87E-10	0.00E+00	6.53E-12	4.77E-12	8.78E-08
Ba-140	5.82E+06	7.14E+03	3.75E+05	0.00E+00	2.42E+03	4.80E+03	8.98E+06
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	9.75E-01	4.79E-01	1.27E-01	0.00E+00	0.00E+00	0.00E+00	2.75E+04
La-142	4.09E-12	1.82E-12	4.53E-13	0.00E+00	0.00E+00	0.00E+00	5.53E-08
Ce-141	1.07E+03	7.12E+02	8.17E+01	0.00E+00	3.35E+02	0.00E+00	2.04E+06
Ce-143	9.15E+00	6.66E+03	7.44E-01	0.00E+00	2.99E+00	0.00E+00	2.00E+05
Ce-144	7.90E+04	3.27E+04	4.24E+03	0.00E+00	1.95E+04	0.00E+00	1.99E+07
Pr-143	3.48E+01	1.39E+01	1.73E+00	0.00E+00	8.08E+00	0.00E+00	1.15E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	2.19E+01	2.38E+01	1.43E+00	0.00E+00	1.40E+01	0.00E+00	8.59E+04
W-187	1.43E+03	1.17E+03	4.08E+02	0.00E+00	0.00E+00	0.00E+00	3.15E+05
Np-239	8.40E-01	7.92E-02	4.40E-02	0.00E+00	2.49E-01	0.00E+00	1.27E+04

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 14b
Child Grass-Goat-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.83E+03	1.83E+03	1.83E+03	1.83E+03	1.83E+03	1.83E+03
Na-24	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06	1.07E+06
Cr-51	0.00E+00	0.00E+00	1.22E+04	6.78E+03	1.85E+03	1.24E+04	6.47E+05
Mn-54	0.00E+00	2.52E+06	6.70E+05	0.00E+00	7.06E+05	0.00E+00	2.11E+06
Mn-56	0.00E+00	1.53E-03	3.46E-04	0.00E+00	1.85E-03	0.00E+00	2.22E-01
Fe-55	1.45E+06	7.71E+05	2.39E+05	0.00E+00	0.00E+00	4.36E+05	1.43E+05
Fe-59	1.56E+06	2.53E+06	1.26E+06	0.00E+00	0.00E+00	7.33E+05	2.63E+06
Co-58	0.00E+00	1.46E+06	4.46E+06	0.00E+00	0.00E+00	0.00E+00	8.49E+06
Co-60	0.00E+00	5.18E+06	1.53E+07	0.00E+00	0.00E+00	0.00E+00	2.87E+07
Ni-63	3.56E+09	1.90E+08	1.21E+08	0.00E+00	0.00E+00	0.00E+00	1.28E+07
Ni-65	1.99E-01	1.87E-02	1.09E-02	0.00E+00	0.00E+00	0.00E+00	2.29E+00
Cu-64	0.00E+00	8.24E+03	4.98E+03	0.00E+00	1.99E+04	0.00E+00	3.87E+05
Zn-65	4.96E+08	1.32E+09	8.22E+08	0.00E+00	8.33E+08	0.00E+00	2.32E+08
Zn-69	1.09E-12	1.58E-12	1.46E-13	0.00E+00	9.57E-13	0.00E+00	9.95E-11
Br-83	0.00E+00	0.00E+00	5.24E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.05E+09	6.48E+08	0.00E+00	0.00E+00	0.00E+00	6.78E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.39E+10	0.00E+00	3.97E+08	0.00E+00	0.00E+00	0.00E+00	5.38E+08
Sr-90	3.53E+11	0.00E+00	7.11E+09	0.00E+00	0.00E+00	0.00E+00	3.16E+09
Sr-91	2.72E+05	0.00E+00	1.03E+04	0.00E+00	0.00E+00	0.00E+00	6.00E+05
Sr-92	4.54E+00	0.00E+00	1.82E-01	0.00E+00	0.00E+00	0.00E+00	8.60E+01
Y-90	3.87E+01	0.00E+00	1.04E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+05
Y-91M	3.45E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.75E-17
Y-91	4.68E+03	0.00E+00	1.25E+02	0.00E+00	0.00E+00	0.00E+00	6.24E+05
Y-92	3.03E-05	0.00E+00	8.67E-07	0.00E+00	0.00E+00	0.00E+00	8.75E-01
Y-93	1.20E-01	0.00E+00	3.31E-03	0.00E+00	0.00E+00	0.00E+00	1.80E+03
Zr-95	4.60E+02	1.01E+02	9.00E+01	0.00E+00	1.45E+02	0.00E+00	1.05E+05
Zr-97	2.30E-01	3.32E-02	1.96E-02	0.00E+00	4.77E-02	0.00E+00	5.03E+03
Nb-95	3.82E+04	1.49E+04	1.06E+04	0.00E+00	1.40E+04	0.00E+00	2.75E+07
Mo-99	0.00E+00	9.75E+06	2.41E+06	0.00E+00	2.08E+07	0.00E+00	8.06E+06
Tc- 99M	1.58E+00	3.10E+00	5.14E+01	0.00E+00	4.50E+01	1.57E+00	1.76E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	5.14E+02	0.00E+00	1.97E+02	0.00E+00	1.29E+03	0.00E+00	1.33E+04
Ru-105	4.55E-04	0.00E+00	1.65E-04	0.00E+00	4.00E-03	0.00E+00	2.97E-01
Ru-106	1.11E+04	0.00E+00	1.38E+03	0.00E+00	1.50E+04	0.00E+00	1.72E+05
Ag-110M	2.51E+07	1.69E+07	1.35E+07	0.00E+00	3.15E+07	0.00E+00	2.01E+09

Table 14b (Continued)
Child Grass-Goat-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	8.86E+06	2.40E+06	1.18E+06	2.49E+06	0.00E+00	0.00E+00	8.55E+06
Te-127M	2.50E+07	6.72E+06	2.96E+06	5.97E+06	7.12E+07	0.00E+00	2.02E+07
Te-127	3.64E+02	9.83E+01	7.82E+01	2.52E+02	1.04E+03	0.00E+00	1.42E+04
Te-129M	3.26E+07	9.09E+06	5.05E+06	1.05E+07	9.56E+07	0.00E+00	3.97E+07
Te-129	1.54E-10	4.30E-11	3.66E-11	1.10E-10	4.51E-10	0.00E+00	9.59E-09
Te-131M	1.92E+05	6.63E+04	7.06E+04	1.36E+05	6.42E+05	0.00E+00	2.69E+06
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	1.22E+06	5.42E+05	6.55E+05	7.89E+05	5.03E+06	0.00E+00	5.46E+06
I-130	2.06E+06	4.17E+06	2.15E+06	4.59E+08	6.23E+06	0.00E+00	1.95E+06
I-131	1.56E+09	1.57E+09	8.94E+08	5.20E+11	2.58E+09	0.00E+00	1.40E+08
I-132	8.29E-01	1.52E+00	7.00E-01	7.07E+01	2.33E+00	0.00E+00	1.79E+00
I-133	2.06E+07	2.55E+07	9.66E+06	4.74E+09	4.25E+07	0.00E+00	1.03E+07
I-134	9.53E-12	1.77E-11	8.14E-12	4.07E-10	2.71E-11	0.00E+00	1.17E-11
I-135	6.52E+04	1.17E+05	5.55E+04	1.04E+07	1.80E+05	0.00E+00	8.94E+04
Cs-134	6.79E+10	1.11E+11	2.35E+10	0.00E+00	3.45E+10	1.24E+10	6.01E+08
Cs-136	3.03E+09	8.32E+09	5.39E+09	0.00E+00	4.43E+09	6.61E+08	2.92E+08
Cs-137	9.67E+10	9.26E+10	1.37E+10	0.00E+00	3.02E+10	1.09E+10	5.80E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	2.42E-08	1.29E-11	7.01E-10	0.00E+00	1.13E-11	7.59E-12	1.40E-06
Ba-140	1.41E+07	1.23E+04	8.21E+05	0.00E+00	4.01E+03	7.34E+03	7.12E+06
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	2.33E+00	8.16E-01	2.75E-01	0.00E+00	0.00E+00	0.00E+00	2.27E+04
La-142	9.88E-12	3.15E-12	9.87E-13	0.00E+00	0.00E+00	0.00E+00	6.24E-07
Ce-141	2.62E+03	1.31E+03	1.94E+02	0.00E+00	5.74E+02	0.00E+00	1.63E+06
Ce-143	2.25E+01	1.22E+04	1.76E+00	0.00E+00	5.11E+00	0.00E+00	1.78E+05
Ce-144	1.95E+05	6.11E+04	1.04E+04	0.00E+00	3.38E+04	0.00E+00	1.59E+07
Pr-143	8.62E+01	2.59E+01	4.28E+00	0.00E+00	1.40E+01	0.00E+00	9.30E+04
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	5.37E+01	4.35E+01	3.37E+00	0.00E+00	2.39E+01	0.00E+00	6.89E+04
W-187	3.47E+03	2.05E+03	9.21E+02	0.00E+00	0.00E+00	0.00E+00	2.88E+05
Np-239	2.07E+00	1.48E-01	1.04E-01	0.00E+00	4.29E-01	0.00E+00	1.10E+04

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per µCi/m^3.

Table 14c
Infant Grass-Goat-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	2.78E+03	2.78E+03	2.78E+03	2.78E+03	2.78E+03	2.78E+03
Na-24	1.87E+06	1.87E+06	1.87E+06	1.87E+06	1.87E+06	1.87E+06	1.87E+06
Cr-51	0.00E+00	0.00E+00	1.93E+04	1.26E+04	2.76E+03	2.46E+04	5.64E+05
Mn-54	0.00E+00	4.68E+06	1.06E+06	0.00E+00	1.04E+06	0.00E+00	1.72E+06
Mn-56	0.00E+00	3.75E-03	6.47E-04	0.00E+00	3.22E-03	0.00E+00	3.41E-01
Fe-55	1.76E+06	1.13E+06	3.03E+05	0.00E+00	0.00E+00	5.55E+05	1.44E+05
Fe-59	2.92E+06	5.09E+06	2.01E+06	0.00E+00	0.00E+00	1.51E+06	2.43E+06
Co-58	0.00E+00	2.91E+06	7.26E+06	0.00E+00	0.00E+00	0.00E+00	7.25E+06
Co-60	0.00E+00	1.06E+07	2.50E+07	0.00E+00	0.00E+00	0.00E+00	2.52E+07
Ni-63	4.19E+09	2.59E+08	1.45E+08	0.00E+00	0.00E+00	0.00E+00	1.29E+07
Ni-65	4.21E-01	4.77E-02	2.17E-02	0.00E+00	0.00E+00	0.00E+00	3.63E+00
Cu-64	0.00E+00	2.05E+04	9.48E+03	0.00E+00	3.46E+04	0.00E+00	4.20E+05
Zn-65	6.66E+08	2.28E+09	1.05E+09	0.00E+00	1.11E+09	0.00E+00	1.93E+09
Zn-69	2.33E-12	4.19E-12	3.12E-13	0.00E+00	1.74E-12	0.00E+00	3.42E-10
Br-83	0.00E+00	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.67E+09	1.32E+09	0.00E+00	0.00E+00	0.00E+00	6.84E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.64E+10	0.00E+00	7.58E+08	0.00E+00	0.00E+00	0.00E+00	5.43E+08
Sr-90	3.91E+11	0.00E+00	7.92E+09	0.00E+00	0.00E+00	0.00E+00	3.19E+09
Sr-91	5.66E+05	0.00E+00	2.05E+04	0.00E+00	0.00E+00	0.00E+00	6.70E+05
Sr-92	9.65E+00	0.00E+00	3.59E-01	0.00E+00	0.00E+00	0.00E+00	1.04E+02
Y-90	8.19E+01	0.00E+00	2.20E+00	0.00E+00	0.00E+00	0.00E+00	1.13E+05
Y-91M	7.31E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E-16
Y-91	8.79E+03	0.00E+00	2.34E+02	0.00E+00	0.00E+00	0.00E+00	6.30E+05
Y-92	6.44E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	1.23E+00
Y-93	2.57E-01	0.00E+00	6.99E-03	0.00E+00	0.00E+00	0.00E+00	2.03E+03
Zr-95	8.17E+02	1.99E+02	1.41E+02	0.00E+00	2.15E+02	0.00E+00	9.91E+04
Zr-97	4.87E-01	8.35E-02	3.81E-02	0.00E+00	8.42E-02	0.00E+00	5.33E+03
Nb-95	7.13E+04	2.94E+04	1.70E+04	0.00E+00	2.10E+04	0.00E+00	2.48E+07
Mo-99	0.00E+00	2.49E+07	4.86E+06	0.00E+00	3.72E+07	0.00E+00	8.21E+06
Tc- 99M	3.29E+00	6.78E+00	8.73E+01	0.00E+00	7.29E+01	3.54E+00	1.97E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.04E+03	0.00E+00	3.48E+02	0.00E+00	2.16E+03	0.00E+00	1.27E+04
Ru-105	9.60E-04	0.00E+00	3.23E-04	0.00E+00	7.06E-03	0.00E+00	3.82E-01
Ru-106	2.28E+04	0.00E+00	2.85E+03	0.00E+00	2.70E+04	0.00E+00	1.73E+05
Ag-110M	4.63E+07	3.38E+07	2.24E+07	0.00E+00	4.84E+07	0.00E+00	1.75E+09

Table 14c (Continued)
Infant Grass-Goat-Milk Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	1.81E+07	6.05E+06	2.45E+06	6.09E+06	0.00E+00	0.00E+00	8.62E+06
Te-127M	5.05E+07	1.68E+07	6.12E+06	1.46E+07	1.24E+08	0.00E+00	2.04E+07
Te-127	7.74E+02	2.59E+02	1.66E+02	6.30E+02	1.89E+03	0.00E+00	1.63E+04
Te-129M	6.68E+07	2.29E+07	1.03E+07	2.57E+07	1.67E+08	0.00E+00	3.99E+07
Te-129	3.26E-10	1.13E-10	7.62E-11	2.74E-10	8.13E-10	0.00E+00	2.61E-08
Te-131M	4.05E+05	1.63E+05	1.35E+05	3.30E+05	1.12E+06	0.00E+00	2.74E+06
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.52E+06	1.25E+06	1.17E+06	1.84E+06	7.81E+06	0.00E+00	4.62E+06
I-130	4.24E+06	9.32E+06	3.74E+06	1.04E+09	1.02E+07	0.00E+00	2.00E+06
I-131	3.26E+09	3.85E+09	1.69E+09	1.26E+12	4.49E+09	0.00E+00	1.37E+08
I-132	1.72E+00	3.49E+00	1.24E+00	1.64E+02	3.90E+00	0.00E+00	2.83E+00
I-133	4.36E+07	6.35E+07	1.86E+07	1.15E+10	7.46E+07	0.00E+00	1.07E+07
I-134	1.98E-11	4.05E-11	1.44E-11	9.44E-10	4.53E-11	0.00E+00	4.19E-11
I-135	1.36E+05	2.70E+05	9.83E+04	2.42E+07	3.01E+05	0.00E+00	9.76E+04
Cs-134	1.09E+11	2.04E+11	2.06E+10	0.00E+00	5.25E+10	2.15E+10	5.54E+08
Cs-136	5.91E+09	1.74E+10	6.49E+09	0.00E+00	6.93E+09	1.42E+09	2.64E+08
Cs-137	1.54E+11	1.81E+11	1.28E+10	0.00E+00	4.85E+10	1.96E+10	5.65E+08
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	5.14E-08	3.41E-11	1.49E-09	0.00E+00	2.05E-11	2.07E-11	3.26E-06
Ba-140	2.89E+07	2.89E+04	1.49E+06	0.00E+00	6.87E+03	1.78E+04	7.11E+06
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	4.88E+00	1.92E+00	4.95E-01	0.00E+00	0.00E+00	0.00E+00	2.26E+04
La-142	2.08E-11	7.62E-12	1.82E-12	0.00E+00	0.00E+00	0.00E+00	1.29E-06
Ce-141	5.20E+03	3.17E+03	3.73E+02	0.00E+00	9.78E+02	0.00E+00	1.64E+06
Ce-143	4.75E+01	3.15E+04	3.60E+00	0.00E+00	9.19E+00	0.00E+00	1.84E+05
Ce-144	2.79E+05	1.14E+05	1.56E+04	0.00E+00	4.62E+04	0.00E+00	1.60E+07
Pr-143	1.78E+02	6.67E+01	8.84E+00	0.00E+00	2.48E+01	0.00E+00	9.41E+04
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.07E+02	1.09E+02	6.70E+00	0.00E+00	4.22E+01	0.00E+00	6.93E+04
W-187	7.29E+03	5.07E+03	1.75E+03	0.00E+00	0.00E+00	0.00E+00	2.98E+05
Np-239	4.37E+00	3.91E-01	2.21E-01	0.00E+00	7.80E-01	0.00E+00	1.13E+04

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per µCi/m^3.

Table 15
Adult Grass-Cow-Meat Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.85E+02	1.85E+02	1.85E+02	1.85E+02	1.85E+02	1.85E+02
Na-24	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03
Cr-51	0.00E+00	0.00E+00	7.04E+03	4.21E+03	1.55E+03	9.34E+03	1.77E+06
Mn-54	0.00E+00	9.18E+06	1.75E+06	0.00E+00	2.73E+06	0.00E+00	2.81E+07
Mn-56	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-55	2.93E+08	2.03E+08	4.72E+07	0.00E+00	0.00E+00	1.13E+08	1.16E+08
Fe-59	2.65E+08	6.24E+08	2.39E+08	0.00E+00	0.00E+00	1.74E+08	2.08E+09
Co-58	0.00E+00	1.82E+07	4.09E+07	0.00E+00	0.00E+00	0.00E+00	3.70E+08
Co-60	0.00E+00	7.52E+07	1.66E+08	0.00E+00	0.00E+00	0.00E+00	1.41E+09
Ni-63	1.89E+10	1.31E+09	6.33E+08	0.00E+00	0.00E+00	0.00E+00	2.73E+08
Ni-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cu-64	0.00E+00	2.52E-07	1.18E-07	0.00E+00	6.36E-07	0.00E+00	2.15E-05
Zn-65	3.56E+08	1.13E+09	5.12E+08	0.00E+00	7.57E+08	0.00E+00	7.13E+08
Zn-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.88E+08	2.28E+08	0.00E+00	0.00E+00	0.00E+00	9.63E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.01E+08	0.00E+00	8.65E+06	0.00E+00	0.00E+00	0.00E+00	4.83E+07
Sr-90	1.43E+10	0.00E+00	2.87E+08	0.00E+00	0.00E+00	0.00E+00	3.59E+08
Sr-91	1.43E-10	0.00E+00	5.79E-12	0.00E+00	0.00E+00	0.00E+00	6.83E-10
Sr-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	1.08E+02	0.00E+00	2.91E+00	0.00E+00	0.00E+00	0.00E+00	1.15E+06
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.13E+06	0.00E+00	3.03E+04	0.00E+00	0.00E+00	0.00E+00	6.23E+08
Y-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-93	4.39E-12	0.00E+00	1.21E-13	0.00E+00	0.00E+00	0.00E+00	1.39E-07
Zr-95	1.87E+06	6.01E+05	4.07E+05	0.00E+00	9.43E+05	0.00E+00	1.91E+09
Zr-97	2.04E-05	4.12E-06	1.88E-06	0.00E+00	6.22E-06	0.00E+00	1.28E+00
Nb-95	2.30E+06	1.28E+06	6.89E+05	0.00E+00	1.27E+06	0.00E+00	7.78E+09
Mo-99	0.00E+00	9.93E+04	1.89E+04	0.00E+00	2.25E+05	0.00E+00	2.30E+05
Tc- 99M	0.00E+00	1.22E-20	1.56E-19	0.00E+00	1.85E-19	0.00E+00	7.23E-18
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.05E+08	0.00E+00	4.53E+07	0.00E+00	4.01E+08	0.00E+00	1.23E+10
Ru-105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106	2.80E+09	0.00E+00	3.54E+08	0.00E+00	5.40E+09	0.00E+00	1.81E+11
Ag-110M	6.68E+06	6.18E+06	3.67E+06	0.00E+00	1.22E+07	0.00E+00	2.52E+09

Table 15 (Continued)
Adult Grass-Cow-Meat Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.59E+08	1.30E+08	4.81E+07	1.08E+08	1.46E+09	0.00E+00	1.43E+09
Te-127M	1.12E+09	3.99E+08	1.36E+08	2.85E+08	4.53E+09	0.00E+00	3.74E+09
Te-127	2.50E-10	8.98E-11	5.41E-11	1.85E-10	1.02E-09	0.00E+00	1.97E-08
Te-129M	1.13E+09	4.23E+08	1.79E+08	3.89E+08	4.73E+09	0.00E+00	5.71E+09
Te-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-131M	4.49E+02	2.20E+02	1.83E+02	3.48E+02	2.23E+03	0.00E+00	2.18E+04
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	1.40E+06	9.03E+05	8.48E+05	9.98E+05	8.70E+06	0.00E+00	4.27E+07
I-130	2.03E-06	5.98E-06	2.36E-06	5.07E-04	9.33E-06	0.00E+00	5.15E-06
I-131	1.07E+07	1.54E+07	8.80E+06	5.03E+09	2.63E+07	0.00E+00	4.05E+06
I-132	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	3.70E-01	6.43E-01	1.96E-01	9.45E+01	1.12E+00	0.00E+00	5.78E-01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	4.66E-17	1.22E-16	4.50E-17	8.04E-15	1.95E-16	0.00E+00	1.38E-16
Cs-134	6.58E+08	1.57E+09	1.28E+09	0.00E+00	5.07E+08	1.68E+08	2.74E+07
Cs-136	1.20E+07	4.73E+07	3.40E+07	0.00E+00	2.63E+07	3.61E+06	5.37E+06
Cs-137	8.72E+08	1.19E+09	7.81E+08	0.00E+00	4.05E+08	1.35E+08	2.31E+07
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-140	2.88E+07	3.61E+04	1.88E+06	0.00E+00	1.23E+04	2.07E+04	5.92E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	3.76E-02	1.90E-02	5.01E-03	0.00E+00	0.00E+00	0.00E+00	1.39E+03
La-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-141	1.40E+04	9.49E+03	1.08E+03	0.00E+00	4.41E+03	0.00E+00	3.63E+07
Ce-143	1.99E-02	1.47E+01	1.63E-03	0.00E+00	6.47E-03	0.00E+00	5.49E+02
Ce-144	1.46E+06	6.09E+05	7.83E+04	0.00E+00	3.61E+05	0.00E+00	4.93E+08
Pr-143	2.10E+04	8.42E+03	1.04E+03	0.00E+00	4.86E+03	0.00E+00	9.20E+07
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	7.21E+03	8.33E+03	4.98E+02	0.00E+00	4.87E+03	0.00E+00	4.00E+07
W-187	2.07E-02	1.73E-02	6.04E-03	0.00E+00	0.00E+00	0.00E+00	5.66E+00
Np-239	2.57E-01	2.53E-02	1.40E-02	0.00E+00	7.90E-02	0.00E+00	5.19E+03

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 15a
Teen Grass-Cow-Meat Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.10E+02
Na-24	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03	1.16E-03
Cr-51	0.00E+00	0.00E+00	5.63E+03	3.13E+03	1.23E+03	8.04E+03	9.46E+05
Mn-54	0.00E+00	7.00E+06	1.39E+06	0.00E+00	2.09E+06	0.00E+00	1.44E+07
Mn-56	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-55	2.38E+08	1.69E+08	3.94E+07	0.00E+00	0.00E+00	1.07E+08	7.31E+07
Fe-59	2.12E+08	4.95E+08	1.91E+08	0.00E+00	0.00E+00	1.56E+08	1.17E+09
Co-58	0.00E+00	1.41E+07	3.24E+07	0.00E+00	0.00E+00	0.00E+00	1.94E+08
Co-60	0.00E+00	5.83E+07	1.31E+08	0.00E+00	0.00E+00	0.00E+00	7.60E+08
Ni-63	1.52E+10	1.07E+09	5.15E+08	0.00E+00	0.00E+00	0.00E+00	1.71E+08
Ni-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cu-64	0.00E+00	2.06E-07	9.68E-08	0.00E+00	5.21E-07	0.00E+00	1.60E-05
Zn-65	2.50E+08	8.69E+08	4.05E+08	0.00E+00	5.56E+08	0.00E+00	3.68E+08
Zn-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.08E+08	1.91E+08	0.00E+00	0.00E+00	0.00E+00	6.03E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.54E+08	0.00E+00	7.28E+06	0.00E+00	0.00E+00	0.00E+00	3.03E+07
Sr-90	9.89E+09	0.00E+00	1.98E+08	0.00E+00	0.00E+00	0.00E+00	2.26E+08
Sr-91	1.21E-10	0.00E+00	4.80E-12	0.00E+00	0.00E+00	0.00E+00	5.47E-10
Sr-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	9.13E+01	0.00E+00	2.46E+00	0.00E+00	0.00E+00	0.00E+00	7.53E+05
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	9.54E+05	0.00E+00	2.56E+04	0.00E+00	0.00E+00	0.00E+00	3.91E+08
Y-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-93	3.71E-12	0.00E+00	1.02E-13	0.00E+00	0.00E+00	0.00E+00	1.13E-07
Zr-95	1.50E+06	4.74E+05	3.26E+05	0.00E+00	6.96E+05	0.00E+00	1.09E+09
Zr-97	1.70E-05	3.37E-06	1.55E-06	0.00E+00	5.10E-06	0.00E+00	9.11E-01
Nb-95	1.80E+06	9.98E+05	5.49E+05	0.00E+00	9.67E+05	0.00E+00	4.27E+09
Mo-99	0.00E+00	8.21E+04	1.57E+04	0.00E+00	1.88E+05	0.00E+00	1.47E+05
Tc- 99M	0.00E+00	0.00E+00	1.24E-19	0.00E+00	1.43E-19	0.00E+00	6.29E-18
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	8.56E+07	0.00E+00	3.66E+07	0.00E+00	3.02E+08	0.00E+00	7.15E+09
Ru-105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106	2.36E+09	0.00E+00	2.97E+08	0.00E+00	4.55E+09	0.00E+00	1.13E+11
Ag-110M	5.06E+06	4.79E+06	2.91E+06	0.00E+00	9.13E+06	0.00E+00	1.35E+09

Table 15a (Continued)
Teen Grass-Cow-Meat Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	3.03E+08	1.09E+08	4.06E+07	8.47E+07	0.00E+00	0.00E+00	8.95E+08
Te-127M	9.41E+08	3.34E+08	1.12E+08	2.24E+08	3.82E+09	0.00E+00	2.35E+09
Te-127	2.12E-10	7.53E-11	4.57E-11	1.46E-10	8.60E-10	0.00E+00	1.64E-08
Te-129M	9.49E+08	3.52E+08	1.50E+08	3.06E+08	3.97E+09	0.00E+00	3.56E+09
Te-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-131M	3.75E+02	1.80E+02	1.50E+02	2.70E+02	1.87E+03	0.00E+00	1.44E+04
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	1.14E+06	7.24E+05	6.81E+05	7.63E+05	6.94E+06	0.00E+00	2.29E+07
I-130	1.63E-06	4.72E-06	1.88E-06	3.85E-04	7.27E-06	0.00E+00	3.63E-06
I-131	8.92E+06	1.25E+07	6.71E+06	3.64E+09	2.15E+07	0.00E+00	2.47E+06
I-132	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	3.09E-01	5.25E-01	1.60E-01	7.32E+01	9.20E-01	0.00E+00	3.97E-01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	3.79E-17	9.75E-17	3.61E-17	6.27E-15	1.54E-16	0.00E+00	1.08E-16
Cs-134	5.23E+08	1.23E+09	5.71E+08	0.00E+00	3.91E+08	1.49E+08	1.53E+07
Cs-136	9.34E+06	3.68E+07	2.47E+07	0.00E+00	2.00E+07	3.15E+06	2.96E+06
Cs-137	7.24E+08	9.63E+08	3.36E+08	0.00E+00	3.28E+08	1.27E+08	1.37E+07
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-140	2.38E+07	2.91E+04	1.53E+06	0.00E+00	9.88E+03	1.96E+04	3.67E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	3.09E-02	1.52E-02	4.04E-03	0.00E+00	0.00E+00	0.00E+00	8.73E+02
La-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-141	1.18E+04	7.87E+03	9.04E+02	0.00E+00	3.70E+03	0.00E+00	2.25E+07
Ce-143	1.67E-02	1.22E+01	1.36E-03	0.00E+00	5.46E-03	0.00E+00	3.66E+02
Ce-144	1.23E+06	5.08E+05	6.60E+04	0.00E+00	3.04E+05	0.00E+00	3.09E+08
Pr-143	1.77E+04	7.05E+03	8.79E+02	0.00E+00	4.10E+03	0.00E+00	5.81E+07
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	6.35E+03	6.90E+03	4.14E+02	0.00E+00	4.05E+03	0.00E+00	2.49E+07
W-187	1.73E-02	1.41E-02	4.94E-03	0.00E+00	0.00E+00	0.00E+00	3.82E+00
Np-239	2.25E-01	2.12E-02	1.18E-02	0.00E+00	6.66E-02	0.00E+00	3.41E+03

Notes:

1) Units are m^2 mrem/yr per µCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

Table 15b
Child Grass-Cow-Meat Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E+00	1.34E+02	1.34E+02	1.34E+02	1.34E+02	1.34E+02	1.34E+02
Na-24	1.84E-03	1.84E-03	1.84E-03	1.84E-03	1.84E-03	1.84E-03	1.84E-03
Cr-51	0.00E+00	0.00E+00	8.78E+03	4.87E+03	1.33E+03	8.90E+03	4.66E+05
Mn-54	0.00E+00	8.01E+06	2.13E+06	0.00E+00	2.25E+06	0.00E+00	6.72E+06
Mn-56	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-55	4.57E+08	2.42E+08	7.51E+07	0.00E+00	0.00E+00	1.37E+08	4.49E+07
Fe-59	3.76E+08	6.08E+08	3.03E+08	0.00E+00	0.00E+00	1.76E+08	6.34E+08
Co-58	0.00E+00	1.64E+07	5.03E+07	0.00E+00	0.00E+00	0.00E+00	9.59E+07
Co-60	0.00E+00	6.93E+07	2.04E+08	0.00E+00	0.00E+00	0.00E+00	3.84E+08
Ni-63	2.91E+10	1.56E+09	9.91E+08	0.00E+00	0.00E+00	0.00E+00	1.05E+08
Ni-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cu-64	0.00E+00	2.77E-07	1.67E-07	0.00E+00	6.68E-07	0.00E+00	1.30E-05
Zn-65	3.75E+08	1.00E+09	6.22E+08	0.00E+00	6.30E+08	0.00E+00	1.76E+08
Zn-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-83	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.78E+08	3.55E+08	0.00E+00	0.00E+00	0.00E+00	3.72E+07
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	4.81E+08	0.00E+00	1.37E+07	0.00E+00	0.00E+00	0.00E+00	1.86E+07
Sr-90	1.57E+10	0.00E+00	3.15E+08	0.00E+00	0.00E+00	0.00E+00	1.40E+08
Sr-91	2.26E-10	0.00E+00	8.54E-12	0.00E+00	0.00E+00	0.00E+00	5.00E-10
Sr-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	1.73E+02	0.00E+00	4.62E+00	0.00E+00	0.00E+00	0.00E+00	4.92E+05
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.80E+06	0.00E+00	4.82E+04	0.00E+00	0.00E+00	0.00E+00	2.40E+08
Y-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-93	6.97E-12	0.00E+00	1.91E-13	0.00E+00	0.00E+00	0.00E+00	1.04E-07
Zr-95	2.67E+06	5.86E+05	5.22E+05	0.00E+00	8.39E+05	0.00E+00	6.11E+08
Zr-97	3.16E-05	4.57E-06	2.70E-06	0.00E+00	6.56E-06	0.00E+00	6.93E-01
Nb-95	3.11E+06	1.21E+06	8.64E+05	0.00E+00	1.14E+06	0.00E+00	2.24E+09
Mo-99	0.00E+00	1.14E+05	2.82E+04	0.00E+00	2.44E+05	0.00E+00	9.44E+04
Tc- 99M	0.00E+00	1.18E-20	1.96E-19	0.00E+00	1.72E-19	0.00E+00	6.72E-18
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.55E+08	0.00E+00	5.95E+07	0.00E+00	3.90E+08	0.00E+00	4.00E+09
Ru-105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106	4.44E+09	0.00E+00	5.54E+08	0.00E+00	5.99E+09	0.00E+00	6.90E+10
Ag-110M	8.39E+06	5.67E+06	4.53E+06	0.00E+00	1.06E+07	0.00E+00	6.74E+08

Table 15b (Continued)
Child Grass-Cow-Meat Dose Factors

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	5.70E+08	1.54E+08	7.59E+07	1.60E+08	0.00E+00	0.00E+00	5.50E+08
Te-127M	1.77E+09	4.78E+08	2.11E+08	4.24E+08	5.06E+09	0.00E+00	1.44E+09
Te-127	3.99E-10	1.08E-10	8.56E-11	2.76E-10	1.14E-09	0.00E+00	1.56E-08
Te-129M	1.79E+09	5.00E+08	2.78E+08	5.77E+08	5.25E+09	0.00E+00	2.18E+09
Te-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-131M	6.97E+02	2.41E+02	2.57E+02	4.96E+02	2.33E+03	0.00E+00	9.78E+03
Te-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-132	2.09E+06	9.23E+05	1.12E+06	1.34E+06	8.57E+06	0.00E+00	9.30E+06
I-130	2.92E-06	5.89E-06	3.04E-06	6.49E-04	8.81E-06	0.00E+00	2.76E-06
I-131	1.65E+07	1.66E+07	9.45E+06	5.50E+09	2.73E+07	0.00E+00	1.48E+06
I-132	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	5.75E-01	7.10E-01	2.69E-01	1.32E+02	1.18E+00	0.00E+00	2.86E-01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	6.86E-17	1.23E-16	5.84E-17	1.09E-14	1.89E-16	0.00E+00	9.40E-17
Cs-134	9.22E+08	1.51E+09	3.19E+08	0.00E+00	4.69E+08	1.68E+08	8.16E+06
Cs-136	1.61E+07	4.43E+07	2.87E+07	0.00E+00	2.36E+07	3.52E+06	1.56E+06
Cs-137	1.33E+09	1.28E+09	1.88E+08	0.00E+00	4.16E+08	1.50E+08	7.99E+06
Cs-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-140	4.39E+07	3.84E+04	2.56E+06	0.00E+00	1.25E+04	2.29E+04	2.22E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	5.66E-02	1.98E-02	6.67E-03	0.00E+00	0.00E+00	0.00E+00	5.52E+02
La-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-141	2.22E+04	1.11E+04	1.64E+03	0.00E+00	4.85E+03	0.00E+00	1.38E+07
Ce-143	3.14E-02	1.70E+01	2.46E-03	0.00E+00	7.14E-03	0.00E+00	2.49E+02
Ce-144	2.32E+06	7.26E+05	1.24E+05	0.00E+00	4.02E+05	0.00E+00	1.89E+08
Pr-143	3.34E+04	1.00E+04	1.66E+03	0.00E+00	5.44E+03	0.00E+00	3.61E+07
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.19E+04	9.65E+03	7.47E+02	0.00E+00	5.29E+03	0.00E+00	1.53E+07
W-187	3.21E-02	1.90E-02	8.52E-03	0.00E+00	0.00E+00	0.00E+00	2.67E+00
Np-239	4.23E-01	3.04E-02	2.14E-02	0.00E+00	8.79E-02	0.00E+00	2.25E+03

Notes:

1) Units are m^2 mrem/yr per μCi/sec with the exception of H-3.

2) For H-3, the units are mrem/yr per $\mu Ci/m^3$.

3) The infant age group is assumed to receive no dose through the meat ingestion pathway therefore no dose factors are supplied.

Supplemental Table A
Mixed Mode Joint Frequency Distribution Table Summaries

203 Foot Elevation Data

Summary Table of Percent by Direction and Class

Class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
A	290	.321	.441	.315	.303	.256	.292	.266	.474	.369	.202	.197	.191	.274	.463	.421	5.076
B	.197	.241	.284	.208	205	.167	.196	.220	.352	.288	.190	.192	.206	.225	.327	.335	3 833
C	.321	.302	.421	.293	.201	.203	.277	.312	.437	.404	.322	.342	.373	.399	.457	.409	5.474
D	1.523	1 590	2.149	1 974	1.372	1.014	1.324	1.529	2.031	1.900	1.899	1.846	2.109	2.248	2.191	2 014	28 713
E	679	.612	.764	.976	986	870	1.136	1 439	2.079	1 501	1 065	.921	993	1.133	.922	.790	16.866
F	.344	.278	.260	.298	.387	.496	530	.438	.559	526	.386	397	.589	.688	.556	.417	7.148
G	.166	.095	.098	.078	.156	.174	.270	.213	.186	.199	.258	.210	.253	.266	.184	.159	2.966
Total	3.520	3 439	4.418	4.143	3 611	3 180	4.025	4 418	6.118	5.187	4 322	4.104	4 714	5.231	5.100	4 545	70 076

Summary Table of Percent by Direction and Speed

Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
.45	.008	016	.027	025	.001	000	.017	017	.001	.001	.002	.016	.037	026	.001	.026	222
1.05	.044	.032	.042	.045	.026	.025	036	.031	032	.023	033	025	.037	035	.040	.026	.532
2 05	.224	266	.281	260	.239	.213	.243	.225	.237	.220	.208	.208	.262	.244	.244	243	3 819
3 05	.405	.426	540	.610	459	.334	.467	.438	.596	.383	.393	.384	.447	.437	.507	.487	7.313
4 05	.669	622	.756	973	.670	.453	.614	663	.695	.543	.596	.663	.678	.702	.749	.782	10.829
5 05	.624	.519	.875	.926	.681	.482	.669	.639	.769	.677	.711	.681	.738	.782	.889	808	11.470
6 05	.670	.607	.761	675	674	.587	.657	.729	944	.825	.833	.766	.788	.975	.909	.876	12 279
8.05	.732	.789	956	.534	.726	.919	1.073	1.227	2 070	1.858	1.268	1.131	1 378	1.598	1.381	1 041	18 680
10 05	.137	.154	.174	094	.127	.158	235	.423	.727	.621	.265	.216	.331	.404	.359	.245	4.667
13 05	.007	.008	005	002	.008	.010	014	.026	.047	.037	.012	.012	.017	.028	020	.012	265
18 00	.000	.000	.000	.000	000	.000	.000	.000	.000	.000	000	.000	.000	.000	.000	.000	.000
99 00	.000	.000	.000	.000	000	.000	.000	.000	.000	.000	000	000	.000	000	000	.000	.000
Total	3 520	3 439	4 418	4.143	3 611	3 180	4 025	4.418	6.118	5.187	4.322	4.104	4.714	5.231	5.100	4 545	70 076

NOTE: Wind directions in tables are presented in "wind from" and not "wind to" direction.

In order to determine the final mixed mode values, 70.076% of the elevated value (presented in the 250 FT Mixed Mode table) and 29.924% of the ground level value (presented in the 30 FT Mixed Mode table) are used to calculate the final values.

Supplemental Table A - Continued
Mixed Mode Joint Frequency Distribution Table Summaries

203 Foot Elevation Data

Summary Table of Percent by Speed and Class

Class Speed	A	B	C	D	E	F	G
.45	006	.005	006	.075	.052	.048	.030
1.05	.014	025	027	.200	.108	071	.086
2 05	.175	.197	.378	1.756	.659	.372	.283
3 05	.500	.593	.836	3 100	1.206	.683	393
4 05	803	.697	1.005	4.441	2.225	1.083	.575
5 05	.880	.674	.921	4 456	2.845	1.230	.464
6 05	.885	.588	.806	4.760	3 357	1.417	.466
8 05	1.469	.854	1.160	7 631	5.000	1 976	.591
10 05	.325	.190	.320	2.165	1.332	.259	.076
13 05	.018	.011	.015	.129	.081	.009	.002
18 00	.000	.000	.000	.000	.000	.000	.000
99.00	.000	.000	.000	.000	.000	.000	.000

Supplemental Table A - Continued
Mixed Mode Joint Frequency Distribution Table Summaries

34 Foot Elevation Data

Summary Table of Percent by Direction and Class

Class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
A	.068	071	.077	054	.100	075	.110	.135	.278	.215	.062	.050	.127	.270	.257	.176	2.125
B	.054	.044	.059	.031	.035	.049	.061	.083	.172	.123	.058	.045	.121	.176	.150	.096	1.357
C	.067	056	.098	.059	.044	.049	091	.124	.212	.133	.121	.082	.212	.276	.219	.164	2.005
D	.453	.551	613	.453	.420	.423	641	926	1.487	1.230	697	.717	1 084	1.496	1.044	.889	13.125
E	.304	.387	.249	.180	.230	.368	.580	1.093	1.991	1.311	.435	.346	.299	.343	.227	.317	8 659
F	044	063	050	.059	.086	.160	.161	.137	.339	.306	.077	.133	.144	.130	.074	.050	2 014
G	.022	.006	013	.025	035	.059	061	.037	.102	.079	024	058	.039	.038	026	.017	.641
Total	1.012	1.177	1.159	.860	.950	1.181	1.705	2 535	4.580	3 397	1.475	1.430	2.027	2.729	1.997	1.709	29.924

Summary Table of Percent by Direction and Speed

Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
.45	014	.002	.014	018	010	.009	.004	008	001	.001	.000	.000	.005	.000	.008	.000	.096
1 05	.014	016	.027	.048	.065	.061	.030	025	.013	.010	.010	.016	.019	.018	018	.017	.408
2 05	.051	052	.093	.181	.246	259	.165	099	.072	.055	.051	.087	.119	.138	.103	.077	1 849
3 05	.121	.145	.172	.202	.189	251	.309	.248	.269	222	.166	.260	.234	.213	.174	.151	3 325
4 05	.158	.155	.187	.158	.173	.215	.319	.364	.490	.509	.246	.222	.241	.243	237	.220	4.139
5 05	.130	.134	.156	.123	.152	.191	.296	.385	.600	521	.236	.146	.233	.287	.270	.214	4 075
6.05	.141	.152	.186	.089	098	.128	.310	.435	.718	.639	.216	.167	.244	.388	.340	.247	4.499
8 05	250	.325	.268	.038	.017	.066	.236	667	1.496	1.032	.420	.321	.544	.922	648	.498	7.748
10 05	.111	.168	.050	.001	.000	001	.032	.214	.679	.302	.102	.117	.269	.371	.183	.199	2.799
13 05	.023	.029	.006	.000	.000	.000	.005	076	.214	.102	024	.082	.107	.131	.015	076	891
18.00	.000	.000	000	.000	000	.000	000	.014	.027	.002	.004	012	011	.017	.000	.010	.096
99 00	.000	000	.000	.000	000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	000	.000
Total	1.012	1.177	1.159	.860	.950	1.181	1.705	2 535	4.580	3 397	1.475	1.430	2 027	2.729	1.997	1.709	29 924

NOTE: Wind directions in tables are presented in "wind from" and not "wind to" direction.

Supplemental Table A - Continued
Mixed Mode Joint Frequency Distribution Table Summaries

34 Foot Elevation Data

Summary Table of Percent by Speed and Class

Class Speed	A	B	C	D	E	F	G
45	.000	.000	.000	006	015	.031	.044
1 05	001	001	.003	.049	.126	.151	.076
2.05	017	020	029	.335	.690	.531	226
3.05	.127	.103	.157	1.118	1.175	.491	.155
4 05	.277	.192	.291	1 686	1 211	.383	.098
5 05	.332	.209	.274	1 870	1.179	.176	.035
6 05	381	.219	358	2.236	1.223	.076	005
8 05	.735	.445	632	3 993	1.844	098	.001
10 05	.214	.126	.211	1.358	.837	.053	.000
13 05	038	.040	.044	.424	.320	024	.000
18 00	001	.002	.004	049	040	.000	.000
99 00	000	000	000	000	.000	.000	000

Supplemental Table B
Ground Level Joint Frequency Distribution Table Summaries

Summary Table of Percent by Direction and Class

Class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
A	379	.415	.470	.394	.420	291	.417	.418	.728	.637	.246	.229	.358	.572	648	.609	7.230
B	.280	.286	.336	.241	229	.206	.265	332	.539	.411	.256	.206	.340	.407	.441	.431	5 203
C	385	.373	.501	.358	.246	.226	.388	471	.665	.521	.462	380	.598	.688	.624	.619	7.504
D	2 098	2 216	2 532	2 483	1.766	1 392	2 034	2.692	3 611	3.198	2.674	2.392	3 065	3.678	3 063	2 925	41.820
E	.968	1.029	914	1.221	1 210	1.387	1.849	2 754	4.116	2.772	1.298	1.258	1.197	1.411	1.052	1 068	25.502
F	.339	.347	.302	.382	.552	.788	.729	.605	.949	.850	.366	.630	.795	.765	.441	.313	9.153
G	.147	.074	.128	.163	.228	.358	.330	.229	.404	300	.133	.268	.248	.233	.191	.157	3.588
Total	4.595	4.740	5.183	5.242	4 650	4 647	6 012	7 502	11.013	8 687	5.435	5 359	6.600	7.753	6.460	6 122	100.000

Summary Table of Percent by Direction and Speed

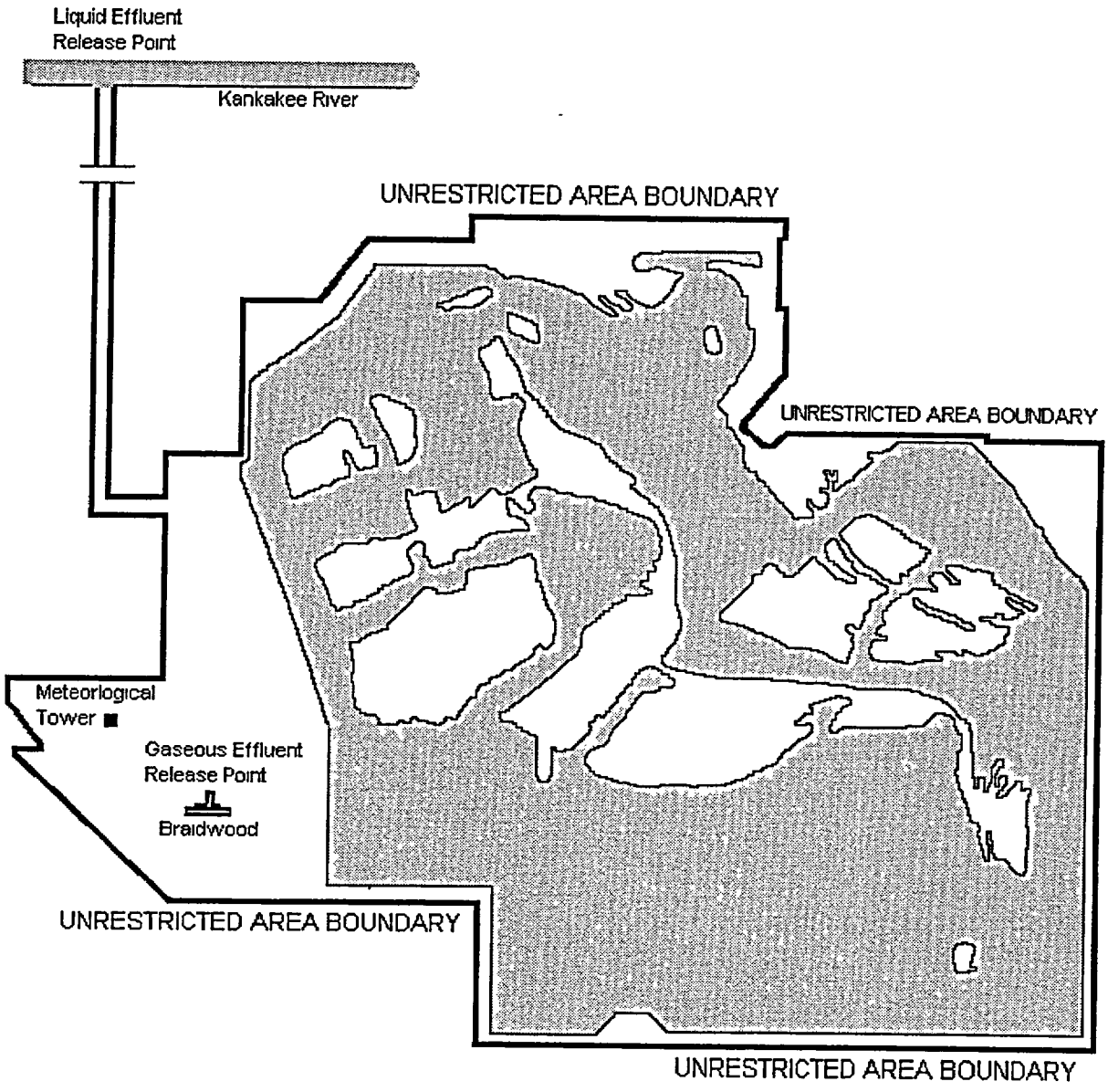
Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
.45	.194	.111	.128	.160	.078	087	042	.126	063	.013	078	.004	.037	.051	.101	.054	1.328
1.05	219	.263	.364	579	686	.517	.311	.267	.218	.181	.174	.196	.257	.264	.275	.269	5 038
2 05	.630	645	.996	1.658	1.833	1 698	1.367	962	.771	631	.561	842	1.076	1.169	.952	.780	16 571
3 05	949	1.045	1.179	1.382	1.085	1.218	1 744	1.581	1.820	1.435	1.128	1.533	1 442	1.369	1.174	1.070	21.156
4 05	.915	.902	1 015	.839	577	624	1.228	1 593	2.123	2 039	1.256	1 084	1.167	1.180	1.189	1.215	18 947
5.05	650	.641	667	.416	.260	.292	.641	1.126	1.881	1.520	.937	609	884	1.104	.995	.959	13 582
6.05	495	.462	.432	.159	.113	.143	.395	.758	1.435	1.236	598	.445	644	.936	.770	.751	9.771
8 05	.408	.472	.346	.046	018	067	.247	.785	1.782	1 226	.573	.436	.706	1.160	.806	.738	9.815
10.05	.113	170	.050	.001	000	001	032	214	.679	.302	.102	.116	.269	372	.183	201	2 805
13 05	023	029	.006	.000	.000	.000	005	.076	.214	.102	.024	082	.107	.131	015	076	889
18 00	000	.000	.000	000	.000	.000	.000	.014	027	.002	004	.012	011	.017	.000	.010	.096
99.00	000	000	.000	000	.000	.000	000	.000	.000	000	.000	.000	.000	.000	.000	.000	.000
Total	4.595	4.740	5.183	5 242	4.650	4 647	6 012	7.502	11.013	8.687	5 435	5.359	6 600	7.753	6.460	6.122	100 000

NOTE: Wind directions in tables are presented in "wind from" and not "wind to" direction.

Supplemental Table B -Continued
Ground Level Joint Frequency Distribution Table Summaries

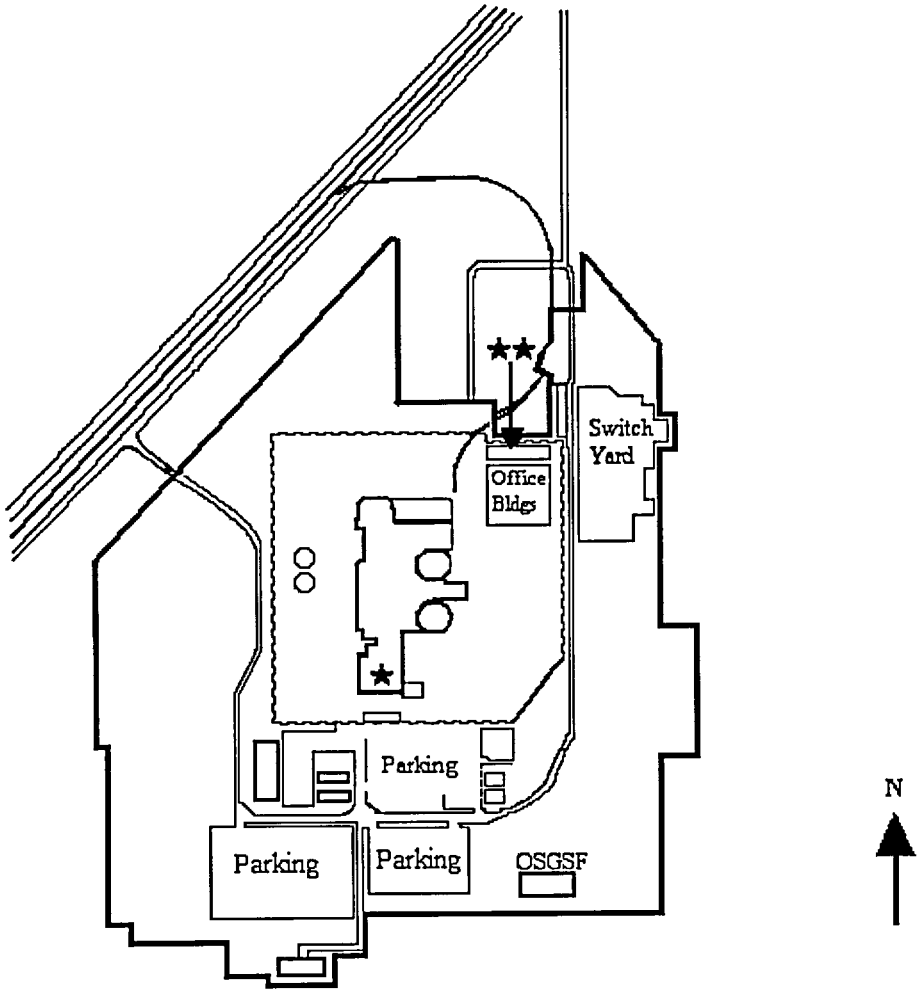
Summary Table of Percent by Speed and Class

Class Speed	A	B	C	D	E	F	G
.45	027	018	.021	.197	.339	.388	.338
1 05	.102	.093	.145	1.038	1 463	1.379	818
2 05	.426	.498	.798	4 865	5.159	3 380	1.446
3 05	1.147	1.009	1.493	8 268	6.225	2.342	.672
4.05	1 618	1.158	1.699	8 574	4.596	1.059	.244
5.05	1.446	.969	1.213	6.908	2 689	.304	.055
6.05	1.155	661	1.007	5 053	1.763	.118	014
8 05	1 054	.629	.870	5 084	2 068	.107	002
10.05	.215	.126	.212	1.360	.839	.053	.000
13.05	.038	.040	.044	.423	.320	.024	000
18.00	.001	.002	004	.049	.040	.000	.000
99 00	.000	.000	.000	.000	.000	.000	.000



OFFSITE DOSE CALCULATION
MANUAL BRAIDWOOD STATION

FIGURE F-1
UNRESTRICTED AREA BOUNDARY



★ Low Level Radwaste Storage Building (in Service Building Truck Bay)

★★ DAW Storage Area

— Restricted Area Boundary

OSGSF Old Steam Generator Storage Facility

OFFSITE DOSE CALCULATION MANUAL BRAIDWOOD STATION
FIGURE F-2 RESTRICTED AREA BOUNDARY

APPENDIX O

ODCM BASES and REFERENCE DOCUMENT

TABLE OF CONTENTS

ODCM BASES and REFERENCE

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ODCM BASES and REFERENCE

LIST OF TABLES

ODCM BASES and REFERENCE (Generic Section)

This document provides supplementary information on the bases of material in the generic section of the ODCM, Chapters 1 through 6 and Appendices A through C.

O.1 BASES OF CHAPTER 1, INTRODUCTION

O.1.1 Offsite Radiation Doses Due to Nuclear Power Plants

It is estimated that the average radiation dose received by an individual in the United States is about 360 mrem/yr and that nuclear power stations account for less than two parts in a thousand of this radiation. These figures are based on data in Table 8.1 of NCRP 93, (Reference 80). The table includes the following data:

Source	Average Individual Dose (mrem/yr)
Natural sources (average in U.S.)	300
Medical (whole-body equivalent)	53
Nuclear fuel cycle	0.05
Other	~7
Total	About 360

The radiological effects of nuclear power station operation on the environment are characterized as "usually so small that they are masked by normal fluctuations in natural background sources and by the normal uncertainties of the measurement process." Evidence of this is provided by the following data:

- **Calculated Doses Due to Airborne Effluents**

  The maximum calculated doses due to airborne effluents from Dresden 3 for 1987 were as follows (Reference 58, Page 73):

Gamma Air (mrad)	0.19
Beta Air (mrad)	0.06
Total Body (mrem)	0.19
Skin (mrem)	0.14
Thyroid (mrem)	1.62

- **TLD Measurements of Direct Radiation**

  TLD measurements of background radiation at 17 locations in the vicinity of the Dresden Station are reported on Page 86 of Reference 55. At these locations, background radiation ranged from 12 mR/quarter to 21 mR/quarter in 1987. The standard deviations of the measurements ranged from 0.6 mR/quarter to 4.7 mR/quarter. Fluctuations from quarter to quarter at a given location and fluctuations between measuring locations were often larger than 1 mR/quarter. Note that the standard deviations and the fluctuations both exceeded the calculated maximum offsite total body dose of 0.19 mrem.

The text of Chapter 1 also states that "assessing compliance with regulatory limits requires calculations because some of the limits involve quantities that cannot be directly measured. . ." Limits that cannot be feasibly monitored by direct measurement include doses to internal organs and doses attributable to particular pathways (see Appendix A).

O.1.2 Historical and Concurrent Meteorology

The use of historical average atmospheric conditions for assessment of radiation doses due to airborne effluents is stipulated in the Bases Section 12.4 and 12.6 of each station's RETS.

For Byron, Braidwood, and Zion, there is an additional requirement that the Annual Radiological Environmental Operating Report include an assessment of radiation doses due to gaseous effluents based on the "meteorological conditions concurrent with the time of release". The bases for this requirement are from Reference 7.

O.2 BASES OF CHAPTER 2, REGULATIONS AND GUIDELINES

See the documents cited in the text.

O.3 BASES OF CHAPTER 3, PATHWAYS

General information on offsite exposure pathways may be found in several texts and monographs (see References 16, 18, 20, 22, 25, 28, 29 and 31).

O.3.1 Airborne Releases (Section 3.1)

The nuclear power stations address radiation dose for the airborne pathways considered in NUREG 0133 (Reference 14). The airborne pathways found in NUREG 0133 are:

- Exposure to a cloud of noble gas.
- Exposure to standing on a contaminated ground plane.
- Inhalation of radioiodines, tritium and/or particulates.
- Ingestion of contaminated vegetation.
- Ingestion of contaminated cow and/or goat milk.
- Ingestion of contaminated cow meat.

The noble gas exposures are assessed at the site boundary. The ground plane, inhalation and ingestion exposures are determined at the location in the unrestricted area where the combination of pathways, age group and airborne deposition produce the highest potential dose to a member of the public. The ground plane and inhalation pathways are considered present at every location in the unrestricted area. Ingestion pathways are considered present at the locations determined by the land use census.

Soil uptake is not considered by the NUREG 0133 methodology but is addressed by Regulatory Guide 1.109 (Reference 6). Ingestion exposure through the mechanism of soil uptake has been shown to be minor as compared to direct deposition onto foliage. This assumption is based upon an analysis of three nuclides: I-131, Cs-134 and Cs-137. In a study of nuclear power station radiation exposures in the upper Mississippi River basin, these nuclides were found to contribute the major portion of the dose due to exposure to airborne radioactivity deposited on soil (see page IX-12 of Reference 20).

The relative importance of uptake from soil was assessed by use of Equation C-5 of Regulatory Guide 1.109. This equation calculates radioactivity concentration in vegetation. The first term inside the curly brackets of the equation represents the contribution from radioactivity directly deposited on plant foliage. The second term represents the contribution from radioactivity initially deposited on the ground and then taken up through the root system of the vegetation. For each of the three nuclides, the ratio of the uptake term to the direct deposition term was evaluated for two pathways; the grass-cow-milk pathway and the pathway of direct ingestion by man of produce and leafy vegetables. The parameter values used and the results are in Table O-1 of this document. For the six cases, the soil uptake term ranged from about

0.01% to about 10% of the direct deposition term (see the column labeled "Uptake ÷ Direct Dep" in Table O-1).

O.3.2 Liquid Releases (Section 3.2)

The nuclear power stations address radiation dose for the waterborne pathways considered in NUREG 0133. The waterborne pathways found in NUREG 0133 are:

- Ingestion of contaminated potable water.
- Ingestion of fish taken from contaminated water.
- Ingestion of invertebrates taken from contaminated water.

All of these dose pathways are considered unless demonstrated not be present. Exposure can also occur through recreation (shoreline activities, swimming and boating) and irrigation pathways (irrigation of directly ingested vegetation and food crops for animal consumption), but these have been shown to be minor as compared to direct ingestion.

The liquid pathways were evaluated based on surveys of surface water use and on liquid pathway dose calculations. Table O-2 of this document summarizes principal results of the surface water use surveys. On the basis of these surveys, it was decided to ignore the following pathways:

- Ingestion of vegetation contaminated because of irrigation with water containing radioactivity from plant liquid discharges.
- Ingestion of radioactivity that entered an animal food product (milk or meat) because the animal drank water contaminated by radioactive liquid effluents from the plant or because the animal consumed feed contaminated by irrigation with such water.

Calculations were performed to estimate annual doses from the following liquid pathways:

- Consumption of drinking water.
- Consumption of fish.
- Shoreline activities (with exposure to shoreline sediments).
- Swimming and boating.

Predicted annual doses to the total body and the thyroid for the six nuclear power stations are summarized in Tables O-3 and O-4 of this document. In all but one of the cases tabulated, the liquid pathway with the maximum annual dose is fish ingestion; the exception is for thyroid dose at Dresden 2/3, for which the maximum liquid pathway is consumption of drinking water. Doses due to shoreline activities and swimming and boating are not evaluated annually because dose estimates for these pathways are generally low. In Tables O-3 and O-4, they range from 0.02% to 10% of the doses calculated for the maximum pathway.

O.3.3 Radiation from Contained Sources (Section 3.3)

Annual radiation doses due to contained sources of radioactivity at nuclear power stations are judged to be negligible in comparison with applicable limits except for doses due to BWR turbine skyshine. This judgment is based on the considerations below.

Evaluations in the Environmental Reports

Evaluations of direct radiation from the nuclear power stations are reported in Section 5.2.4.3 of the Environmental Reports for the Braidwood, Byron, and LaSalle Stations. For the two PWRs (Braidwood and Byron), the radiation sources considered were the following:

- The containment building.
- Nitrogen-16 in primary coolant.
- Radioactivity in tanks storing refueling water, primary water or contaminated secondary water.

Annual doses calculated on the basis of 100% occupancy were as follows:

Distance From Sources (miles)	Annual Dose (mrem/yr)*
0.3	1.5E0
0.6	4.4E-2
1.0	1.4E-3

These results may be compared with the distances to the closest points on the site boundaries, which are as follows:

Station	Distance to Closest Point On Boundary (miles)**
Braidwood	0.32
Byron	0.50
Zion	0.27

From these data, the maximum annual dose at the site boundary due to direct radiation from PWRs is on the order of 1.5 mrem/yr assuming 100% occupancy at the boundary. Since the actual occupancy is likely to be much lower than 100%, the actual annual dose is likely to be much lower than 1.5 mrem/yr. Therefore, the direct radiation dose from contained sources at PWRs is judged to be negligible in comparison with 40CFR190 annual limits (25 mrem to the total body, 75 mrem to the thyroid, and 25 mrem to other organs).

For LaSalle, the maximum annual dose at the site boundary due to direct radiation was calculated in the Environmental Report to be less than 4 mrem. The largest contributor was found to be nitrogen-16 from process steam. The cycled condensate storage tanks were considered in the calculation and found to contribute less than 0.1 mrem/yr. Based on these results, the direct radiation dose from contained sources at BWRs is judged to be negligible in comparison with 40CFR190 limits except possibly for the dose due to nitrogen-16.

* Per Table 5.2-9 of Byron and Braidwood Environmental Reports.
** Based on data in ODCM Table F-3 of Appendix F.

Interim Radwaste Storage Facilities

Interim Radwaste Storage facilities (IRSF) were designed to serve as temporary repositories of solidified (dewatered) radwaste before shipment offsite. The surface dose rate of these containers may be as high as 15 R/hr (or 380 R/hr if 50.59 evaluation has been approved).

Consideration is also being given to store containers of compacted dry active waste (DAW) in Sea-Land containers at all nuclear power plant sites. These may have surface dose rates as high as 8 mR/hr at a distance of 2-meters from the container surface.

Both the IRSF and DAW will contribute direct radiation to locations in the controlled and unrestricted areas. Thus a dose assessment is required to assure site compliance to the regulations of 40CFR190 and 10CFR20.

The doses due to IRSF's have been calculated in References 60, 61, 62 and 63. In these calculations, the containers were assumed to have a contact dose rate of 15 R/hr; consideration was given to accessible sites outside of the restricted area boundary, but near the IRSF. Although some of these sites

are less than 200 meters from the IRSF, the annual doses are less than 10% of the 40CFR190 limit of 25 mrem/year when realistic occupancy factors are considered. (Additional calculations may be performed using other assumptions.)

The above calculations are, of course, estimates as the inventories, nuclide mixes, decay times, container self-shielding, and other factors affect the corresponding out-of-building dose rate. As the IRSF's become operational, the above estimates will be re-evaluated. A correlation of internal IRSF dose rate (radiation levels) with measured external IRSF dose rate will be evaluated as a better means of quantifying the IRSF offsite dose rates.

The dose due to storage of Dry Active Waste (DAW) on site in arrays of Sea/Land Vans has been evaluated. For a design basis source of 8 mR/hr at a distance of 2 meters, calculations (References 65, 66, 67 and 68) show that a dose rate of 1 mrem per year will not be exceeded at the restricted area boundary for realistic combinations of DAW locations and occupancy factors.

Since occupancy at the points of maximum offsite exposure is likely to be much less than 100%, doses due to the interim radwaste storage facilities are judged negligible in comparison with 40CFR190 limits.

O.4 BASES OF CHAPTER 4, INTRODUCTION TO METHODOLOGY

Most of the material in this chapter is based on Appendix A. Additional information on bases is provided below.

O.4.1 Introduction of Time Factors

The release rate of radioactive materials is the discharge of radioactive materials in liquid or gaseous effluents per unit time. The second is used as the practical reporting time unit for establishing release rates to show compliance with instantaneous limitations for noble gases. The hour is used as the practical reporting time unit is established average release rates to show conformance with the requirements of 10CFR50 for radioiodines and particulates released in gaseous effluents and for liquids effluents.

O.4.2 Release Point Classifications (Section 4.1.4)

For additional information, see Meteorology and Atomic Energy 1968 (Reference 18), Section 3-3.5.2, and Regulatory Guide 1.111 (Reference 7), Section B.2.

O.4.3 Airborne Releases (Section 4.2)

The noble gases expected to be released from a typical PWR or BWR are listed in Table O-5 of this document. The energies and intensities of radiations emitted from them are listed in standard compendia (e.g., see Reference 70). From Reference 70, Krypton-89 has gamma and beta emissions in excess of 4 MeV and Xenon-137 has beta emissions in excess of 4 MeV.

Gamma Radiation Mean Free Path

The mean free path **X** of gamma radiation is calculated using the following equations:

$$X = 1/\mu \qquad \text{(O-1)}$$

$$\mu = (\mu/\rho)\rho \qquad \text{(O-2)}$$

X	Mean Free Path	[cm]
	The average distance traveled by a photon before interacting with matter.	
μ	Attenuation Coefficient of Air	[cm^{-1}]
	Probability of photon absorption or scattering per unit distance traveled in air.	
ρ	Density of Air	[g/cc]

The results for photon mean free path (Section 4.2.1) are based on data in Reference 71. For a 4-MeV photon, the calculation is as follows:

μ/ρ = 0.0308 cm^2/g (per Table 5.2 of Reference 71)

ρ = 0.001293 g/cc (per Table 1.3 of Reference 71)

μ = (0.0308 cm^2/g) (0.001293 g/cc) = 3.982E-5 cm^{-1}

X = (1/3.982E-5 cm^{-1})(1 ft/30.48 cm) = 823.9 ft

Range of Beta Radiation in Air

The results for beta radiation range (Section 4.2.2) are based on equations in Reference 38. The range of beta radiation with a maximum energy greater than 2.5 MeV is given by the following equation (Reference 38, Page 100):

$$R = (530)(E_{max}) - 106 \quad \text{(O-3)}$$

R	Range	[mg/cm^2]
E_{max}	Maximum Beta Energy	[MeV]

For E_{max} = 4 MeV,

$$R = (530)(4) - 106 = 2.01E3 \text{ mg/cm}^2$$

For an air density of 1.293 mg/cc, the range is

$$[(2.01E3 \text{ mg/cm}^2)/(1.293 \text{ mg/cc})] (1 \text{ ft}/30.48 \text{ cm}) = 51.0 \text{ ft}$$

For $0.01 \leq E_{max} \leq 2.5$ MeV, the range of beta radiation is given by the following equation (Reference 38, Page 99):

$$R = (412)(E_{max})^{1.265 - (0.0954)(\ln E_{max})} \quad \text{(O-4)}$$

where R and E_{max} have the same definitions as for Equation O-3.

For example, for E_{max} = 0.1 MeV,

$$R = (412)(0.1)^{1.265 - (0.0954)\ln(0.1)} = 13.5 \text{ mg/cm}^2$$

For an air density of 1.293 mg/cc, the range is

$$[(13.5 \text{ mg/cm}^2)/(1.293 \text{ mg/cc})] (1 \text{ ft}/30.48 \text{ cm}) = 0.34 \text{ ft}$$

O.4.4 Radionuclide Types Considered For Airborne Effluent Exposure Pathways (Table 4-1)

The radionuclide types considered are the same as those recommended for concern in Regulatory Guide 1.109 except that carbon-14 is omitted. The reasons for this are discussed in the next section.

O.4.5 Reasons for Not Calculating Doses Due to Carbon-14

Carbon-14 is not considered by the stations because their RETS do not require it. The stations are required to consider only the following non-noble gas radionuclides: iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days. Although carbon-14 has a half-life of 5730 years, it does not fall in the last category (in particulate form with half-life greater than 8 days) because it is emitted as a gas, mainly CO_2 (see Reference 29, Page 167). Moreover, carbon-14 was not found to be a significant contributor to offsite radiation dose in a study of the potential radiological implications of nuclear facilities in the upper Mississippi River basin (see Reference 20, Page IX-8, Table IX-2).

O.5 BASES OF CHAPTER 5, MEASUREMENT

See the documents cited in the text.

O.6 BASES OF CHAPTER 6, IMPLEMENTATION OF THE OFFSITE DOSE ASSESSMENT PROGRAM

Chapter 6 is based on Exelon's organizational structure and departmental responsibilities.

O.7 BASES OF AIRBORNE EFFLUENT CALCULATIONS (SECTION A.1 AND APPENDIX B)

The methodology used to calculate doses and dose rates due to releases of radioactivity in airborne effluents is discussed below. The calculations use equations presented in Section A.1 of Appendix A. The equations involve meteorological transport and dose factors that are either obtained from the literature or calculated as described in Appendix B.

For the most part, the methodology of this manual for airborne effluent dose calculations is identical to that of Regulatory Guides 1.109 (Reference 6) and 1.111 (Reference 7). In the discussion below, special attention will be given to the few differences.

O.7.1 Release Point Classifications (Section A.1.1 of Appendix A)

Regulatory Guide 1.109 uses two classifications for airborne releases (see Reference 6, Regulatory Position C.2):

- Releases from free standing stacks more than 80 meters high.
- All other releases.

This manual uses three classifications for airborne releases: stack, ground and vent level. The classifications used here are based on Regulatory Positions C.2.a and C.2.b of Regulatory Guide 1.111.

O.7.2 Meteorological Data (Section B.1.1 of Appendix B)

The information in Section B.1.1 of Appendix B is based on Sargent & Lundy reviews and analyses of meteorological data from the nuclear stations. The procedure for treating calms is based on guidance in Regulatory Guide 1.111, Regulatory Position C.4.

O.7.3 Joint Frequency Distribution (Section B.1.2 of Appendix B)

The information in Section B.1.2 of Appendix B is based on discussions with Sargent & Lundy. The procedure for determining the JFD for a vent release is based on Regulatory Position C.2.b of Regulatory Guide 1.111. For each nuclear power station, an historical average JFD was calculated at Sargent & Lundy by a computer program that later evolved into the computer program METWRSUM (Reference 75). For further information on these calculations, see Reference 76.

Wind speed and direction may change with height. In accordance with Regulatory Position C.2.b of Regulatory Guide 1.111, JFD calculations for elevated releases were made using wind parameters representative of conditions at the actual release height, and calculations for ground level releases were made using wind parameters corresponding to a height of approximately 10 meters. As noted in Reference 76, in some cases interpolation of wind speed data measured at different heights was used to obtain data characteristic of the height of interest.

O.7.4 Average Wind Speed (Section B.1.3 of Appendix B)

The equations for obtaining average wind speed are based on the standard method of determining the average value of a quantity for which the frequency distribution is known. Average wind speeds for the nuclear power stations were computed using Sargent & Lundy computer program AZAP (Reference 77).

Regulatory Position C.2.a of Regulatory Guide 1.109 and C.1.c of Regulatory Guide 1.111 specify that a wind speed class be represented by the wind speed of its midpoint (i.e., average of its upper and lower limits). In the calculations this is done for each wind speed class except the highest. The highest class contains all wind speeds greater than a specified value and so has an undefined upper limit. This class is represented by the lower limit of its wind speed range in all calculations for this manual (calculations of average wind speed, χ/Q, gamma dose factors, and total body dose factors).

O.7.5 Gaussian Plume Models (Section B.2 of Appendix B)

For discussion of the Gaussian plume diffusion model and its applications to dose assessment, see References 18 (Sections 2-7.2, 3-3, 4-6.2, 7-4, and 7-5), 24, 31 (Section 2.1), and 22 (Chapter 3).

Equation B-9 of Appendix B is identical to Equation 3.115 on Page 99 of Reference 18.

Equation B-10 of Appendix B is derived from Equation B-9 of Appendix B as follows:

- A location at ground level ($z = 0$) is assumed. Equation B-9 of Appendix B becomes:

$$\chi(x,y,0) = [Q/(\pi\,\sigma_y\,\sigma_z\,u)]\ \exp[-(y^2/2\sigma^2_y) - (h_e^2/2\sigma^2_z)] \qquad \text{(O-5)}$$

- This expression for $\chi(x,y,0)$ is integrated in the crosswind direction from $y = -\infty$ to $+\infty$. This yields the following result (see Equation 3.143 of Reference 18):

$$[2^{1/2}Q/(\pi^{1/2}\sigma_z u)]\exp(-h^2e^2/2\sigma^2_z)$$

- The above expression is divided by the width of a sector at downwind distance x, $2\pi x/16$. The result is:

$$[16/(2^{1/2}\pi^{3/2})][Q/(\sigma_z\, u\, x)]\exp(-h^2_e/2\sigma^2_z)$$

that is equal to

$$[2.032Q/(\sigma_z\, u\, x)]\exp(-h^2_e/2\sigma^2_z)$$

- The result above is multiplied by a fraction f representing the fraction of time that the wind blows into the sector of interest. This yields

$$[2.032\, f\, Q/(\sigma_z\, u\, x)]\exp(-h^2_e/2\sigma^2_z)$$

that is identical to the expression in Equation B-10 of Appendix B and also to Equation 3.144 of Reference 18.

O.7.6 Relative Concentration Factor χ/Q (Section B.3 of Appendix B)

O.7.6.1 Stack Release

Equation B-13 of Appendix B is the formula for calculating the relative concentration factor $(\chi/Q)_s$ due to a stack release. Equation B-13 of Appendix B is obtained from the formula for sector-averaged concentration, Equation B-10 of Appendix B, and is of the same form as Equation 3 of Regulatory Guide 1.111. In applying Equation B-13 of Appendix B, the vertical plume spread is calculated in the way specified in the regulatory guide.

The effective release height is calculated with Equation B-14 of Appendix B. The formulas used are in accordance with those in Regulatory Guide 1.111. However, the following should be noted:

- Plume heights are limited to a maximum of 100 meters. This is done to allow use of the plume depletion and relative deposition data in Regulatory Guide 1.111. These data are not provided for release heights above 100 meters. The limitation to 100 meters represents a conservative approximation for cases in which the release height and the plume rise formulas would lead to higher plumes.

- Due to the general flatness of the terrain in the vicinity of nuclear power stations, all terrain correction parameters were taken as zero.

- Plume rise due to buoyancy was ignored because typical nuclear power plant plumes are not significantly warmer than room temperature. This neglect of buoyancy (which can be significant for plumes from fossil plants) is in accord with the guidelines of Regulatory Guide 1.111. The regulatory guide states that plume rise is calculated in accordance with Reference 78, which neglects rise due to buoyancy (see last sentence on Page 5 of Reference 78).

O.7.6.2 Ground Level Release

Equation B-25 of Appendix B is the formula for calculating the relative concentration factor $(\chi/Q)_g$ due to a ground level release. Equation B-25 of Appendix B is obtained from the formula for sector-averaged concentration, Equation B-10 of Appendix B, and is of the same form as Equation 3 of Regulatory Guide 1.111. In applying Equation B-25 of Appendix B, the vertical dispersion coefficient is calculated using Equations B-26, B-27 and B-28 of Appendix B, which are based on the prescription in Regulatory Position C.2.c.

O.7.6.3 Vent Release

Equation B-29 of Appendix B may be used for calculating the relative concentration factor $(\chi/Q)_v$ due to a vent release. The relative concentration factor is obtained as a mixture of stack and ground level factors in accordance with the guidelines in Regulatory Position C.2.b of Regulatory Guide 1.111.

O.7.6.4 Removal Mechanisms

Regulatory Position C.3 of Regulatory Guide 1.111 discusses three removal mechanisms that reduce airborne radioactivity concentration: radioactive decay, dry deposition and wet deposition. In the dose calculations involving χ/Q (see Appendix A), radioactive decay is taken into account by adjusting the measured release rate of each radionuclide for radiodecay in transit from the release point to the dose point. However, wet and dry deposition are not considered. This is a conservative approximation made to simplify the calculations. If these deposition mechanisms were considered, the X/Q values for noble gases would be different from those for particulate and iodine.

O.7.6.5 Gamma-χ/Q (Section B.3.5)

The noble gas dose factors used in Equations A-1, A-3, A-4, A-5 of Appendix A are taken from Regulatory Guide 1.109, Table B-1. These values are based upon assumption of immersion in a semi-infinite cloud. For ground level and mixed mode releases this tends to overestimate the gamma air dose arising from a plume that is actually finite in nature.

For elevated releases, the Regulatory Guide 1.109 noble gas dose factors will underestimate exposure as they consider only immersion and not that portion of exposure arising from sky shine. At distances close in to the point of elevated release, the ground level concentration as predicted by χ/Q will be essentially zero. In such a case, the sky shine component of the exposure becomes significant and must be considered.

The gamma-χ/Q provides a simplified method of calculating gamma air dose and dose rates for a finite and/or elevated plume. Regulatory Guide 1.109, Section C.2 and Appendix B provides the methodology for calculating finite cloud gamma air dose factors from which the gamma-χ/Q values can be derived.

The gamma-χ/Q is defined such that for a given finite cloud the semi-infinite cloud methodology will yield the same gamma air dose as the finite cloud methodology.

Three gamma-χ/Q values are defined: for stack, vent and ground level releases, respectively. The gamma-χ/Q values are calculated by Equations B-30, B-31 and B-32 of Appendix B and makes use of the finite cloud gamma air dose factors described in Section B-5 of Appendix B. These equations also utilizes

a noble gas nuclide fraction. These fractions can be based upon historical data or a calculated noble gas source term.

O.7.7 Relative Deposition Factor D/Q (Section B.4 of Appendix B)

Equations B-34, B-35, and B-36 of Appendix B are used to calculate values of the relative deposition factor D/Q [$1/m^2$]. These equations use data on deposition rate D_r [1/m] provided in Figures 6 through 9 of Regulatory Guide 1.111. Values of D/Q are obtained from D_r in accordance with the prescription in paragraph 5 of Regulatory Position C.3.b. Equation B-37 of Appendix B applies to a vent release and provides a value that is a mixture of stack and ground level factors in accordance with the guidelines in Regulatory Position C.2.b of Regulatory Guide 1.111.

O.7.8 Gamma Air Dose (Section A.1.2.1 of Appendix A and Section B.5 of Appendix B)

O.7.8.1 Dose (Equation A-1 of Appendix A)

Gamma air dose is calculated by Equation A-1 of Appendix A. This equation makes use of a term referred to as gamma-χ/Q (gamma-chi-over-q) which is explained in Section 4.2.1.1. It is derived from the methodology of NUREG 0133, Section 5.3.1..
NUREG 0133 deals only with two classes of noble gas releases; those from free-standing stacks more than 80 meters high and all other noble gas releases. Equation A-1 of Appendix A contains terms representing the appropriate release point classifications discussed in Section 4.1.4. The use of three release point classifications is based on Regulatory Guide 1.111, Regulatory Position C.2. The dose factors $\mathbf{M_i}$ used in Equation A-1 of Appendix A are identical to the gamma air dose factors $\mathbf{DFB_i}$ specified in Table B-1 of Regulatory Guide 1.109.

O.7.8.2 Dose Factors (Section B.5 of Appendix B)

Calculation of gamma-χ/Q involves the use of finite plume gamma air dose factors, each of which represents dose rate at a specified point per unit of radioactivity release rate. The dose factors are calculated by Equations B-40 through B-42 of Appendix B.

Equation B-40 of Appendix B is used to calculate the finite plume gamma air dose factors for a stack release. The formula is based on Equations 6 and B-1 of Regulatory Guide 1.109. Except for notation, Equation B-40 of Appendix B and the regulatory prescription are identical.

The finite plume gamma air dose factors for a ground level release are obtained by Equation B-40 of Appendix B using the ground level joint frequency distribution data and assuming an effective release height of zero. The use of a finite plume model differs from NUREG 0133 in that ground level releases are based on a semi-infinite cloud model (see Equation 7 of Regulatory Position C.2.b). The approach used here is more realistic than that in the regulatory guide.

Equation B-42 of Appendix B is used to calculate the gamma air dose factors for a vent release. The dose factors are obtained as a mixture of stack and ground level dose factors in accordance with the guidelines in Regulatory Position C.2.b of Regulatory Guide 1.111.

O.7.8.3 Use of Unrestricted Area Boundary Values for Gamma Air Dose Factors

To assess compliance with RETS limits on gamma air dose, maximum offsite values of gamma air dose should be determined. Therefore, the gamma-χ/Q values should be determined for the offsite locations where they are maximum. However, the values provided in Table F-5b of Appendix F are for the unrestricted area boundary. They are judged to be very good approximations to the maximum offsite values. This judgment is based on published values for finite cloud gamma air dose factors used to calculate gamma-χ/Q (see Reference 79).

Reference 79 provides values of the gamma air factor as follows:

- For 13 of the 15 noble gas radionuclides included in the ODCM.
- For each of the seven atmospheric stability classes considered in this manual (A through G).
- For two release heights (0 and 100 meters).
- As a function of distance from the release point. (Data is provided for six downwind distances over the range from 400 to 16,090 meters.)

Examination of the dose factor in Reference 79 for the sector-averaged meandering plume model reveals the following:

- For a ground level release, the dose factor always decreases as distance from the release point increases. (The plume broadens as it moves away from the release point.)

- For an elevated release, the dose factor decreases as distance from the release point increases with only a few exceptions (five exceptions among the 546 dose factors that are provided). The exceptions involve only weak gamma emitters (Xe-131m, Xe-133m, and Xe-133) in combination with certain stability classes. (The exceptions are due to portions of an elevated plume moving closer to the ground as the plume moves away from the release point. This increases dose rate at ground level.)

The gamma air dose factors used to calculate gamma-χ/Q in each station's Appendix F are based on historical average atmospheric conditions (see Section 4.1.5). Therefore, each gamma air dose factor involves an average over all of the meteorological stability classes, nearly all of which have dose factors that decrease as distance from the release point increases. Furthermore, the gamma air dose factors in the ODCM for ground level releases or for mixed mode releases include a large ground level component. The ground level dose factors will always decrease as distance increases, and the mixed mode factors are likely to decrease with distance because of the effect of their ground level component. Thus, it is judged that a gamma-χ/Q value calculated at the unrestricted area boundary in each sector is a very good approximation to the highest offsite value for that sector.

O.7.9 Beta Air Dose (Section A.1.2.2 of Appendix A and Section B.7 of Appendix B)

Beta air dose is calculated by Equation A-2 of Appendix A. This equation is explained in Section 4.2.2. It is based on Section 5.3.1 of NUREG 0133. Like Equation A-1 of Appendix A for gamma air dose, Equation A-2 of Appendix A contains a term representing each of the three release point classifications discussed in Section 4.1.4. The use of three release point classifications is based on Regulatory Guide 1.111, Regulatory Position C.2. The dose factors N_i used in Equation A-2 of Appendix A are identical to the beta air dose factors DFB_i specified in Table B-1 of Regulatory Guide 1.109.

O.7.10 Total Body Dose (Section A.1.2.3 of Appendix A and Section B.6 of Appendix B)

Total body dose is calculated by Equation A-3 of Appendix A. This equation is explained in Section 4.2.3. It is based on Section 5.3.1 of NUREG 0133. Like Equation A-1 of Appendix A for gamma air dose, Equation A-3 of Appendix A contains a term representing each of the three release point classifications discussed in Section 4.1.4. The use of three release point classifications is based on Regulatory Guide 1.111, Regulatory Position C.2. The dose factors K_i used in Equation A-3 of Appendix A are identical to the beta air dose factors DFB_i specified in Table B-1 of Regulatory Guide 1.109.

O.7.11 Skin Dose (Section A.1.2.4 of Appendix A and Section B.7 of Appendix B)

Skin dose is calculated by Equation A-4 of Appendix A. This equation is explained in Section 4.2.4. It is based on Section 5.2.1 of NUREG 0133. Like Equation A-1 of Appendix A for gamma air dose, Equation A-4 of Appendix A contains a term representing each of the three release point classifications discussed in Section 4.1.4. The use of three release point classifications is based on Regulatory Guide 1.111, Regulatory Position C.2. The dose factors L_i and M_i used in Equation A-4 of Appendix A are identical to the gamma and beta skin dose factors DFS_i specified in Table B-1 of Regulatory Guide 1.109.

The gamma contribution to skin dose is calculated with gamma-χ/Q in the same manner as that of Equation A-1 of Appendix A to calculate gamma air dose. This approach differs from that of the regulatory guide in that a finite cloud model is used in accounting for the portion of the dose contribution to the skin due to gamma emissions. This is more realistic than the semi-infinite cloud model used in the regulatory guide.

O.7.12 Total Body Dose Rate (Section A.1.3.1 of Appendix A)

Total body dose rate is calculated by Equation A-5 of Appendix A. This equation is explained in Section 4.2.3.

O.7.13 Skin Dose Rate (Section A.1.3.2 of Appendix A)

Skin dose rate is calculated by Equation A-6 of Appendix A. This equation is explained in Section 4.2.4.

O.7.14 Dose Due to Non-Noble Gas Radionuclides (Section A.1.4 of Appendix A)

The term dose in the title of Section A.1.4 of Appendix A includes both dose and dose commitment (see Section 4.1.1). This is based on its usage in the standard Technical Specifications (see Specification 3.11.2.3 of References 2 and 3).

The dose due to non-noble gas radionuclides is calculated by Equation A-7 of Appendix A. It is based on Section 5.3.1 of NUREG 0133.

O.7.15 Ground Deposition Dose (Section A.1.4.1 of Appendix A and Section B.8 of Appendix B)

The dose due to deposited radionuclides is calculated by Equations A-7and A-8 of Appendix A. These equations are explained in Section 4.2.5. The methodology is based upon Sections 5.3.1 and 5.3.1.2 of NUREG 0133. The ground plane dose conversion factors DFG_i used in Equation A-8 of Appendix A are identical to the dose factors provided in Table E-6 of R.G. 1.109.

Equation A-8 of Appendix A uses a value of 0.7 for the shielding factor which accounts for shielding due to occupancy of structures. This value is specified in Section 1 of Appendix B, Section II; of Regulatory Guide 1.109 and Section 5.3.1.2 of NUREG 0133.

O.7.16 Inhalation Dose (Section A.1.4.2 of Appendix A and Section B.9 of Appendix B)

The dose commitment due to inhalation is calculated by Equations A-7 and A-9 of Appendix A. This equation is explained in Section 4.2.6. It is based on Sections 5.3.1 and 5.3.1.1 of NUREG 0133. The dose factors, DFA_{ija}, used in Equation A-9 of Appendix A for 10CFR50 Appendix I compliance are identical to the inhalation dose factors provided in Tables E-7 through E-10 of Regulatory Guide 1.109.

O.7.17 Food Pathways Doses (Section A.1.4.3 of Appendix A and Section B.10 of Appendix B)

The dose commitment due to food pathways is calculated by Equations A-7 and A-10 through A-15 of Appendix A. These equations are discussed in Section 4.2.7. They are based the methodology found in Sections 5.3.1.3 through 5.3.1.5 of NUREG 0133. The dose calculations for particulate and radioiodine account for doses resulting from dry deposition of radioactive materials onto the ground and foliage. Wet deposition is not considered in evaluating long-term-average environmental doses at the nuclear power stations for the reason put forth in Regulatory Guide 1.111 (see Page 1.111-12):

O.7.18 Inhalation Dose Rate (Section A.1.5 of Appendix A)

Inhalation dose commitment rate is calculated by Equation A-16 of Appendix A. This equation is explained in Section 4.2.6.

O.8 BASES OF LIQUID EFFLUENT CALCULATIONS (SECTION A.2 and Appendix B; SECTION II)

This section presents bases of the methodology used to calculate doses and radioactivity concentrations due to releases of radioactivity in liquid effluents. The calculations use equations presented in Section A.2 of Appendix A. The equations involve transport and dose factors that are determined as described in Appendix B; Section II.

O.8.1 Dose (Section A.2.1 of Appendix A and Section B.15 of Appendix B)

The dose due to radioactive materials in liquid effluents is calculated by Equations A-17 through A-20 of Appendix A. The dose is based upon the sum of contributions from drinking water (calculated by Equations A-17, A-18 and A-19 of Appendix A) and fish (calculated by Equations A-17, A-18 and A-20 of Appendix A). The equations are explained in Section 4.3 and Section B.15 of Appendix B. They are based on Sections 4.3 and 4.3.1 of NUREG 0133.

For all stations except Zion, the flow and dilution parameters in Equations A-18 (Z) and A-18 (D^w) of Appendix A are determined using the river model (Section B.15.3.1.1 of Appendix B). For drinking water drawn downstream of Byron, Dresden, LaSalle, and Quad Cities Stations, this model assumes complete

mixing of the station discharge with river water before withdrawal as potable water. This is based on the existence of one or more dams between the station liquid discharge and the water supply intake point. For drinking water drawn downstream of Braidwood Station, this model assumes partial mixing of the Station's discharge with river water before withdrawal as potable water. See Table O-6 of this document.

For fish, the river model assumes complete mixing in the near-field river flow (Z).

For Zion the flow and dilution parameters in Equations A-18 and A-19 of Appendix A are determined using the Lake Michigan model. The assumptions of this model are stated in Section B.15.3.1.2 of Appendix B. The assumptions used to obtain the additional dilution parameter for water consumption ($Z = 10$) are based on judgment, and the assumptions used to obtain the dilution flow for fish consumption ($D^w = 6$) are based on the cited observational data.

O.8.2 Concentration Due to Tank Discharges (Section A.2.3 of Appendix A)

The concentration of radioactivity in tank discharges is calculated by Equation A-22 of Appendix A. The basis of this equation is explained in Section B.16 of Appendix B.

O.9 BASES OF CALCULATIONS OF DOSE DUE TO CONTAINED SOURCES (SECTION A.3)

Annual radiation doses due to contained sources of radioactivity at the nuclear power stations are judged to be negligible in comparison with applicable limits except for doses due to BWR turbine skyshine. This judgment is based on the considerations discussed in Section O.3.3.

O.9.1 BWR Skyshine Dose

The dose due to N^{16} skyshine is calculated by Equation A-23 of Appendix A. This equation is based on the following:

- Measurements of dose rate due to skyshine made at Dresden, Quad Cities and LaSalle.
- An empirical fit to the above data (References 46, 47 and 48).
- Measurements of the radiological effects of hydrogen addition to primary coolant at Dresden 2 (Reference 83).
- Guidelines for BWR hydrogen water chemistry installations prepared by the Hydrogen Installation Subcommittee of the BWR Owners Group for Intragranular Stress Corrosion Cracking (Reference 39).

References 46 and 47 and provides a mathematical expression for calculating an upper bound to skyshine dose when there is no hydrogen addition to primary coolant. When there is hydrogen addition, the dose is multiplied by a factor of up to 10 depending on injection rates and power level. The value of this factor is based on data and guidelines in References 83 (see Page 4-13) and 39 (see Page 8-1).

Because of natural background radiation, it was only possible to measure skyshine dose rate only to about 600 meters from the turbines. Beyond this distance, the skyshine dose rate was so small that it was masked by fluctuations in the background radiation levels (see References 46, 47 and 48). Despite this, Equation A-23 of Appendix A is put forth here for use at greater distances. This is done because estimates of skyshine dose at distances above 600 meters are sometimes needed and because Equation A-23 of Appendix A is consistent with measurements at lower distances.

O.9.2 Estimate of Dose Due to Other Facilities of the Uranium Fuel Cycle (Section A.5.2 of Appendix A)

In evaluating compliance with 40CFR190, radiation doses from other uranium fuel cycle facilities are treated as negligible except for contributions due to radioactive liquid effluents from the nuclear power stations. The reasons for evaluating the latter are conservatism and completeness. The other contributions are judged negligible on the following grounds:

- Doses due to direct radiation and airborne effluents decrease very rapidly as distance from a source or release point increases. For direct radiation, this is due to the shielding effects of air, to the $1/r^2$ falloff of radiation from a point source as distance r from the source increases, and to the exponential falloff of skyshine radiation (see Section A.3.2 of Appendix A). For airborne effluents, this is due to plume broadening, plume depletion, and the variability of wind direction (see Reference 18, especially Section 7-5.2).

- Doses due to radioactivity in liquid effluents are reduced by mixing, dilution, and plate out as water containing radioactivity moves away from the release point.

- Maximum offsite doses expected in the vicinities of uranium milling, conversion, enrichment, and fabrication facilities associated with electric power production have been shown to be less than 10CFR20 limits (see the references listed in Table O-7 of this document). Their dose effects should be negligible in the vicinity of any nuclear power station since all such facilities are located more than 100 kilometers (62 miles) from any other nuclear power station (see Table O-8 of this document).

- Maximum offsite doses from light-water-cooled nuclear power reactors are required to be below limits based on requirements in 10CFR20 and 10CFR50 Appendix I. The maximum offsite doses due to airborne effluents occur at or near the site boundary and decrease rapidly as distance from the site increases. Doses at the nuclear power stations due to other nuclear stations should be well below the limits of 10CFR20 and 10CFR50 Appendix I since all other nuclear power stations are at least 17 km (10 miles) distant from any station (see Table O-9 of this document).

- Standard Radiological Effluent Technical Specifications (References 2 and 3)/RETS and the Technical Specifications of the Byron, Braidwood and LaSalle stations allow neglect of doses due to nuclear fuel cycle facilities more than 8 kilometers (5 miles) distant (see Bases Section 12.4 for Byron, Braidwood and LaSalle.).

- The only uranium fuel cycle facility within 8 kilometers of a nuclear power station is the General Electric (GE) Company's Morris Operation at Morris, Illinois, adjacent to the Dresden. This facility is used for storage of spent fuel. Releases of radioactivity from the facility are very low (see Pages 8-1 and 8-2 of Reference 89). Ventilation air from areas of actual and potential contamination passes through a sand filter and a 300-foot high stack before release. In the period July 1974 through December 1982, maximum offsite gross beta activity never exceeded 1E-18 μCi/cc averaged over a 6-month period. This concentration may be compared to the derived air concentrations (DAC) given in 10CFR20 Appendix B; Table 2 for members of the public. Exposure to the DAC corresponds to an annual dose of 50 mrem/year. As the Morris facility results in an airborne concentration many decades below the DACs, the corresponding dose is similarly negligible. Therefore, no further consideration of this facility is required for 40CFR190 analysis.

O.10 BASES OF APPENDIX C, GENERIC DATA

The bases of the data in Appendix C are presented in Appendix C.

Table O-1
Comparison of Contributions
of Direct Deposition and Soil Uptake Terms
To Radioactivity Concentration in Vegetation

For the Grass-Cow-Milk Pathway:

	r	λ_i (hrs^{-1})	λ_w (hrs^{-1})	λ_{El} (hrs^{-1})	t_e (hrs)
I-131	1.0	3.59E-03	2.1E-03	5.69E-03	720
Cs-134	0.2	3.83E-05	2.1E-03	2.14E-03	720
Cs-137	0.2	2.62E-06	2.1E-03	2.10E-03	720

	Y_v (kg/m^2)	B_{iv}	t_b (hrs)	P (kg/m^2)	Uptake ÷ Direct Dep
I-131	0.7	2.0E-02	1.31E+05	240	9.40E-05
Cs-134	0.7	1.0E-02	1.31E+05	240	1.03E-02
Cs-137	0.7	1.0E-02	1.31E+05	240	4.36E-02

For Produce or Leafy Vegetables Ingested by Man:

	r	λ_i (hrs^{-1})	λ_w (hrs^{-1})	λ_{El} (hrs^{-1})	t_e (hrs)
I-131	1.0	3.59E-03	2.1E-03	5.69E-03	1440
Cs-134	0.2	3.83E-05	2.1E-03	2.14E-03	1440
Cs-137	0.2	2.62E-06	2.1E-03	2.10E-03	1440

	Y_v (kg/m^2)	B_{iv}	t_b (hrs)	P (kg/m^2)	Uptake ÷ Direct Dep
I-131	2	2.0E-02	1.31E+05	240	2.64E-04
Cs-134	2	1.0E-02	1.31E+05	240	2.42E-02
Cs-137	2	1.0E-02	1.31E+05	240	1.02E-01

Note: The parameter definitions are the same as in Regulatory Guide 1.109.

Table O-2
Principal Surface Water Uses

Station	Body of Water	Recreation[a]	Irrigation	Nearest Public Potable Receiving Water Intake
Braidwood[b]	Kankakee R.	Yes	No	Wilmington (5 river miles down-stream of station)
Byron[c]	Rock R.	Yes	No[d]	None on Rock River
		(Note: Rock R. flows into Mississippi R. about 115 river miles downstream of the station.)		
Dresden[e]	Illinois R.	Yes[f]	No[f]	Peoria (106 river miles down-stream of station[g])
LaSalle[h]	Illinois R.	Yes	No	Peoria (97 river miles down-stream of station)
Quad Cities[i]	Mississippi R.	Yes	Not Cited[j]	E. Moline (16 river miles down-stream of station[k])
Zion[l]	Lake Michigan	Yes	Not	Lake County Cited[m] Public Water District (1.4 mile north of site and 3000 ft out in Lake)

Note: This table summarizes selected information from the reports referenced in the footnotes below. For more complete information, see the referenced reports.

[a] Recreation includes one or more of the following: boating, water skiing, swimming, and sport fishing.

[b] Per "Assessment of the Impact of Liquid Radioactive Effluents from Braidwood Station on Proposed Public Water Intakes at Wilmington, Illinois", J.C. Golden, NSEP, January 1990.

[c] Per Byron ER, Figure 3.3-1 and Section 2.1.3.2.1.

[d] Per "Irrigation from the Rock River" letter from G.P. Lahti (Sargent & Lundy) to J C. Golden (NSEP) June 4, 1990.

[e] Per Dresden Safety Analysis Report (SAR), Section 2.5 and Dresden Station Water Flow Schematic 8/29/88.

[f] Based on data for Braidwood and LaSalle, which are near Dresden and also discharge into the Illinois River.

[g] Per Table 7.2-1 of Revision 11 of Dresden ODCM.

[h] Per LaSalle ER, Figure 3.3-1 and Section 2.1.4.2.1.

[i] Per Quad Cities Updated Final Safety Analysis Report (UFSAR) updated through Amendment 5 (9-3-87), Section 1.5.2 and Quad Cities Plant Design Analysis, Section 4.4.

[j] Existence of irrigation not mentioned in Quad Cities Final Safety Analysis Report (FSAR), UFSAR, or Plant Design Analysis.

[k] Per "Quad Cities public Water Supply" letter from B.S. Ferguson (NSEP) to G. Wassenhove (U. S. Army Corps of Engineers), February 16, 1989.

[l] Per Zion ER, Section 2.3.2.2.

[m] Existence of irrigation not mentioned in Zion ER.

Table O-3
Predicted PWR Annual Doses for Selected
Liquid Effluent Pathways

Pathway/Limit	Annual Whole Body Dose (mrem/yr per reactor) Braidwood[a]	Byron[b]	Zion[c]
Eating Fish	1.6E-2	4.5E-1	4.5E-2
Drinking Water	2.0E-2[d]	4.4E-3[d]	1.7E-3
Shoreline Activities	1.0E-2	7.8E-3	1.4E-4
Swimming and Boating	3.4E-4	2.5E-4	1.1E-5
10 CFR 50 Objective	3	3	3

Pathway/Limit	Annual Thyroid Dose (mrem/yr per reactor) Braidwood[a]	Byron[b]	Zion[c]
Eating Fish	3.5E-2	1.0E-1	3.6E-2
Drinking Water	6.3E-2	2.1E-2[e]	1.7E-2
Shoreline Activities	1.0E-2	7.8E-3	1.4E-4
Swimming and Boating	3.4E-4	2.5E-4	1.1E-5
10CFR50 Objective	10	10	10

Note: This table summarizes selected information from the reports referenced in the footnotes below. For more complete information, see the referenced reports.

[a] Per Braidwood ER, Table 5.2-7, and Reference 91. Except for potable water and fish, these values are based on water in the discharge canal. For potable water, the point of consumption is Wilmington, IL. For fish, it is assumed that they are caught in the Kankakee River.

[b] Per Byron ER, Table 5.2-7. Except for drinking water (see Footnote e), these values are based on water in the discharge canal.

[c] Per Zion Appendix I Report (Reference 72), Table 1.1-7. Except for drinking water, these values are based on water in the discharge canal; drinking water is assumed to be from the Lake County Illinois intake (see Appendix I Report, Table 1.1-6).

[d] The value in the Byron ER is based on drinking discharge canal water. The value in this table is derived by dividing the Byron ER value by 167 to account for dilution in the Rock River. This dilution factor is based on the assumption of an annual cooling tower flow rate of 30 cfs (see Byron FSAR Section 5.2.4.1) and a Rock River flow rate of 5000 cfs (per Byron ER Section 2.4.1.2). (The plant discharges liquid to the Rock River at a point approximately 115 miles above the confluence of the Rock and Mississippi Rivers. There are no public potable water intakes on the Rock River.)

Table O-4
Predicted BWR Annual Doses for Selected
Liquid Effluent Pathways

Pathway/Limit	Annual Whole Body Dose (mrem/yr per reactor) Dresden 2/3[a]	LaSalle[b]	Quad Cities[c]
Eating Fish	1.0E-2	2.8E-2	1.9E-2
Drinking Water	3.8E-4	2.4E-4	1.3E-4
Shoreline Activities	5.0E-5	1.5E-4	7.7E-5
Swimming and Boating	1.7E-5	1.4E-5	4.0E-6
10 CFR 50 Objective	3	3	3

Pathway/Limit	Annual Thyroid Dose (mrem/yr per reactor) Dresden 2/3[a]	LaSalle[b]	Quad Cities[c]
Eating Fish	3.1E-3	2.4E-2	3.0E-3
Drinking Water	1.0E-2	4.4E-3	2.2E-3
Shoreline Activities	5.0E-5	1.5E-4	7.7E-5
Swimming and Boating	1.7E-5	1.4E-5	4.0E-6
10CFR50 Objective	10	10	10

Note: This table summarizes selected information from the reports referenced in the footnotes below. For more complete information, see the referenced reports.

[a] Per Dresden 2/3 Appendix I Report (Reference 73), Table 1.1-7. Except for drinking water, these values are based on water in the discharge canal; drinking water is assumed to be from the potable water supply at the Illinois Nitrogen Corp., Marseilles, Illinois (see Appendix I Report, Table 1.1-6). Doses calculated for this water supply are higher than doses calculated for the municipal water supply at Peoria, Illinois.

[b] Per LaSalle ER, Table 5.2-5. Except for drinking water, these values are based on water in the discharge canal. Drinking water is assumed to be from the municipal water supply at Peoria, Illinois.

[c] Per Quad Cities Appendix I Report (Reference 74), Table 1.1-7. Except for drinking water, these values are based on water in the discharge canal; drinking water is assumed to be from the municipal water supply at East Moline, Illinois (see Appendix I Report, Table 1.1-6).

Table O-5
Noble Gas Radionuclides Expected
To Be Released from a Typical PWR or BWR

Kr-83m	Xe-131m	Ar-41
Kr-85m	Xe-133m	
Kr-85	Xe-133	
Kr-87	Xe-135m	
Kr-88	Xe-135	
Kr-89	Xe-137	
	Xe-138	

Note: This list is based on Table 11.3-6 of the Byron/Braidwood Final Safety Analysis Report and Table 1.11 of the LaSalle Appendix I Report (Reference 40).

Table O-6
Dams Between Liquid Discharge Points And Community Water Supply Intake Points

Braidwood
The station liquid discharge flows into the Kankakee River. The nearest public potable water intake is at Wilmington, 5 river miles downstream of station (see Table O-2 of this document).

Downstream dams within 50 miles of the station are located as follows:

- On the Kankakee River at Wilmington.
- On the Illinois River at Dresden Island, Marseilles and Starved Rock. The Kankakee River flows into the Illinois River about 12 river miles downstream of the station.

This is based on information in Figure 2.1-13 of the Braidwood Environmental Report and in Section 2.4.1.1 and Figure 2.4-2 of the LaSalle Environmental Report.

Byron
The station liquid discharge flows into the Rock River. The Rock River flows into the Mississippi River about 115 river miles downstream of the station. There are no public potable water intakes on the Rock River (see Table O-2 of this document).

According to Section 2.4.1.2 and Figure 2.4-5 of the Byron Environmental Report, there are four downstream dams on the Rock River within approximately 50 miles of the station:

- One at Oregon.
- One at Dixon.
- Two at Sterling.

Dresden
The station liquid discharge flows into the Illinois River. The nearest public potable water intake is at Peoria 106 river miles downstream of station (see Table O-2 of this document).

Downstream dams on the Illinois River within 50 miles of the station are located as follows:

- At Dresden Island.
- At Marseilles.
- At Starved Rock.

This is based on information in Figure 2.2.6:1 of the Dresden Updated Final Safety Analysis Report (updated through Rev. 5, June 1987) and in Section 2.4.1.1 and Figure 2.4-2 of the LaSalle Environmental Report.

LaSalle
The station liquid discharge flows into the Illinois River. The nearest public potable water intake is at Peoria 97 river miles downstream of station (see Table O-2 of this document).

Downstream dams on the Illinois River within 50 miles of the station are located as follows:

- At Marseilles.
- At Starved Rock.

This is based on information in Section 2.4.1.1 and Figures 2.4-2 and 2.4-6 of the LaSalle Environmental Report.

Quad Cities
The station liquid discharge flows into the Mississippi River. The nearest public potable water intake is at E. Moline, 16 river miles downstream of station (see Table O-2 of this document). Mississippi River Lock and Dam Number 14 is located between the station discharge and the E. Moline intake (see Figure 12 of the Quad Cities Unit 1 Plant Design Analysis, Volume II, and Figure 2.4.1 of the Quad Cities Safety Analysis Report).

Table O-7

Estimated Doses Due to Uranium Milling, Conversion, Enrichment, and Fabrication Facilities

The references below indicate that the maximum expected offsite doses due to uranium milling, conversion, enrichment, and fabrication facilities are less than 40CFR190 limits:

Facility Type	References
Milling	84, Page 4 85, Section 2.4 86, Page IV F-29
Conversion	85, Section 3.4 86, Page IV F-40 and Table IV F-10
Enrichment	85, Section 4.4 86, Page IV F-51
Fabrication	85, Section 5.4 86, Page IV F-63

Table O-8
Locations of Uranium Processing Facilities
Associated with Electric Power Production

Facility Type and Location	Distance From Nearest Exelon Station[a]
Milling[b]	
Colorado (2 mills)	Greater than 100 km
New Mexico (5 mills)	Greater than 100 km
Texas (7 mills)	Greater than 100 km
Utah (2 mills)	Greater than 100 km
Wyoming (8 mills)	Greater than 100 km
Conversion[c]	
Metropolis, Ill.	Greater than 100 km
Sequoyah, Okla.	Greater than 100 km
Enrichment[d]	
Oak Ridge, Tenn.	Greater than 100 km
Paducah, Ky.	Greater than 100 km
Portsmouth, Ohio	Greater than 100 km
Fabrication[d]	
Apollo, Pa.	Greater than 100 km
Cimarron, Okla.	Greater than 100 km
Columbia, S.C.	Greater than 100 km
Erwin, Tenn.	Greater than 100 km
Hematite, Mo.	Greater than 100 km
Lynchburg, Va.	Greater than 100 km
Richland, Wash.	Greater than 100 km
Wilmington, N.C.	Greater than 100 km
Windsor, Conn.	Greater than 100 km

[a] Distances based on the Rand McNally Road Atlas of the United States, Canada, and Mexico, 1983 edition.

[b] Reference 84, Page 3-5, Table 3.4, entitled "U.S. Uranium Ore Processing Mills Operating in 1978."

[c] Reference 86, Page IV F-33.

[d] Reference 86, Page IV F-43.

Table O-9
Distances Between Nearby Midwestern Nuclear Stations and Exelon Nuclear Stations

State and Station[b]		Distance to Exelon Station[a] BR	BY	DR	LA	QC	ZI
Illinois							
Braidwood (BR)	km	0	127	17	37	184	140
	miles	0	79	10	23	114	87
Byron (BY)	km	127	0	113	106	96	129
	miles	79	0	70	66	60	80
Clinton	km	130	215	143	120	214	268
	miles	81	134	89	74	133	167
Dresden (DR)	km	17	113	0	37	176	125
	miles	10	70	0	23	110	78
LaSalle (LA)	km	37	106	37	0	149	153
	miles	23	66	23	0	93	95
Quad Cites (QC)	km	184	96	176	149	0	224
	miles	114	60	110	93	0	139
Zion (ZI)	km	140	129	125	153	224	0
	miles	87	80	78	95	139	0
Iowa							
Duane Arnold	km	309	206	301	275	125	329
	miles	192	128	187	171	78	204
Michigan							
Big Rock Point	km	519	491	506	537	579	384
	miles	323	305	315	334	360	239
Donald C. Cook	km	161	225	156	194	314	116
	miles	100	140	97	120	195	72
Fermi	km	421	497	421	457	587	378
	miles	262	309	262	284	365	235
Palisades	km	199	246	192	229	339	123
	miles	124	153	120	143	211	77
Missouri							
Callaway	km	409	425	418	382	352	531
	miles	254	264	260	238	219	330
Wisconsin							
Kewaunee	km	348	288	332	356	369	209
	miles	216	179	206	221	229	130
Point Beach	km	342	283	327	350	365	203
	miles	213	176	203	218	227	126

[a] Distances between stations were calculated using latitude and longitude of each station's location. For Byron, the latitude and longitude are specified on Page 2.1-1 of the Byron Environmental Report. For each of the other stations, the latitude and longitude are specified in Appendix B of Reference 87.

[b] Considered in this table are all nuclear power stations, 30 MWe or over, operational as of December 1988 and located in Illinois, in a state neighboring Illinois (Indiana, Iowa, Kentucky, Missouri, and Wisconsin), or in Michigan. This list is based primarily on the "World List of Nuclear Power Plants" in the August 1988 issue of **Nuclear News** (Reference 88).