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United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Byron Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: 2015 Annual Radioactive Effluent Release Report

Enclosed is the Annual Radioactive Effluent Release Report for Byron Station. This report is being submitted in accordance with 10 CFR 50.36 a(2), "Technical specifications on effluents from nuclear power reactors," and includes a summary of radiological liquid and gaseous effluents and solid waste released from the site from January 2015 through December 2015. We are enclosing Revision 11 of the Byron Station Offsite Dose Calculation Manual (ODCM), the ODCM Change Determination and ODCM Change Log.

If you have any questions regarding this information, please contact Douglas Spitzer, Regulatory Assurance Manager, at (815) 406-2800.

Respectfully,

Mark E. Kanavos
Site Vice President
Byron Nuclear Generating Station

MEK/JG/AC/sg

Enclosures

cc: Cynthia D. Pederson, Regional Administrator – NRC Region III

BYRON NUCLEAR POWER STATION

ANNUAL RADIOLOGICAL EFFLUENT RELEASE REPORT (ARERR)

2015

BYRON NUCLEAR POWER STATION
UNIT 1/2 DOCKET NUMBER STN-50-454/455
RADIOACTIVE EFFLUENT RELEASE REPORT
January 2015 - December 2015
Supplemental Information

1. Regulatory Limits

   a. Fission and activation products:

Tech Spec Whole Body	=	500 mrem/year
Skin	=	3000 mrem/year
10CFR50 Gamma	=	5 mrad/quarter; 10 mrad/year
Beta	=	10 mrad/quarter; 20 mrad/year

   b. Iodine: (summed with particulate, see below)

   c. Particulates with half-lives > 8 days:

Tech Spec Organ	=	1500 mrem/year
10CFR50 Organ	=	7.5 mrem/quarter; 15 mrem/year

   d. Liquid Effluents:

10CFR50 Whole Body	=	1.5 mrem/quarter; 3 mrem/year
Organ	=	5 mrem/quarter; 10 mrem/year

2. Maximum Permissible Concentration

   a. Fission and Activation Products: 10CFR20 Appendix B Table 2
   b. Iodine: 10CFR20 Appendix B Table 2
   c. Particulates: 10CFR20 Appendix B Table 2
   d. Liquid Effluents: 10 X 10CFR20 Appendix B Table 2

3. Average Energy: This item is not applicable. The ODCM limits the dose equivalent rates due to the release of noble gases to less than or equal to 500 mrem/year to the total body and less than or equal to 3000 mrem/year to the skin.

4. Measurements and Approximations of Total Radioactivity

   a. Fission and activation products: Prior to release, the isotopic content is determined. Released activity is calculated using volume of release, which is determined by the change in tank level, containment pressure, or containment purge fan flow rates.

   b. Particulate and iodine sampling media for the plant vent stacks are continuously collected and analyzed weekly. Tritium and noble gas analysis for the plant vent stacks are obtained and analyzed weekly.

c. Liquid effluents: Isotopic analysis is performed on each batch liquid release tank prior to its release. Total release activity is calculated using volume of release. Total tritium activity released is calculated from the highest of a monthly circulating water blowdown composite activity or a sum of the effluent input composite activities.

d. All positive results (i.e. higher than the lower limit of detection (LLD)) are reported in units of uCi/cc or uCi/ml unless otherwise noted. All LLD values and the associated LLD requirements are listed in Attachment A.

5. Batch Releases:

a. Liquid:

1. Number of batch releases = 79
2. Total time period for batch releases = 17,902 minutes
3. Maximum time period for a batch release = 558 minutes
4. Average time period for a batch release = 227 minutes
5. Minimum time period for a batch release = 63 minutes
6. Average Rock River stream flow during periods of release of effluent into a flowing stream = 168 m^3/sec, based on information from the U.S. Geological Survey Byron Gauging Station.

b. Gaseous:

1. Number of batch releases = 370
2. Total time period for batch releases = 35,241 minutes
3. Maximum time period for a batch release = 4,923 minutes
4. Average time period for batch releases = 95 minutes
5. Minimum time period for a batch release = 5 minutes

6. Abnormal Releases:

a. Liquid - None

b. Gaseous – None

7. There was one revision to the Off Site Dose Calculation Manual (ODCM), which was implemented in February 2015. The revision included updating the reference for a revised dose analysis report regarding the Independent Spent Fuel Storage Installation (ISFSI), adding a note specifying that dosimeters are present at each air sampling location, improvements to dosimeter maps, location changes for two Special Interest dosimeters, and several administrative changes.

8. Errata

No errata data to report.

9. 2015 Radiological Groundwater Protection Program (RGPP) Results Summary:

In 2015, fifteen (15) Radiological Groundwater Protection Program (RGPP) monitoring wells were sampled in total. Groundwater samples were obtained in March, May, August, and November and analyzed for tritium. In addition, a study of gamma, gross beta, and gross alpha radioisotopes was performed in accordance with Nuclear Energy Institute (NEI) 07-07, Groundwater Protection Initiative, for the samples obtained in May. None of the May samples showed concentrations of radionuclides above what is considered background levels. Three wells contained levels of tritium above the lower limit of detection (LLD) of 200 pCi/L. They were: AR-4 (493 pCi/L in March, 723 pCi/L in May, 417

pCi/L in August, 450 pCi/L in November) and AR-11 (945 pCi/L in March, 839 pCi/L in May, 422 pCi/L in August, 1040 pCi/L in November). Wells AR-4 and AR-11 are near the Circulating Water Blowdown piping, where historical leakage through vacuum breakers was known to have occurred. Tritium concentrations in these wells have gradually decreased since being first sampled in 2006. In 2015, tritium was measured in Well AR-7, located on-site, just west plant structures, at concentrations ranging between the lower limit of detection (200 pCi/L) and 508 pCi/L. Tritium has been measured in this well just above detectable limits on an intermittent basis since the well was first drilled in 2006. The tritium present in this well is at or below tritium levels that have been measured in rainwater as a result of precipitation recapture from permitted gaseous releases and it is not believed to be the result of new leak(s). In August 2014, a break in the well piping was discovered about six feet below the surface that could have served as the entry point for tritium in the recapture water. Should the water in these aquifers migrate to off-site wells used for drinking, the off-site dose consequence from tritium present in any of these three wells would be negligible. There are no existing or new leaks evident at the site and all groundwater well sample results are well below the drinking water standard of 20,000 pCi/L tritium.

SUMMARY

Calculations based on gaseous and liquid effluents and meteorological data indicate that public dose due to radioactive material attributable to Byron Station during the period did not exceed any regulatory or Offsite Dose Calculation Manual (ODCM) limits.

The Total Effective Dose Equivalent (TEDE) due to licensed activities at Byron Station calculated for the maximum exposed individual for the period is 2.66E-01 mrem. The annual limit on TEDE is 100 mrem.

The assessment of radiation doses to the public is performed in accordance with the ODCM. The results of these analyses confirm that the station is operating in compliance with 10CFR50 Appendix I, 10CFR20 and 40CFR190.

There were no additional operational controls implemented in 2015 that affected radiological effluents.

There were no measurements which exceeded the reporting levels, including any that would not have been attributable to station effluents.

The results of the current radiological environmental monitoring program are approximately the same as those found during the pre-operational studies conducted at Byron Station.

RELEASES

Gaseous Effluents to the Atmosphere

A total of 2.12E+01 curies of fission and activation gases were released with a maximum average quarterly release rate of 2.55E+00 µCi/sec.

A total of 4.45E-06 curies of 1-131 were released during the year with a maximum average quarterly release rate of 3.88E-07 µCi/sec.

A total of 1.01E-06 curies were released as airborne particulate matter with a maximum average quarterly release rate of 1.28E-07 µCi/sec.

A total of 8.85E+00 curies of other (C-14) radioisotopes were released with a maximum average quarterly release rate of 3.06E-01 µCi/sec.

A total of 8.05E+01 curies of tritium were released with a maximum average quarterly release rate of 3.99E+00 µCi/sec.

Gross alpha-emitting radionuclides were below detectable limits.

Liquids Released to Rock River

A total of 2.86E+10 liters of radioactive liquid wastes containing 8.48E-03 curies of fission and activation products were discharged with a maximum quarterly average concentration of 4.71E-10 µCi/ml.

A total of 3.32E+03 curies of tritium were discharged with a maximum quarterly average concentration of 1.56E-04 uCi/ml.

A total of 5.08E-04 curies of dissolved and entrained gases were discharged with a maximum quarterly average concentration of 5.56E-11 uCi/ml.

Gross alpha-emitting radionuclides were below detectable limits.

DOSE TO MAN

GASEOUS EFFLUENT PATHWAYS

Noble Gas - Gamma Dose Rates

Offsite Gamma air and whole body dose rates for the period were calculated based on measured release rates, isotopic composition of the noble gases, and average meteorological data. The maximum gamma air dose was 1.76E-02 mrad based on measured effluents and average meteorological data, and 3.19E-03 mrad based on measured effluents and concurrent meteorological data.

Noble Gas - Beta Air and Skin Dose Rates

The range of beta particles in air is relatively small (on the order of a few meters or less). Consequently, plumes of gaseous effluents may be considered "semi-infinite" for the purpose of calculating the dose from beta radiation incident on the skin. However, the actual dose to sensitive skin tissues is difficult to calculate due to the effect of the beta particle energies, thickness of inert skin, and clothing covering sensitive tissues. For purposes of this report the skin is taken to have a thickness of 7.0 mg/cm^2 and an occupancy factor of 1.0 is used. The maximum skin dose was 2.84E-04 mrem based on measured effluents and average meteorological data, and 2.97E-03 mrem based on measured effluents and concurrent meteorological data.

The maximum offsite beta air dose for the year based on measured effluents and average meteorological data was 8.55E-04 mrad, and 6.29E-04 mrad based on measured effluents and concurrent meteorological data.

Radioactive Iodine & Particulate

The human thyroid exhibits a significant capacity to concentrate ingested or inhaled iodine. I-131 released during routine operation of the station may be made available to man resulting in dose to the thyroid. C-14 is also included in this category. C-14 exhibits a capacity to concentrate in bone. C-14 is released in gaseous form and is absorbed into vegetation through photosynthesis. The principal pathways of interest for C-14 are the consumption of vegetation by humans and milk from which animals have ingested C-14 through the consumption of vegetation. With the requirement to begin

reporting C-14 dose in 2011 and the addition of C-14 to plant effluents, human dose in this category is primarily driven by the release of C-14 from the plant.

The hypothetical dose to the maximum exposed individual living near the station via ingestion of milk and vegetation was calculated. The source of milk and vegetation was assumed to be at the nearest site boundary with the cows pastured and vegetation grown from May through October. The maximum organ dose from radioactive iodine and particulate (including C-14) to any organ was 7.22E-01 mrem (child/bone) based on measured effluents and average meteorological data, and 6.95E-01 mrem (child/bone) based on measured effluents and concurrent meteorological data. The maximum dose from radioactive iodine and particulate (including C-14) to the whole body was 1.49E-01 mrem (child) based on measured effluents and average meteorological data, and 1.46E-01 mrem (child) based on measured effluents and concurrent meteorological data.

Gaseous Total Dose

The maximum total dose from gaseous releases to any organ was 7.22E-01 mrem (child/bone) based on measured effluents and average meteorological data, and 6.95E-01 mrem (child/bone) based on measured effluents and concurrent meteorological data. The maximum total dose from gaseous releases to the whole body was 1.49E-01 mrem (child) based on measured effluents and average meteorological data, and 1.46E-01 mrem (child) based on measured effluents and concurrent meteorological data.

LIQUID EFFLUENT PATHWAYS

The principal pathways through the aquatic environment for potential doses to man from liquid waste are ingestion of potable water and eating aquatic foods. Liquid dose was calculated based on the ingestion of potable water and sport fish. It should be noted, however, there are currently no communities within 10 km downstream of the plant using the Rock River for drinking water. NRC-developed equations are used to calculate the doses to the whole body, bone, liver, thyroid, kidney, lung, lower GI tract, and skin. Specific parameters for use in the equations are given in the Exelon Offsite Dose Calculation Manual (ODCM).

The maximum dose from liquid releases to any organ was 1.58E-01 mrem (adult/gilli). The maximum dose from liquid releases to the whole body was 1.40E-01 mrem (adult).

GASEOUS + LIQUID TOTAL DOSE

The maximum total dose to any organ via both gaseous and liquid effluents is 7.22E-01 mrem (child/bone). The maximum dose to the whole body via both gaseous and liquid effluents is 2.66E-01 mrem (child).

Dose Limits to Members of the Public

Byron Station did not exceed any of the dose limits as shown below based on concurrent or historical meteorological data.

- The limits on dose or dose commitment to a member of the public due to radioactive materials in liquid effluents from each reactor is 1.5 mrem to the whole body or 5 mrem to any organ during any calendar quarter and 3 mrem to the whole body or 10 mrem to any organ during a calendar year.

- The limits on air dose due to noble gases released in gaseous effluents to a member of the public from each reactor is 5 mrad for gamma radiation or 10 mrad for beta radiation during any calendar quarter and 10 mrad for gamma radiation or 20 mrad for beta radiation during a calendar year.

- The limits on dose to a member of the public due to radioactive iodine & particulate with half-lives greater than eight days in gaseous effluents released from each reactor is 7.5 mrem to any organ during any calendar quarter and 15 mrem to any organ during a calendar year.

- The annual 10CFR20 limit on Total Effective Dose Equivalent to individual members of the public is 100 mrem.

- The 40CFR190 limits on individual members of the public is 25 mrem to the whole body, 25 mrem to any organ (except thyroid), and 75 mrem to the thyroid.

SITE METEOROLOGY

Detailed records of the site meteorological measurements taken during each calendar quarter of the year are maintained by the meteorological vendor, retained on site, and are available upon request. The data are presented as cumulative joint frequency distributions of the wind direction for the 250' level and wind speed class by atmospheric stability class determined from the temperature difference between the 250' and 30' levels. Data recovery for all measurements on the meteorological tower was 99.7% during 2015.

SOLID RADIOACTIVE WASTE FOR BURIAL 1ST QUARTER 2015

No Shipments in 1st Quarter 2015

SOLID RADIOACTIVE WASTE FOR BURIAL 2ND QUARTER 2015

DATE Shipment # Description	DISPOSITION OF MATERIAL (DESCRIPTION, CLASS, TYPE AND SOLIDIFYING AGENT)	MODE OF TRANSPORT/ CARRIER	DESTINATION	VOLUME (m^3) PER SHIPMENT	CURIES* PER SHIPMENT
4/10/15 RWS 15-003 DAW	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, 20' METAL BOX(2), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Bear Creek Oak Ridge, TN	6.44E+01	4.16E-02
4/28/15 RWS 15-001 Bead Resin	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, FISSILE EXCEPTED, CASK(1), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Energy Solutions Clive, UT	4.81E+00	3.51E+00
5/19/15 RWS 15-002 Bead Resin/Charcoal	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, FISSILE EXCEPTED, CASK(1), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Energy Solutions Clive, UT	4.39E+00	7.57E+00
Quarterly Totals		**Number of Shipments:**	**3**	**7.36E+01**	**1.11E+01**
* Calculated using measured ratios				CUBIC M	CURIES

SOLID RADIOACTIVE WASTE FOR BURIAL 3RD QUARTER 2015

DATE Shipment # Description	DISPOSITION OF MATERIAL (DESCRIPTION, CLASS, TYPE AND SOLIDIFYING AGENT)	MODE OF TRANSPORT/ CARRIER	DESTINATION	VOLUME (m^3) PER SHIPMENT	CURIES* PER SHIPMENT
7/7/15 RWS 15-004 DAW	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, 20' METAL BOX(2), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Bear Creek Oak Ridge, TN	6.44E+01	8.33E-03
8/3/15 RWS 15-005 Bead Resin	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, CASK(1), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Energy Solutions Clive, UT	4.39E+00	7.08E+00
8/5/15 RWS 15-006 Bead Resin	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, CASK(1), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Energy Solutions Clive, UT	4.39E+00	3.25E+00
9/2/15 RWS 15-007 Sludge/DAW	UN2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE-LIMITED QUANTITY OF MATERIAL, 7, 20' METAL BOX(2), CLASS A, NONE UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, 20' METAL BOX(1), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Bear Creek Oak Ridge, TN	3.94E+01	3.26E-02
9/3/15 RWS 15-008 Sludge	UN2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE-LIMITED QUANTITY OF MATERIAL, 7, 20' METAL BOX(6), CLASS A, NONE	Highway Hittman Transport	Gallaher Road Kingston, TN	1.61E+01	3.83E-02
9/21/15 RWS 15-009 DAW	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, 20' METAL BOX(2), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Bear Creek Oak Ridge, TN	6.44E+01	7.67E-02
9/25/15 RWS 15-010 DAW	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, 20' METAL BOX(1), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Bear Creek Oak Ridge, TN	3.13E+01	4.26E-02
9/25/15 RWS 15-011 Oil	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, 20' METAL BOX(1), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Bear Creek Oak Ridge, TN	1.10E+01	1.17E-02
9/25/15 RWS 15-012 DAW	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, 20' METAL BOX(2), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Bear Creek Oak Ridge, TN	6.26E+01	1.95E-01
Quarterly Totals		**Number of Shipments:**	**9**	**2.98E+02**	**1.07E+01**
* Calculated using measured ratios				CUBIC M	CURIES

SOLID RADIOACTIVE WASTE FOR BURIAL 4TH QUARTER 2015

DATE Shipment # Description	DISPOSITION OF MATERIAL (DESCRIPTION, CLASS, TYPE AND SOLIDIFYING AGENT)	MODE OF TRANSPORT/ CARRIER	DESTINATION	VOLUME(m^3) PER SHIPMENT	CURIES* PER SHIPMENT
10/1/15 RWS 15-013 DAW	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, 20' METAL BOX(2), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Bear Creek Oak Ridge, TN	6.44E+01	2.84E-01
10/13/15 RWS 15-014 Bead Resin/Charcoal	UN3321, RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), 7, CASK(1), CLASS A, NONE	Highway Hittman Transport EXCLUSIVE-USE	Energy Solutions Clive, UT	4.53E+00	6.37E+00
Quarterly Totals		**Number of Shipments:**	**2**	**6.89E+01**	**6.65E+00**
* Calculated using measured ratios				CUBIC M	CURIES

SOLID RADIOACTIVE WASTE FOR BURIAL
Estimated Solid Waste Composition
2015

Resins, Filters, Evap Bottoms			
2015			
Volume (m3) 2.25E+01			
Class A			
Nuclide	% Abund	Curies	uCi/ml
H-3	41.60	1.16E+01	5.16E-01
Be-7	0.03	7.35E-03	3.27E-04
C-14	0.81	2.26E-01	1.00E-02
Cr-51	0.10	2.82E-02	1.25E-03
Mn-54	1.05	2.92E-01	1.30E-02
Fe-55	3.66	1.02E+00	4.53E-02
Fe-59	0.01	2.79E-03	1.24E-04
Co-57	0.27	7.54E-02	3.35E-03
Co-58	12.73	3.54E+00	1.57E-01
Co-60	9.63	2.68E+00	1.19E-01
Ni-59	0.05	1.37E-02	6.09E-04
Ni-63	22.40	6.22E+00	2.76E-01
Zn-65	0.24	6.65E-02	2.96E-03
Sr-90	0.00	8.10E-06	3.60E-07
Zr-95	0.01	3.13E-03	1.39E-04
Nb-95	0.28	7.92E-02	3.52E-03
Mo-99	0.00	7.31E-04	3.25E-05
Tc-99	0.04	1.09E-02	4.84E-04
Ru-103	0.00	5.27E-05	2.34E-06
Ag-110m	0.00	9.75E-05	4.33E-06
Sn-113	0.01	2.62E-03	1.16E-04
Sb-124	0.00	1.19E-03	5.29E-05
Sb-125	6.39	1.78E+00	7.91E-02
Te-125m	0.07	1.83E-02	8.13E-04
Te-132	0.00	3.20E-05	1.42E-06
I-129	0.01	1.49E-03	6.62E-05
I-131	0.01	1.58E-03	7.02E-05
Cs-134	0.01	2.06E-03	9.16E-05
Cs-137	0.55	1.52E-01	6.76E-03
Ce-144	0.05	1.44E-02	6.40E-04

Dry Active Waste			
2015			
Volume (m3) 4.07E+02			
Class A			
Nuclide	% Abund	Curies	uCi/ml
H-3	11.11	8.00E-02	1.97E-04
C-14	0.03	2.14E-04	5.26E-07
Cr-51	0.19	1.36E-03	3.34E-06
Mn-54	0.85	6.11E-03	1.50E-05
Fe-55	48.44	3.49E-01	8.57E-04
Fe-59	0.01	4.24E-05	1.04E-07
Co-57	0.07	5.05E-04	1.24E-06
Co-58	2.80	2.02E-02	4.96E-05
Co-60	17.42	1.25E-01	3.07E-04
Ni-59	0.02	1.61E-04	3.96E-07
Ni-63	15.75	1.13E-01	2.78E-04
Zn-65	0.03	2.38E-04	5.85E-07
Zr-95	0.81	5.82E-03	1.43E-05
Nb-95	1.13	8.16E-03	2.00E-05
Tc-99	0.09	6.42E-04	1.58E-06
Ag-110m	0.01	5.11E-05	1.26E-07
Sn-113	0.02	1.47E-04	3.61E-07
Sb-125	1.17	8.40E-03	2.06E-05
I-129	0.00	2.23E-05	5.48E-08
Cs-137	0.04	2.85E-04	7.00E-07
Ce-144	0.01	6.37E-05	1.57E-07

Other Waste (Oil)			
2015			
Volume (m3) 1.10E+01			
Class A			
Nuclide	% Abund	Curies	uCi/ml
H-3	0.20	2.31E-05	2.10E-06
C-14	0.03	4.07E-06	3.70E-07
Mn-54	0.88	1.03E-04	9.36E-06
Fe-55	56.59	6.65E-03	6.05E-04
Co-57	0.08	9.61E-06	8.74E-07
Co-58	3.03	3.56E-04	3.24E-05
Co-60	19.01	2.23E-03	2.03E-04
Ni-63	17.22	2.02E-03	1.84E-04
Zr-95	0.58	6.85E-05	6.23E-06
Nb-95	0.93	1.10E-04	1.00E-05
Tc-99	0.10	1.16E-05	1.05E-06
Sb-125	1.28	1.51E-04	1.37E-05
I-129	0.00	3.29E-07	2.99E-08
Cs-137	0.04	5.13E-06	4.66E-07
Ce-144	0.01	9.91E-07	9.01E-08

Irradiated Components
2015
Volume (m3) 0.00E+00
Class N/A
No Shipments

SOLID RADIOACTIVE WASTE FOR BURIAL
Estimated Solid Waste Composition
2015

Sum of All Categories			
2015			
Volume (m3) 4.41E+02			
Class A			
Nuclide	% Abund	Curies	uCi/ml
H-3	40.81	1.16E+01	2.63E-02
Be-7	0.03	7.35E-03	1.67E-05
C-14	0.79	2.27E-01	5.15E-04
Cr-51	0.10	2.95E-02	6.69E-05
Mn-54	1.04	2.98E-01	6.76E-04
Fe-55	4.81	1.37E+00	3.11E-03
Fe-59	0.01	2.83E-03	6.42E-06
Co-57	0.27	7.59E-02	1.72E-04
Co-58	12.48	3.56E+00	8.07E-03
Co-60	9.83	2.80E+00	6.35E-03
Ni-59	0.05	1.39E-02	3.15E-05
Ni-63	22.23	6.34E+00	1.44E-02
Zn-65	0.23	6.67E-02	1.51E-04
Sr-90	0.00	8.10E-06	1.84E-08
Zr-95	0.03	9.02E-03	2.05E-05
Nb-95	0.31	8.75E-02	1.98E-04
Mo-99	0.00	7.31E-04	1.66E-06
Tc-99	0.04	1.15E-02	2.61E-05
Ru-103	0.00	5.27E-05	1.20E-07
Ag-110m	0.00	1.49E-04	3.38E-07
Sn-113	0.01	2.77E-03	6.28E-06
Sb-124	0.00	1.19E-03	2.70E-06
Sb-125	6.25	1.78E+00	4.04E-03
Te-125m	0.06	1.83E-02	4.15E-05
Te-132	0.00	3.20E-05	7.26E-08
I-129	0.01	1.51E-03	3.42E-06
I-131	0.01	1.58E-03	3.58E-06
Cs-134	0.01	2.06E-03	4.67E-06
Cs-137	0.53	1.52E-01	3.45E-04
Ce-144	0.05	1.44E-02	3.27E-05

RW-AA-100, Process Control Program (PCP) for Radioactive Waste, Revision 11, was implemented in June, 2015. The revision incorporated the following changes:

The terms and definitions were alphabetized and some had updated definitions as follows:

2. **TERMS AND DEFINITIONS**

2.1. **Blending:** The mixing of LLRW with different concentrations of radionuclides, typically in an effort to create a relatively homogeneous mixture for disposal.

2.2. **Classification Controlling Nuclides**: One or more nuclides, listed in Table 1 or Table 2 of 10CFR61.55, whose concentration is the specific basis for the classification of the waste container. This could be a single nuclide or multiple nuclides that make up >50% of the sum of the fractions.

2.3. **Compaction:** When dry wastes such as paper, wood, plastic, cardboard, incinerator ash, and etc. are volume reduced through the use of a compactor.

2.4. **Concentration Averaging**: The averaging of the radionuclide concentrations for specific wastes or mixture of waste over the volume or weight of the waste.

2.5. **Dewatering:** The process of removing fluids from liquid waste streams to produce a waste form that meets the requirements of 10CFR Part 61 and applicable burial site criteria, <0.5% by volume when the waste is packaged to an "unstable" state, or <1% by volume when the waste is packaged to a "stable" form.

2.6. **Encapsulation**: Encapsulation is the surrounding of a radioactive source or component with a nonradioactive material. Encapsulation involves a radioactive core surrounded by a non-radioactive matrix.

2.7. **High Integrity Container (HIC):** A disposable container that is approved to the Requirements of 10CFR61. The use of HIC's is an alternative to solidification or encapsulation in a steel container to meet burial stability. HIC's are used to package dewatered liquid wastes, (e.g. filter cartridges, filter media, resin, sludges, etc), or dry active waste.

2.8. **Homogeneous Waste:** Waste in which concentrations of radionuclides of concern are likely to approach uniformity in the context of reasonable foreseeable intruder scenarios (This is because hot spots are a concern with respect to protection of an individual who may inadvertently intrude into the burial site).

2.9. **Incineration, RVR, and/or Glass Vitrification of Liquid or Solid:** Dry or wet waste processed via incineration and/or thermal processing where the volume is reduced by thermal means meets 10CFR61 requirements.

2.10. **Liquid Waste Processing Systems:** In-plant or vendor supplied processing systems consisting of equipment utilized for evaporation, filtration, demineralization, dewatering, compression dewatering, solidification, or reverse osmosis (RO) for the treatment of liquid wastes (such as Floor Drains, Chemical Drains and Equipment Drain inputs).

2.11. **Mixable Waste**: Waste that is amenable to physical mixing to create relatively uniform radionuclide concentrations.

2.12. **Nuclides of Concern**: A nuclide in the waste in concentrations greater than 1% of

the concentration of that nuclide listed in Table 1 of 10CFR61.55 or 1% of the applicable class-dependent concentration of that nuclide in Table 2 of 10CFR61.55, Column 2 or 3.

2.13. **Process Control Program (PCP):** The program which contains the current formulas, sampling, analysis, tests, and determinations to be made to ensure that processing and packaging of solid radioactive waste based on demonstrated processing of actual or simulated wet solid wastes will be accomplished in such a way as to assure the waste meets the stabilization criteria specified in 10CFR Parts 20, 61 and 71, state regulations, and burial site requirements.

2.14. **Solidification:** Liquid waste processed to either an unstable or stable form per 10CFR61 requirements. Waste solidified does not have to meet the 300-year free standing monolith criteria. Approved formulas, samples and tests do not have to meet NRC approval for wastes solidified in a container meeting stability criteria (e.g. High Integrity Container).

2.15. **Solidification Media:** An approved media (e.g. Barnwell - vinyl ester styrene, cement, bitumen) when waste containing nuclides with greater than 5-year half lives is solidified in a container with activity greater than 1 micro curie/cc. Waste solidified in a HIC is approved by the commission meeting the 10CFR61 stabilization criteria, including 1% free standing liquids by volume when the waste is packaged to a "stable" form and < 0.5% when waste is packaged to an "unstable" form. The formulas, sampling, analysis, and test do not require NRC approval, because the HIC meets the stability criteria.

2.15.1. Solidification to an unstable or stable state is performed by vendors, when applicable. Liquid waste solidified to meet stabilization criteria (10CFR61 and 01-91 Branch Technical Requirements) shall have documentation available that demonstrates that the process is approved by the NRC or disposal facility.

2.16. **Stabilization:** Liquid waste processed to a "stable state" per 10CFR61 Requirements. Established formulas, samples, and tests shall be approved by the NRC in order to meet solidification "stabilization" criteria. This processing method is currently not available, because the NRC recognizes that waste packed in a High Integrity Container meets the 300-year stabilization criteria. In the event that this processing method becomes an acceptable method, then the NRC shall approve the stabilization formulas, samples, tests, etc.

2.17. **Waste Streams:** Consist of but are not limited to
– Filter media (powdered, bead resin and fiber),
– Filter cartridges,
– Pre-coat body feed material,
– Contaminated charcoal,
– Fuel pool activated hardware,
– Oil Dry absorbent material added to a container to absorb liquids
– Fuel Pool Crud
– Sump and tank sludges,
– High activity filter cartridges,
– Concentrated liquids,
– Contaminated waste oil,
– Dried sewage or wastewater plant waste,
– Dry Active Waste (DAW): Waste such as filters, air filters, low activity cartridge filters, paper, wood, glass, plastic, cardboard, hoses, cloth, and metals, etc, which have become contaminated as a consequence of normal operating, housekeeping and maintenance activities.
– Other radioactive waste generated from cleanup of inadvertent contamination.

Section 4.2.13 was updated to include "NRC-2001-0022" as follows:

4.2.13. Concentration averaging may be **PERFORMED** to combine LLRW having different concentrations of radionuclides to form a homogeneous mixture in accordance with the guidance in the NRC's Branch Technical Position on Concentration Averaging
and Encapsulation-1995, NRC-2011-0022:

– For homogeneous waste types such as resins…

The References in Section 6 were edited to include a portion for UFSAR and there was a reformatting of the Writers' References and Users' References as follows:

6.3. UFSAR

6.3.1. Braidwood UFSAR, Section 11.4, Solid Waste Management System
6.3.2. Byron UFSAR Section 11.4, Solid Waste Management System
6.3.3. Calvert Cliffs UFSAR Section 11.1.2.3 Solid Waste Processing System
6.3.4. Clinton USAR Table 11.4, Solid Waste Management System
6.3.5. Dresden UFSAR Section 11.4, Waste Management System
6.3.6. Ft. Calhoun USAR Section 11-03, Radiological Effluent Requirements
6.3.7. Ginna UFSAR Section 11.4, Solid Waste Management System
6.3.8. LaSalle UFSAR Section 11.4.2.7 Storage areas, Table 12.3.6- IRSF Storage Area
6.3.9. Limerick UFSAR Section11.4, Solid Waste Management
6.3.10. Nine Mile Point Unit 1 UFSAR Section 2.3 Solid Waste System
6.3.11. Nine Mile Point Unit 2 UFSAR Section 11.4, Solid Waste Management System
6.3.12. Oyster Creek UFSAR Section 11.4, Solid Waste Management System
6.3.13. Peach Bottom UFSAR Section 9.0, Radioactive Waste Systems
6.3.14. Quad Cities UFSAR Section 11.4.4.5, Interim Radwaste Storage Facility
6.3.15. Three Mile Island UFSAR Section 11.2, Radioactive Waste Disposal Systems Summary

6.4. Writers' References:

– Amendment No. 202 to Facility Operating License No. NPF-11 and Amendment No. 189 to Facility Operating License (FOL) No. NPF-18 for the LaSalle County Station (LSCS), Units 1 and 2
– Code of Federal Regulations: 10 CFR Part 20, Part 61, Part 71, 49 CFR Parts 171-172
– I.E. Circular 80.18, 10CFR 50.59 Safety Evaluation for Changes to Radioactive Waste Treatment Systems
– Low Level Waste Licensing Branch Technical Position on Radioactive Waste Classification, May 1983
– NRC Branch Technical Position on Blending of Low-Level Radioactive Waste, SECY-10-0043
– NRC Concentration Averaging and Encapsulation Branch Technical Position, NRC-2011-0022
– 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
– Technical Position on Waste Form (Revision 1), January 1991

6.5. Users' References:

– CY-AA-170-2000, Annual Radioactive Effluent Release Report
– LS-AA-106, Plant Operations Review Committee
– Quality Assurance Program (QATR)
– RM-AA-101, Records Management Program
– RM-AA-102-1006, Processing Vendor Documents
– RP-AA-600 Series, Radioactive Material/Waste Shipments

Error Analysis

The following is an estimate of the errors associated with effluent monitoring and analysis. The estimate is calculated using the square root of the sum of the squares methodology.

1. Gaseous Effluents

   Qme=3.33%
   RM=N/A
   ECe=5%
   Stdcse/Smplcse=5%
   qme=N/A

   Total error = 7.8%

2. Liquid Effluents

   Qme=3.33%
   RM=N/A
   ECe=N/A
   Stdcse/Smplcse=5%
   qme=2.22%

   Total error = 6.4%

3. Waste Resin

   Qme=10.0%
   RM=N/A
   ECe=5%
   Stdcse/Smplcse=5%
   qme=1.0%

   Total error = 12.3%

4. DAW, Mechanical Filters, and Contaminated Metal

   Qme=10.0%
   RM=N/A
   ECe=N/A
   Stdcse/Smplcse=5%
   qme=N/A

   Instrument calibration error = 10%

   Total error = 11.2%

Qme = the process quantity measurement error associated with the release point (e.g. flow, level measurements)

RM = error associated with the radiation monitor used in quantifying releases through the release point

ECe = error associated with the collection efficiency of the sample media

Stdcse = one-sigma counting error associated with the counting instrument of interest

Smplcse = one-sigma counting error associated with a sample of a given geometry that is used for the release point of interest

qme = sample quantity measurement error associated with the sample of interest

Miscellaneous Information

A. As required by Technical Specification 5.6.2, meteorological and environmental impact information is reported in the 2015 Annual Radiological Environmental Operating Report (AREOR) or is retained on file to be provided upon request.

B. No limits were exceeded during the 2015 reporting period in liquid hold up tanks or waste gas decay tanks as stated in Technical Specification 5.5.12.

C. There were no irradiated fuel shipments during the 2015 reporting period. An Independent Spent Fuel Storage Installation (ISFSI) campaign began in 2010 when used fuel was removed from the Spent Fuel Pool (SFP), placed into six (6) casks, each containing 32 fuel bundles, and transferred to an outdoor storage pad. No additional casks were placed on the pad in 2011. In 2012, eight (8) additional casks were placed on the pad for a total of fourteen (14) casks. No additional casks were placed on the pad in 2013 or 2014. In 2015, six (6) additional casks were placed on the pad for a total of twenty (20) casks. Prior to the ISFSI campaign, additional dosimeters were placed at the site boundary nearest to the storage pad (in between the pad and the nearest resident) for the purpose of measuring any potential offsite dose to the public from the storage pad. Since the dosimeters were placed, data from the dosimeters, when compared to the existing environmental dosimeters in the surrounding area, have shown no statistical difference. As a result, there is currently no offsite dose contribution from the ISFSI facility or any other on-site storage facility, including the Dry Active Waste (DAW) Building and the Old Steam Generator (OSG) Storage Building, as evidenced by dosimetry data that is indistinguishable from the existing environmental dosimeters.

D. There were no REMP sample results that exceeded any technical specification limits or analytical results investigation levels during the 2015 reporting period. REMP composite surface water samples from point BY-12, Rock River downstream of the plant liquid effluent discharge, detected tritium results of 490 pCi/L in the second quarter and 748 pCi/L in the third quarter, against a lower detection limit of 200 pCi/L. The positive sample results can be attributed to one or more weekly samples being obtained shortly after permitted liquid discharges, and are not unexpected. The results are well below the Technical Requirements Manual (TRM) reportable limit of 30,000 pCi/L. There are no communities using the Rock River for drinking water within 10 km downstream of the station. No radionuclides that were a result of plant effluents were detected in any of the other REMP samples.

E. There were no elevated releases during the 2015 reporting period. All planned gaseous releases were discharged by way of the plant vent stacks and are considered to be mixed mode releases.

F. There was one liquid effluent flow loop that exceeded its inoperability time limit as stated in TRM TLCO 3.11.b. On 4/3/15 01:53, 0WX001, Liquid Radwaste Release High Flow Loop, entered 0BOL 11.a due to calibration procedure 0BISR 11.a.3-005. The procedure requires a channel check for operability following completion of the calibration. The channel check requires process flow through the loop and could not be completed within the required 30-day time frame because there were no liquid releases performed during this time utilizing the high flow loop. The flow loop (high/low) to be utilized during liquid releases is contingent upon the radioactivity (i.e. tritium) concentration present in the release tank. The condition was exited on 5/8/15 13:21, when a liquid release was able to be performed utilizing the high flow loop.

G. There were no unplanned gaseous or liquid releases to unrestricted areas during the 2015 reporting period.

H. All Rock River flow measurements during liquid effluent discharges were obtained from the U.S. Geological Survey Byron Gauging Station for the Rock River with the following exceptions. Due to icing

conditions near the Byron gauging station, flows were obtained from the Rockton flow gauge, located on the Rock River approximately 30 miles upstream of the Byron flow gauge, during the liquid effluent releases on 1/21/15 and 1/30/15. Due to icing conditions near the Byron and Rockton gauging stations, the Rock River flow measurement during the liquid effluent release on 1/9/15 was obtained from the Dixon flow gauge, located approximately 32 miles downstream of the Byron flow gauge.

I. Attached are offsite dose calculation reports for January through December of 2015.

The following are the maximum annual calculated cumulative offsite doses resulting from Byron airborne releases in 2015 based on concurrent meteorological data:

Unit 1:

Dose	*Maximum Value*		*Sector Affected*
gamma air [1]	3.19×10^{-3}	mrad	North-Northwest
beta air [2]	6.24×10^{-4}	mrad	North-Northwest
whole body [3]	7.02×10^{-2}	mrem	North-Northwest
skin [4]	2.97×10^{-3}	mrem	North-Northwest
organ [5] (child-bone)	3.34×10^{-1}	mrem	North-Northwest

Unit 1 Compliance Status

10 CFR 50 Appendix I	**Yearly Objective**		**% of Appendix I**
gamma air	10.0	mrad	0.03
beta air	20.0	mrad	0.00
whole body	5.0	mrem	1.40
skin	15.0	mrem	0.02
organ	15.0	mrem	2.23

Unit 2:

Dose	*Maximum Value*		*Sector Affected*
gamma air [1]	2.71×10^{-6}	mrad	North-Northwest
beta air [2]	4.94×10^{-6}	mrad	North-Northwest
whole body [3]	7.54×10^{-2}	mrem	North-Northwest
skin [4]	3.78×10^{-6}	mrem	North-Northwest
organ [5] (child-bone)	3.61×10^{-1}	mrem	North-Northwest

Unit 2 Compliance Status

10 CFR 50 Appendix I	**Yearly Objective**		**% of Appendix I**
gamma air	10.0	mrad	0.00
beta air	20.0	mrad	0.00
whole body	5.0	mrem	1.51
skin	15.0	mrem	0.00
organ	15.0	mrem	2.41

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(1) Gamma Air Dose - GASPAR II, NUREG-0597
(2) Beta Air Dose - GASPAR II, NUREG-0597
(3) Whole Body Dose - GASPAR II, NUREG-0597
(4) Skin Dose - GASPAR II, NUREG-0597
(5) Inhalation and Food Pathways Dose - GASPAR II, NUREG-0597

Data recovery: 99.7%

Attachment A, 2015 Radioactive Effluent Release Report
2015 Lower Limits of Detection (LLD's)

Nuclide	Gaseous LLD (uCi/cc)	Required Gaseous LLD (uCi/cc)
H3	4.52E-08	1.00E-07
Ar41	5.72E-07	
Cr51	2.99E-12	
Mn54	5.86E-13	1.00E-11
Co58	7.39E-13	1.00E-11
Fe59	1.66E-12	1.00E-11
Co60	1.19E-12	1.00E-11
Ni63	5.39E-15	
Zn65	1.36E-12	1.00E-11
Br82	6.63E-13	
Kr85m	2.25E-07	
Kr87	3.33E-07	1.00E-04
Kr88	5.91E-07	1.00E-04
Sr89	1.83E-14	1.00E-11
Sr-90	2.28E-15	1.00E-11
Mo99	2.41E-13	1.00E-11
I131	7.17E-13	1.00E-12
Xe131m	8.10E-06	
I133	9.87E-13	1.00E-10
Xe133	3.33E-07	1.00E-04
Xe133m	1.91E-06	1.00E-04
Cs134	6.61E-13	1.00E-11
I135	4.65E-12	
Xe135	1.91E-07	1.00E-04
Cs137	5.53E-13	1.00E-11
Xe138	8.70E-07	1.00E-04
Ba140	1.75E-12	
La140	7.83E-13	
Ce141	4.40E-13	1.00E-11
Ce144	1.86E-12	1.00E-11
Gross Alpha	2.84E-15	1.00E-11

Nuclide	Liquid LLD (uCi/ml)	Required Liquid LLD (uCi/cc)
H3	1.81E-06	1.00E-05
Na24	3.27E-08	
Cr51	2.65E-07	
Mn54	4.29E-08	5.00E-07
Fe55	7.13E-07	1.00E-06
Co57	2.68E-08	
Co58	3.68E-08	5.00E-07
Fe59	9.29E-08	5.00E-07
Co60	6.94E-08	5.00E-07
Ni63	4.24E-07	
Zn65	9.78E-08	5.00E-07
Sr85	3.80E-08	
Kr85m	3.07E-08	1.00E-05
Kr87	7.50E-08	1.00E-05
Kr88	9.12E-08	1.00E-05
Sr89	3.40E-08	5.00E-08
Sr90	8.59E-09	5.00E-08
Sr92	7.57E-08	
Nb95	4.20E-08	
Zr95	8.31E-08	
Mo99	2.25E-08	5.00E-07
Ag110m	5.10E-08	
Sb122	6.16E-08	
Te123m	2.52E-08	
Sb124	8.48E-08	
Sb125	1.12E-07	
Te125m	7.26E-06	
Sb126	4.23E-08	
Xe131m	1.03E-06	1.00E-05
I131	3.18E-08	1.00E-06
I132	4.62E-08	
Te132	2.31E-08	
I133	3.75E-08	
Xe133	6.42E-08	1.00E-05
Xe133m	2.44E-07	1.00E-05
Cs134	5.23E-08	5.00E-07
Xe135	3.07E-08	1.00E-05
Cs137	4.84E-08	5.00E-07
Xe138	2.12E-07	1.00E-05
Ba140	1.33E-07	
La140	4.03E-08	
Ce141	4.07E-08	5.00E-07
Ce144	1.72E-07	5.00E-06
Gross Alpha	6.40E-08	1.00E-07
Gross Beta	1.72E-07	

EFFLUENT AND WASTE DISPOSAL REPORT
SUPPLEMENTAL INFORMATION
GASEOUS EFFLUENTS - BATCH MODE
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Number of releases		50	55	57	56	218
Total release time	minutes	2.61E+03	3.59E+03	1.58E+04	6.43E+03	2.85E+04
Maximum release time	minutes	2.17E+02	5.25E+02	4.92E+03	1.09E+03	4.92E+03
Average release time	minutes	5.23E+01	6.53E+01	2.78E+02	1.15E+02	1.31E+02
Minimum release time	minutes	5.00E+00	2.50E+01	3.80E+01	3.50E+01	5.00E+00

Note: Waste Gas Decay Tank releases are included with Unit 1 data

EFFLUENT AND WASTE DISPOSAL REPORT
SUPPLEMENTAL INFORMATION
GASEOUS EFFLUENTS - BATCH MODE
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Number of releases		37	41	40	34	152
Total release time	minutes	1.45E+03	1.66E+03	1.77E+03	1.90E+03	6.77E+03
Maximum release time	minutes	6.20E+01	5.80E+01	7.50E+01	8.40E+01	8.40E+01
Average release time	minutes	3.92E+01	4.04E+01	4.41E+01	5.59E+01	4.46E+01
Minimum release time	minutes	1.00E+01	1.40E+01	1.50E+01	3.10E+01	1.00E+01

EFFLUENT AND WASTE DISPOSAL REPORT
SUPPLEMENTAL INFORMATION
LIQUID EFFLUENTS - BATCH MODE
Unit 1 & Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Number of releases		11	14	32	22	79
Total release time	minutes	2.51E+03	4.48E+03	5.66E+03	5.26E+03	1.79E+04
Maximum release time	minutes	5.58E+02	5.30E+02	4.43E+02	4.29E+02	5.58E+02
Average release time	minutes	2.28E+02	3.20E+02	1.77E+02	2.39E+02	2.27E+02
Minimum release time	minutes	6.60E+01	1.78E+02	6.30E+01	7.60E+01	6.30E+01
Average dilution flow	gpm	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: Liquid Releases are divided evenly between units

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 1A
GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
1. Total Release	Ci	4.97E-01	1.46E-01	1.10E-01	2.01E+01	2.08E+01
2. Avg. Release Rate	uCi/sec	6.39E-02	1.86E-02	1.38E-02	2.53E+00	6.60E-01
Iodine-131						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
2. Avg. Release Rate	uCi/sec	(1)	(1)	(1)	(1)	(1)
Particulates Half Life >= 8 days						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
2. Avg. Release Rate	uCi/sec	(1)	(1)	(1)	(1)	(1)
Others						
1. Total Release	Ci	1.12E+00	1.11E+00	9.79E-01	1.04E+00	4.24E+00
2. Avg. Release Rate	uCi/sec	1.44E-01	1.41E-01	1.23E-01	1.31E-01	1.35E-01
Tritium						
1. Total Release	Ci	1.38E+01	8.01E+00	1.49E+00	4.00E+00	2.73E+01
2. Avg. Release Rate	uCi/sec	1.77E+00	1.02E+00	1.87E-01	5.03E-01	8.64E-01
Gross Alpha Radioactivity						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
2. Avg. Release Rate	uCi/sec	(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 1C
GASEOUS EFFLUENTS - MIXED MODE RELEASES - CONTINUOUS MODE
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
KR-88	Ci	(1)	(1)	(1)	1.99E+01	1.99E+01
XE-133	Ci	4.85E-01	1.22E-01	5.59E-02	1.34E-01	7.97E-01
Totals for Period...	Ci	4.85E-01	1.22E-01	5.59E-02	2.01E+01	2.07E+01
Iodines						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)
Particulates Half Life >= 8 days						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)
Others						
C-14	Ci	1.12E+00	1.11E+00	9.79E-01	1.04E+00	4.24E+00
Totals for Period...	Ci	1.12E+00	1.11E+00	9.79E-01	1.04E+00	4.24E+00
Tritium						
H-3	Ci	1.36E+01	7.91E+00	1.26E+00	3.97E+00	2.68E+01
Totals for Period...	Ci	1.36E+01	7.91E+00	1.26E+00	3.97E+00	2.68E+01
Gross Alpha Radioactivity						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 1C
GASEOUS EFFLUENTS - MIXED MODE RELEASES - BATCH MODE
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
AR-41	Ci	8.58E-03	1.96E-02	1.91E-02	2.53E-03	4.99E-02
KR-85M	Ci	(1)	(1)	2.23E-05	1.59E-06	2.39E-05
XE-133	Ci	2.92E-03	4.13E-03	3.31E-02	2.54E-03	4.27E-02
XE-133M	Ci	(1)	(1)	1.80E-04	7.92E-06	1.88E-04
XE-135	Ci	3.91E-04	(1)	1.39E-03	3.28E-05	1.81E-03
Totals for Period...	Ci	1.19E-02	2.37E-02	5.38E-02	5.11E-03	9.46E-02
Iodines						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)
Particulates Half Life >= 8 days						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)
Others						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)
Tritium						
H-3	Ci	1.19E-01	9.96E-02	2.31E-01	3.00E-02	4.79E-01
Totals for Period...	Ci	1.19E-01	9.96E-02	2.31E-01	3.00E-02	4.79E-01
Gross Alpha Radioactivity						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 1A
GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
1. Total Release	Ci	7.09E-02	1.26E-01	7.20E-02	1.42E-01	4.12E-01
2. Avg. Release Rate	uCi/sec	9.12E-03	1.61E-02	9.06E-03	1.79E-02	1.31E-02
Iodine-131						
1. Total Release	Ci	7.01E-07	(1)	3.08E-06	6.64E-07	4.45E-06
2. Avg. Release Rate	uCi/sec	9.01E-08	(1)	3.88E-07	8.36E-08	1.41E-07
Particulates Half Life >= 8 days						
1. Total Release	Ci	(1)	(1)	(1)	1.01E-06	1.01E-06
2. Avg. Release Rate	uCi/sec	(1)	(1)	(1)	1.28E-07	3.21E-08
Others						
1. Total Release	Ci	1.26E+00	1.10E+00	1.20E+00	1.05E+00	4.61E+00
2. Avg. Release Rate	uCi/sec	1.62E-01	1.40E-01	1.51E-01	1.33E-01	1.46E-01
Tritium						
1. Total Release	Ci	1.72E+01	1.71E+01	1.05E+01	8.35E+00	5.32E+01
2. Avg. Release Rate	uCi/sec	2.22E+00	2.17E+00	1.32E+00	1.05E+00	1.69E+00
Gross Alpha Radioactivity						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
2. Avg. Release Rate	uCi/sec	(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 1C
GASEOUS EFFLUENTS - MIXED MODE RELEASES - CONTINUOUS MODE
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
XE-133	Ci	6.92E-02	1.22E-01	5.59E-02	1.34E-01	3.81E-01
Totals for Period...	Ci	6.92E-02	1.22E-01	5.59E-02	1.34E-01	3.81E-01
Iodines						
I-131	Ci	7.01E-07	(1)	3.08E-06	6.64E-07	4.45E-06
Totals for Period...	Ci	7.01E-07	(1)	3.08E-06	6.64E-07	4.45E-06
Particulates Half Life >= 8 days						
CR-51	Ci	(1)	(1)	(1)	1.01E-06	1.01E-06
Totals for Period...	Ci	(1)	(1)	(1)	1.01E-06	1.01E-06
Others						
C-14	Ci	1.26E+00	1.10E+00	1.20E+00	1.05E+00	4.61E+00
Totals for Period...	Ci	1.26E+00	1.10E+00	1.20E+00	1.05E+00	4.61E+00
Tritium						
H-3	Ci	1.72E+01	1.70E+01	1.04E+01	8.28E+00	5.30E+01
Totals for Period...	Ci	1.72E+01	1.70E+01	1.04E+01	8.28E+00	5.30E+01
Gross Alpha Radioactivity						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 1C
GASEOUS EFFLUENTS - MIXED MODE RELEASES - BATCH MODE
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
AR-41	Ci	1.68E-03	3.55E-03	2.54E-03	4.35E-03	1.21E-02
KR-85M	Ci	(1)	(1)	2.22E-05	1.60E-06	2.38E-05
XE-133M	Ci	(1)	(1)	1.80E-04	7.88E-06	1.88E-04
XE-133	Ci	2.71E-05	7.40E-04	1.20E-02	4.08E-03	1.68E-02
XE-135	Ci	(1)	(1)	1.38E-03	3.29E-05	1.41E-03
Totals for Period...	Ci	1.71E-03	4.29E-03	1.61E-02	8.47E-03	3.05E-02
Iodines						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)
Particulates Half Life >= 8 days						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)
Others						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)
Tritium						
H-3	Ci	3.56E-02	4.82E-02	5.94E-02	6.49E-02	2.08E-01
Totals for Period...	Ci	3.56E-02	4.82E-02	5.94E-02	6.49E-02	2.08E-01
Gross Alpha Radioactivity						
** No Nuclide Activities **		(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2A
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
1. Total Release	Ci	9.90E-04	7.13E-04	1.63E-03	1.33E-03	4.24E-03
2. Avg. Diluted Conc.	uCi/ml	2.89E-10	1.93E-10	4.71E-10	3.56E-10	2.96E-10
Tritium						
1. Total Release	Ci	2.47E+02	3.80E+02	4.48E+02	5.81E+02	1.66E+03
2. Avg. Diluted Conc.	uCi/ml	7.21E-05	1.03E-04	1.29E-04	1.56E-04	1.16E-04
Dissolved and Entrained Gases						
1. Total Release	Ci	5.16E-05	9.32E-06	1.93E-04	(1)	2.54E-04
2. Avg. Diluted Conc.	uCi/ml	1.51E-11	2.52E-12	5.56E-11	(1)	1.77E-11
Gross Alpha Radioactivity						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
Volume of liquid waste	liters	3.42E+09	3.70E+09	3.47E+09	3.73E+09	1.43E+10

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2A - Release Tank
LIQUID EFFLUENTS - SUMMATION BY RELEASE POINT
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
1. Total Release	Ci	9.90E-04	7.13E-04	1.63E-03	1.33E-03	4.24E-03
2. Avg. Diluted Conc.	uCi/ml	2.13E-06	1.17E-06	1.22E-06	1.40E-06	1.26E-06
Tritium						
1. Total Release	Ci	2.03E+02	3.60E+02	4.13E+02	4.17E+02	1.39E+03
2. Avg. Diluted Conc.	uCi/ml	4.36E-01	5.91E-01	3.08E-01	4.41E-01	4.15E-01
Dissolved and Entrained Gases						
1. Total Release	Ci	5.16E-05	9.32E-06	1.93E-04	(1)	2.54E-04
2. Avg. Diluted Conc.	uCi/ml	1.11E-07	1.53E-08	1.44E-07	(1)	7.56E-08
Gross Alpha Radioactivity						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
Volume of liquid waste	liters	4.66E+05	6.09E+05	1.34E+06	9.46E+05	3.36E+06

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2A - Circulating Water Blowdown
LIQUID EFFLUENTS - SUMMATION BY RELEASE POINT
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
2. Avg. Diluted Conc.	uCi/ml	(1)	(1)	(1)	(1)	(1)
Tritium						
1. Total Release	Ci	4.39E+01	1.93E+01	3.58E+01	1.64E+02	2.63E+02
2. Avg. Diluted Conc.	uCi/ml	1.28E-05	5.22E-06	1.03E-05	4.39E-05	1.83E-05
Dissolved and Entrained Gases						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
2. Avg. Diluted Conc.	uCi/ml	(1)	(1)	(1)	(1)	(1)
Gross Alpha Radioactivity						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
Volume of liquid waste	liters	3.42E+09	3.70E+09	3.47E+09	3.73E+09	1.43E+10

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2B
LIQUID EFFLUENTS - CONTINUOUS MODE
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
No Nuclide Activities	Ci	(1)	(1)	(1)	(1)	(1)
Totals for Period...	Ci	(1)	(1)	(1)	(1)	(1)
Tritium						
H-3	Ci	4.39E+01	1.93E+01	3.58E+01	1.64E+02	2.63E+02
Totals for Period...	Ci	4.39E+01	1.93E+01	3.58E+01	1.64E+02	2.63E+02
Dissolved and Entrained Gases						
No Nuclide Activities	Ci	(1)	(1)	(1)	(1)	(1)
Totals for Period...	Ci	(1)	(1)	(1)	(1)	(1)
Gross Alpha Radioactivity						
No Nuclide Activities	Ci	(1)	(1)	(1)	(1)	(1)
Totals for Period...	Ci	(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2B
LIQUID EFFLUENTS - BATCH MODE
Unit 1

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
CO-57	Ci	3.23E-06	4.19E-06	4.93E-06	1.60E-06	1.40E-05
CO-58	Ci	7.03E-04	4.73E-04	5.97E-04	9.86E-04	2.76E-03
CO-60	Ci	2.52E-04	1.49E-04	4.64E-04	2.24E-04	1.09E-03
CR-51	Ci	(1)	(1)	1.92E-04	(1)	1.92E-04
FE-59	Ci	4.47E-06	(1)	(1)	(1)	4.47E-06
I-132	Ci	(1)	(1)	1.95E-05	(1)	1.95E-05
I-133	Ci	(1)	1.93E-06	(1)	(1)	1.93E-06
MN-54	Ci	(1)	3.94E-06	(1)	(1)	3.94E-06
NB-95	Ci	3.08E-06	(1)	1.11E-05	(1)	1.42E-05
SB-122	Ci	(1)	(1)	5.08E-06	(1)	5.08E-06
SB-124	Ci	(1)	(1)	2.48E-05	2.14E-06	2.69E-05
SB-125	Ci	2.21E-05	5.52E-06	4.36E-05	(1)	7.12E-05
TE-123M	Ci	2.28E-06	(1)	1.82E-05	(1)	2.05E-05
TE-132	Ci	(1)	(1)	1.32E-05	(1)	1.32E-05
ZR-95	Ci	(1)	(1)	5.34E-06	(1)	5.34E-06
Totals for Period...	Ci	9.90E-04	6.37E-04	1.40E-03	1.21E-03	4.24E-03
Tritium						
H-3	Ci	2.03E+02	3.60E+02	4.13E+02	4.17E+02	1.39E+03
Totals for Period...	Ci	2.03E+02	3.60E+02	4.13E+02	4.17E+02	1.39E+03
Dissolved and Entrained Gases						
XE-133	Ci	5.16E-05	9.32E-06	1.93E-04	(1)	2.54E-04
Totals for Period...	Ci	5.16E-05	9.32E-06	1.93E-04	(1)	2.54E-04
Gross Alpha Radioactivity						
No Nuclide Activities	Ci	(1)	(1)	(1)	(1)	(1)
Totals for Period...	Ci	(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2A
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
1. Total Release	Ci	9.90E-04	7.13E-04	1.63E-03	1.33E-03	4.24E-03
2. Avg. Diluted Conc.	uCi/ml	2.89E-10	1.93E-10	4.71E-10	3.56E-10	2.96E-10
Tritium						
1. Total Release	Ci	2.47E+02	3.80E+02	4.48E+02	5.81E+02	1.66E+03
2. Avg. Diluted Conc.	uCi/ml	7.21E-05	1.03E-04	1.29E-04	1.56E-04	1.16E-04
Dissolved and Entrained Gases						
1. Total Release	Ci	5.16E-05	9.32E-06	1.93E-04	(1)	2.54E-04
2. Avg. Diluted Conc.	uCi/ml	1.51E-11	2.52E-12	5.56E-11	(1)	1.77E-11
Gross Alpha Radioactivity						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
Volume of liquid waste	liters	3.42E+09	3.70E+09	3.47E+09	3.73E+09	1.43E+10

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2A - Release Tank
LIQUID EFFLUENTS - SUMMATION BY RELEASE POINT
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
1. Total Release	Ci	9.90E-04	7.13E-04	1.63E-03	1.33E-03	4.24E-03
2. Avg. Diluted Conc.	uCi/ml	2.13E-06	1.17E-06	1.22E-06	1.40E-06	1.26E-06
Tritium						
1. Total Release	Ci	2.03E+02	3.60E+02	4.13E+02	4.17E+02	1.39E+03
2. Avg. Diluted Conc.	uCi/ml	4.36E-01	5.91E-01	3.08E-01	4.41E-01	4.15E-01
Dissolved and Entrained Gases						
1. Total Release	Ci	5.16E-05	9.32E-06	1.93E-04	(1)	2.54E-04
2. Avg. Diluted Conc.	uCi/ml	1.11E-07	1.53E-08	1.44E-07	(1)	7.56E-08
Gross Alpha Radioactivity						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
Volume of liquid waste	liters	4.66E+05	6.09E+05	1.34E+06	9.46E+05	3.36E+06

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2A - Circulating Water Blowdown
LIQUID EFFLUENTS - SUMMATION BY RELEASE POINT
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
2. Avg. Diluted Conc.	uCi/ml	(1)	(1)	(1)	(1)	(1)
Tritium						
1. Total Release	Ci	4.39E+01	1.93E+01	3.58E+01	1.64E+02	2.63E+02
2. Avg. Diluted Conc.	uCi/ml	1.28E-05	5.22E-06	1.03E-05	4.39E-05	1.83E-05
Dissolved and Entrained Gases						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
2. Avg. Diluted Conc.	uCi/ml	(1)	(1)	(1)	(1)	(1)
Gross Alpha Radioactivity						
1. Total Release	Ci	(1)	(1)	(1)	(1)	(1)
Volume of liquid waste	liters	3.42E+09	3.70E+09	3.47E+09	3.73E+09	1.43E+10

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2B
LIQUID EFFLUENTS - CONTINUOUS MODE
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
No Nuclide Activities	Ci	(1)	(1)	(1)	(1)	(1)
Totals for Period...	Ci	(1)	(1)	(1)	(1)	(1)
Tritium						
H-3	Ci	4.39E+01	1.93E+01	3.58E+01	1.64E+02	2.63E+02
Totals for Period...	Ci	4.39E+01	1.93E+01	3.58E+01	1.64E+02	2.63E+02
Dissolved and Entrained Gases						
No Nuclide Activities	Ci	(1)	(1)	(1)	(1)	(1)
Totals for Period...	Ci	(1)	(1)	(1)	(1)	(1)
Gross Alpha Radioactivity						
No Nuclide Activities	Ci	(1)	(1)	(1)	(1)	(1)
Totals for Period...	Ci	(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

RG 1.21 EFFLUENT AND WASTE DISPOSAL REPORT
TABLE 2B
LIQUID EFFLUENTS - BATCH MODE
Unit 2

REPORT FOR 2015	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
CO-57	Ci	3.23E-06	4.19E-06	4.93E-06	1.60E-06	1.40E-05
CO-58	Ci	7.03E-04	4.73E-04	5.97E-04	9.86E-04	2.76E-03
CO-60	Ci	2.52E-04	1.49E-04	4.64E-04	2.24E-04	1.09E-03
CR-51	Ci	(1)	(1)	1.92E-04	(1)	1.92E-04
FE-59	Ci	4.47E-06	(1)	(1)	(1)	4.47E-06
I-132	Ci	(1)	(1)	1.95E-05	(1)	1.95E-05
I-133	Ci	(1)	1.93E-06	(1)	(1)	1.93E-06
MN-54	Ci	(1)	3.94E-06	(1)	(1)	3.94E-06
NB-95	Ci	3.08E-06	(1)	1.11E-05	(1)	1.42E-05
SB-122	Ci	(1)	(1)	5.08E-06	(1)	5.08E-06
SB-124	Ci	(1)	(1)	2.48E-05	2.14E-06	2.69E-05
SB-125	Ci	2.21E-05	5.52E-06	4.36E-05	(1)	7.12E-05
TE-123M	Ci	2.28E-06	(1)	1.82E-05	(1)	2.05E-05
TE-132	Ci	(1)	(1)	1.32E-05	(1)	1.32E-05
ZR-95	Ci	(1)	(1)	5.34E-06	(1)	5.34E-06
Totals for Period...	Ci	9.90E-04	6.37E-04	1.40E-03	1.21E-03	4.24E-03
Tritium						
H-3	Ci	2.03E+02	3.60E+02	4.13E+02	4.17E+02	1.39E+03
Totals for Period...	Ci	2.03E+02	3.60E+02	4.13E+02	4.17E+02	1.39E+03
Dissolved and Entrained Gases						
XE-133	Ci	5.16E-05	9.32E-06	1.93E-04	(1)	2.54E-04
Totals for Period...	Ci	5.16E-05	9.32E-06	1.93E-04	(1)	2.54E-04
Gross Alpha Radioactivity						
No Nuclide Activities	Ci	(1)	(1)	(1)	(1)	(1)
Totals for Period...	Ci	(1)	(1)	(1)	(1)	(1)

(1) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of TRM Section 3.11

40CFR190 URANIUM FUEL CYCLE DOSE REPORT

LIQUID DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2
Liquid Receptor

=== PERIOD DOSE BY ORGAN AND AGE GROUP (mrem) ========== QUARTER 1 ==========

Agegrp	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	TB
ADULT	6.22E-06	3.69E-02	3.68E-02	3.68E-02	3.68E-02	4.40E-02	0.00E+00	3.71E-02
TEEN	6.38E-06	2.77E-02	2.76E-02	2.76E-02	2.76E-02	3.27E-02	0.00E+00	2.79E-02
CHILD	7.77E-06	3.09E-02	3.08E-02	3.08E-02	3.08E-02	3.26E-02	0.00E+00	3.11E-02
INFANT	1.56E-07	1.36E-02	1.36E-02	1.36E-02	1.36E-02	1.37E-02	0.00E+00	1.37E-02

=== SITE DOSE LIMIT ANALYSIS ========== QUARTER 1 ==========

Quarter - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
Qtr 1 - Admin. Any Organ	ADULT	GILLI	4.40E-02	3.75E+00	1.17E+00
Qtr 1 - Admin. Total Body	ADULT	TBODY	3.71E-02	1.13E+00	3.30E+00
Qtr 1 - T.Spc. Any Organ	ADULT	GILLI	4.40E-02	5.00E+00	8.81E-01

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	8.35E+01
FE-59	8.37E-02
CO-58	2.93E+00
CO-60	2.80E+00
NB-95	1.07E+01
SB-125	3.23E-03

Qtr 1 - T.Spc. Total Body	ADULT	TBODY	3.71E-02	1.50E+00	2.47E+00

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	9.92E+01
FE-59	1.14E-02
CO-58	3.86E-01
CO-60	3.90E-01
NB-95	1.12E-03
SB-125	8.28E-05

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LIQUID DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2
Liquid Receptor

=== PERIOD DOSE BY ORGAN AND AGE GROUP (mrem) ========== QUARTER 2 ==========

Agegrp	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	TB
ADULT	4.24E-04	3.47E-02	3.47E-02	3.47E-02	3.47E-02	3.56E-02	0.00E+00	3.48E-02
TEEN	3.88E-04	2.61E-02	2.60E-02	2.60E-02	2.60E-02	2.66E-02	0.00E+00	2.61E-02
CHILD	4.38E-04	2.90E-02	2.90E-02	2.90E-02	2.90E-02	2.92E-02	0.00E+00	2.91E-02
INFANT	7.65E-06	1.28E-02	1.28E-02	1.28E-02	1.28E-02	1.28E-02	0.00E+00	1.28E-02

=== SITE DOSE LIMIT ANALYSIS ========== QUARTER 2 ==========

Quarter - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
Qtr 2 - Admin. Any Organ	ADULT	GILLI	3.56E-02	3.75E+00	9.48E-01
Qtr 2 - Admin. Total Body	ADULT	TBODY	3.48E-02	1.13E+00	3.09E+00
Qtr 2 - T.Spc. Any Organ	ADULT	GILLI	3.56E-02	5.00E+00	7.11E-01

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	9.75E+01
MN-54	7.98E-02
FE-55	2.86E-02
CO-58	1.30E+00
CO-60	1.09E+00
SR-89	1.28E-02
SR-90	2.62E-02
SB-125	5.30E-04
I-133	2.38E-04

Qtr 2 - T.Spc. Total Body	ADULT	TBODY	3.48E-02	1.50E+00	2.32E+00

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	9.97E+01
MN-54	5.08E-03
FE-55	1.19E-02
CO-58	1.47E-01
CO-60	1.31E-01
SR-89	2.34E-03
SR-90	2.14E-02
SB-125	1.17E-05
I-133	8.25E-05

40CFR190 URANIUM FUEL CYCLE DOSE REPORT

LIQUID DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2
Liquid Receptor

=== PERIOD DOSE BY ORGAN AND AGE GROUP (mrem) ========== QUARTER 3 ==========

Agegrp	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	TB
ADULT	1.15E-03	3.43E-02	3.41E-02	3.42E-02	3.41E-02	4.40E-02	0.00E+00	3.43E-02
TEEN	1.06E-03	2.57E-02	2.56E-02	2.57E-02	2.56E-02	3.25E-02	0.00E+00	2.58E-02
CHILD	1.19E-03	2.87E-02	2.86E-02	2.86E-02	2.86E-02	3.10E-02	0.00E+00	2.88E-02
INFANT	2.07E-05	1.27E-02	1.27E-02	1.27E-02	1.27E-02	1.27E-02	0.00E+00	1.27E-02

=== SITE DOSE LIMIT ANALYSIS ========== QUARTER 3 ==========

Quarter - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
Qtr 3 - Admin. Any Organ	ADULT	GILLI	4.40E-02	3.75E+00	1.17E+00
Qtr 3 - Admin. Total Body	ADULT	TBODY	3.43E-02	1.13E+00	3.05E+00
Qtr 3 - T.Spc. Any Organ	ADULT	GILLI	4.40E-02	5.00E+00	8.79E-01

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	7.76E+01
CR-51	6.46E-02
FE-55	6.19E-02
CO-58	1.14E+00
CO-60	2.36E+00
SR-89	2.76E-02
SR-90	5.67E-02
ZR-95	1.51E-03
NB-95	1.76E+01
SB-124	6.69E-03
SB-125	2.91E-03
TE-132	1.02E+00
I-132	7.66E-05

Qtr 3 - T.Spc. Total Body	ADULT	TBODY	3.43E-02	1.50E+00	2.29E+00

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	9.94E+01
CR-51	3.29E-04
FE-55	3.22E-02
CO-58	1.61E-01
CO-60	3.55E-01

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Nuclide	Percentage
SR-89	6.33E-03
SR-90	5.80E-02
ZR-95	4.13E-07
NB-95	2.00E-03
SB-124	1.19E-04
SB-125	8.06E-05
TE-132	2.60E-02
I-132	1.83E-04

40CFR190 URANIUM FUEL CYCLE DOSE REPORT

LIQUID DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2
Liquid Receptor

=== PERIOD DOSE BY ORGAN AND AGE GROUP (mrem) ========== QUARTER 4 ==========

Agegrp	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	TB
ADULT	5.50E-04	3.49E-02	3.48E-02	3.48E-02	3.48E-02	3.61E-02	0.00E+00	3.49E-02
TEEN	5.03E-04	2.62E-02	2.61E-02	2.61E-02	2.61E-02	2.70E-02	0.00E+00	2.62E-02
CHILD	5.68E-04	2.92E-02	2.91E-02	2.91E-02	2.91E-02	2.95E-02	0.00E+00	2.93E-02
INFANT	9.90E-06	1.30E-02	1.30E-02	1.30E-02	1.30E-02	1.30E-02	0.00E+00	1.30E-02

=== SITE DOSE LIMIT ANALYSIS ========== QUARTER 4 ==========

Quarter - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
Qtr 4 - Admin. Any Organ	ADULT	GILLI	3.61E-02	3.75E+00	9.63E-01
Qtr 4 - Admin. Total Body	ADULT	TBODY	3.49E-02	1.13E+00	3.11E+00
Qtr 4 - T.Spc. Any Organ	ADULT	GILLI	3.61E-02	5.00E+00	7.23E-01

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	9.62E+01
FE-55	3.65E-02
CO-58	2.30E+00
CO-60	1.39E+00
SR-89	1.63E-02
SR-90	3.34E-02
SB-124	7.05E-04

Qtr 4 - T.Spc. Total Body	ADULT	TBODY	3.49E-02	1.50E+00	2.33E+00

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	9.95E+01
FE-55	1.53E-02
CO-58	2.63E-01
CO-60	1.69E-01
SR-89	3.01E-03
SR-90	2.76E-02
SB-124	1.02E-05

40CFR190 URANIUM FUEL CYCLE DOSE REPORT

LIQUID DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2
Liquid Receptor

=== PERIOD DOSE BY ORGAN AND AGE GROUP (mrem) ========== ANNUAL 2015 =========

Agegrp	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	TB
ADULT	2.44E-05	1.40E-01	1.39E-01	1.39E-01	1.39E-01	1.58E-01	0.00E+00	1.40E-01
TEEN	2.55E-05	1.05E-01	1.04E-01	1.05E-01	1.04E-01	1.17E-01	0.00E+00	1.05E-01
CHILD	3.17E-05	1.17E-01	1.17E-01	1.17E-01	1.16E-01	1.21E-01	0.00E+00	1.17E-01
INFANT	4.03E-07	5.17E-02	5.17E-02	5.17E-02	5.17E-02	5.17E-02	0.00E+00	5.17E-02

=== SITE DOSE LIMIT ANALYSIS ========== ANNUAL 2015 =========

Annual - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
2015 - Admin. Any Organ	ADULT	GILLI	1.58E-01	7.50E+00	2.10E+00
2015 - Admin. Total Body	ADULT	TBODY	1.40E-01	2.25E+00	6.22E+00
2015 - T.Spc. Any Organ	ADULT	GILLI	1.58E-01	1.00E+01	1.58E+00

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	8.84E+01
CR-51	2.18E-02
MN-54	1.87E-02
FE-59	1.29E-02
CO-58	1.77E+00
CO-60	1.87E+00
ZR-95	5.09E-04
NB-95	7.58E+00
SB-124	2.45E-03
SB-125	1.60E-03
TE-132	3.45E-01
I-132	2.58E-05
I-133	5.56E-05

2015 - T.Spc. Total Body	ADULT	TBODY	1.40E-01	3.00E+00	4.66E+00

Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	9.95E+01
CR-51	9.74E-05
MN-54	1.31E-03
FE-59	1.67E-03
CO-58	2.21E-01

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Nuclide	Percentage
CO-60	2.47E-01
ZR-95	1.22E-07
NB-95	7.56E-04
SB-124	3.84E-05
SB-125	3.90E-05
TE-132	7.71E-03
I-132	5.41E-05
I-133	2.13E-05

40CFR190 URANIUM FUEL CYCLE DOSE REPORT

GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2

=== I&P DOSE LIMIT ANALYSIS ========== QUARTER 1 ==========

Quarter - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
Qtr 1 - Admin. Any Organ	CHILD	BONE	1.94E-01	5.63E+00	3.45E+00
Qtr 1 - Admin. Total Body	CHILD	TBODY	4.06E-02	5.25E+00	7.73E-01
Qtr 1 - T.Spc. Any Organ	CHILD	BONE	1.94E-01	7.50E+00	2.59E+00

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	0.00E+00
C-14	1.00E+02
I-131	6.39E-05

Qtr 1 - T.Spc. Total Body	CHILD	TBODY	4.06E-02	7.50E+00	5.41E-01

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	4.32E+00
C-14	9.57E+01
I-131	1.76E-04

40CFR190 URANIUM FUEL CYCLE DOSE REPORT

GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2

=== NG DOSE LIMIT ANALYSIS ========== QUARTER 1 ==========

Quarter - Limit	Dose (mrad)	Limit (mrad)	Max % of Limit
Qtr 1 - Admin. Gamma	1.70E-05	3.75E+00	4.53E-04
Qtr 1 - Admin. Beta	8.83E-06	7.50E+00	1.18E-04
Qtr 1 - T.Spc. Gamma	1.70E-05	5.00E+00	3.40E-04

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	3.26E+01
XE-135	2.56E-01
XE-133	6.72E+01

Qtr 1 - T.Spc. Beta	8.83E-06	1.00E+01	8.83E-05

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	5.43E+00
XE-135	1.55E-01
XE-133	9.44E+01

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GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2

=== I&P DOSE LIMIT ANALYSIS ========== QUARTER 2 ==========

Quarter - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
Qtr 2 - Admin. Any Organ	CHILD	BONE	1.80E-01	5.63E+00	3.19E+00
Qtr 2 - Admin. Total Body	CHILD	TBODY	3.73E-02	5.25E+00	7.11E-01
Qtr 2 - T.Spc. Any Organ	CHILD	BONE	1.80E-01	7.50E+00	2.40E+00

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	0.00E+00
C-14	1.00E+02

Qtr 2 - T.Spc. Total Body	CHILD	TBODY	3.73E-02	7.50E+00	4.98E-01

Receptor: Composite Crit. Receptor - IP
Distance: 800 (meters) Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	3.79E+00
C-14	9.62E+01

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GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2

=== NG DOSE LIMIT ANALYSIS ========== QUARTER 2 ==========

Quarter - Limit	Dose (mrad)	Limit (mrad)	Max % of Limit
Qtr 2 - Admin. Gamma	1.76E-05	3.75E+00	4.70E-04
Qtr 2 - Admin. Beta	4.81E-06	7.50E+00	6.42E-05
Qtr 2 - T.Spc. Gamma	1.76E-05	5.00E+00	3.52E-04

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	7.10E+01
XE-133	2.90E+01

Qtr 2 - T.Spc. Beta	4.81E-06	1.00E+01	4.81E-05

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	2.25E+01
XE-133	7.75E+01

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GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2

=== I&P DOSE LIMIT ANALYSIS ========== QUARTER 3 ==========

Quarter - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
Qtr 3 - Admin. Any Organ	CHILD	BONE	1.78E-01	5.63E+00	3.16E+00
Qtr 3 - Admin. Total Body	CHILD	TBODY	3.62E-02	5.25E+00	6.89E-01
Qtr 3 - T.Spc. Any Organ	CHILD	BONE	1.78E-01	7.50E+00	2.37E+00

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	0.00E+00
C-14	1.00E+02
I-131	3.08E-04

Qtr 3 - T.Spc. Total Body	CHILD	TBODY	3.62E-02	7.50E+00	4.82E-01

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	1.87E+00
C-14	9.81E+01
I-131	8.70E-04

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GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2

=== NG DOSE LIMIT ANALYSIS ========== QUARTER 3 ==========

Quarter - Limit	Dose (mrad)	Limit (mrad)	Max % of Limit
Qtr 3 - Admin. Gamma	1.52E-05	3.75E+00	4.06E-04
Qtr 3 - Admin. Beta	3.47E-06	7.50E+00	4.62E-05
Qtr 3 - T.Spc. Gamma	1.52E-05	5.00E+00	3.04E-04

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	7.68E+01
KR-85M	2.09E-02
XE-135	2.03E+00
XE-133M	4.49E-02
XE-133	2.11E+01

Qtr 3 - T.Spc. Beta	3.47E-06	1.00E+01	3.47E-05

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	2.92E+01
KR-85M	3.60E-02
XE-135	2.80E+00
XE-133M	2.19E-01
XE-133	6.78E+01

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GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
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=== I&P DOSE LIMIT ANALYSIS ========== QUARTER 4 ==========

Quarter - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
Qtr 4 - Admin. Any Organ	CHILD	BONE	1.70E-01	5.63E+00	3.03E+00
Qtr 4 - Admin. Total Body	CHILD	TBODY	3.48E-02	5.25E+00	6.62E-01
Qtr 4 - T.Spc. Any Organ	CHILD	BONE	1.70E-01	7.50E+00	2.27E+00

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	0.00E+00
C-14	1.00E+02
CR-51	3.30E-07
I-131	6.90E-05

Qtr 4 - T.Spc. Total Body	CHILD	TBODY	3.48E-02	7.50E+00	4.64E-01

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	2.00E+00
C-14	9.80E+01
CR-51	1.70E-06
I-131	1.95E-04

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GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2

=== NG DOSE LIMIT ANALYSIS ========== QUARTER 4 ==========

Quarter - Limit	Dose (mrad)	Limit (mrad)	Max % of Limit
Qtr 4 - Admin. Gamma	1.76E-02	3.75E+00	4.69E-01
Qtr 4 - Admin. Beta	8.38E-04	7.50E+00	1.12E-02
Qtr 4 - T.Spc. Gamma	1.76E-02	5.00E+00	3.52E-01

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	2.11E-02
KR-85M	1.30E-06
XE-135	4.16E-05
XE-133M	1.70E-06
KR-88	9.99E+01
XE-133	3.20E-02

Qtr 4 - T.Spc. Beta	8.38E-04	1.00E+01	8.38E-03

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	3.84E-02
KR-85M	1.07E-05
XE-135	2.75E-04
XE-133M	3.97E-05
KR-88	9.95E+01
XE-133	4.92E-01

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GASEOUS DOSE SUMMARY

Units 1 & 2

Report for: 2015
Unit Range - From: 1 To: 2

=== I&P DOSE LIMIT ANALYSIS ========== ANNUAL 2015 =========

Annual - Limit	Age Group	Organ	Dose (mrem)	Limit (mrem)	Max % of Limit
2015 - Admin. Any Organ	CHILD	BONE	7.22E-01	1.13E+01	6.42E+00
2015 - Admin. Total Body	CHILD	TBODY	1.49E-01	1.05E+01	1.42E+00
2015 - T.Spc. Any Organ	CHILD	BONE	7.22E-01	1.50E+01	4.81E+00

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	0.00E+00
C-14	1.00E+02
CR-51	7.79E-08
I-131	1.09E-04

2015 - T.Spc. Total Body	CHILD	TBODY	1.49E-01	1.50E+01	9.92E-01

Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE
Critical Pathway: Vegetation
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	3.05E+00
C-14	9.69E+01
CR-51	3.98E-07
I-131	3.05E-04

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Report for: 2015
Unit Range - From: 1 To: 2

=== NG DOSE LIMIT ANALYSIS ========== ANNUAL 2015 =========

Annual - Limit	Dose (mrad)	Limit (mrad)	Max % of Limit
2015 - Admin. Gamma	1.76E-02	7.50E+00	2.35E-01
2015 - Admin. Beta	8.55E-04	1.50E+01	5.70E-03
2015 - T.Spc. Gamma	1.76E-02	1.00E+01	1.76E-01

Receptor: Composite Crit. Receptor - NG
Distance: 800 meters Compass Point: SSE

Nuclide	Percentage
AR-41	1.89E-01
KR-85M	1.93E-05
XE-135	2.03E-03
XE-133M	4.04E-05
KR-88	9.97E+01
XE-133	1.44E-01

2015 - T.Spc. Beta	8.55E-04	2.00E+01	4.27E-03

Receptor: Composite Crit. Receptor - NG
Distance: 800 (meters) Compass Point: SSE

Nuclide	Percentage
AR-41	3.39E-01
KR-85M	1.57E-04
XE-135	1.32E-02
XE-133M	9.29E-04
KR-88	9.75E+01
XE-133	2.17E+00

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Units 1 & 2

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Unit Range - From: 1 To: 2

=== MAXIMUM DOSE ANALYSIS ========== ANNUAL 2015 =========

Dose Type	Age Group	Organ	Dose (mrem)
Any Organ	CHILD	BONE	7.22E-01

Liquid Receptor: Liquid Receptor
Gaseous Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE

Liquid Dose: 3.17E-05 % of Total: 4.39E-03
Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	0.00E+00
CR-51	0.00E+00
MN-54	0.00E+00
FE-59	1.03E+01
CO-58	0.00E+00
CO-60	0.00E+00
ZR-95	3.46E-03
NB-95	1.33E+01
SB-124	7.19E-01
SB-125	1.23E+00
TE-132	7.39E+01
I-132	3.39E-01
I-133	2.49E-01

Gaseous Dose: 7.22E-01 % of Total: 1.00E+02
Critical Pathway: Vegetation (VEG)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	0.00E+00
C-14	1.00E+02
CR-51	7.79E-08
I-131	1.09E-04

=== MAXIMUM DOSE ANALYSIS ========== ANNUAL 2015 =========

Dose Type	Age Group	Organ	Dose (mrem)
Total Body	CHILD	TBODY	2.66E-01

Liquid Receptor: Liquid Receptor
Gaseous Receptor: Composite Crit. Receptor - IP
Distance: 800 meters Compass Point: SSE

40CFR190 URANIUM FUEL CYCLE DOSE REPORT

Liquid Dose: 1.17E-01 % of Total: 4.41E+01
Critical Pathway: Fresh Water Fish - Sport (FFSP)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	9.94E+01
CR-51	1.28E-04
MN-54	1.68E-03
FE-59	2.24E-03
CO-58	2.88E-01
CO-60	3.22E-01
ZR-95	1.83E-07
NB-95	9.98E-04
SB-124	6.80E-05
SB-125	6.95E-05
TE-132	1.07E-02
I-132	7.75E-05
I-133	3.14E-05

Gaseous Dose: 1.49E-01 % of Total: 5.60E+01
Critical Pathway: Vegetation (VEG)
Major Contributors (0% or greater to total)

Nuclide	Percentage
H-3	3.05E+00
C-14	9.69E+01
CR-51	3.98E-07
I-131	3.05E-04

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 1

=== RELEASE DATA ==========

Total Release Duration (minutes)	6.183E+05
Total Release Volume (cf)	6.672E+10
Average Release Flowrate (cfm)	1.079E+05
Average Period Flowrate (cfm)	1.269E+05

=== NUCLIDE DATA ==========

Nuclide	uCi	Average uCi/cc	EC Ratio	EC
AR-41	4.99E+04	2.64E-11	2.64E-03	1.00E-08
KR-85M	2.38E+01	1.26E-14	1.26E-07	1.00E-07
KR-88	1.99E+07	1.06E-08	1.17E+00	9.00E-09
XE-133M	1.88E+02	9.95E-14	1.66E-07	6.00E-07
XE-133	8.40E+05	4.45E-10	8.89E-04	5.00E-07
XE-135	1.81E+03	9.56E-13	1.37E-05	7.00E-08
F&AG	2.08E+07	1.10E-08	1.18E+00	
C-14	4.24E+06	2.25E-09	7.49E-01	3.00E-09
Other	4.24E+06	2.25E-09	7.49E-01	
H-3	2.73E+07	1.44E-08	1.44E-01	1.00E-07
H-3	2.73E+07	1.44E-08	1.44E-01	
Total	5.23E+07	2.77E-08	2.07E+00	

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 1

=== MAXIMUM I&P DOSE FOR PERIOD ===

Limit Type	Organ Type	Age Group	Organ	Dose (mrem)	Limit Period	Limit (mrem)	Percent of Limit
Admin	Any Organ	CHILD	BONE	3.46E-01	31-day	2.25E-01	1.54E+02
					Quarter	5.63E+00	6.15E+00
					Annual	1.13E+01	3.07E+00
T.Spec	Any Organ	CHILD	BONE	3.46E-01	31-day	3.00E-01	1.15E+02
					Quarter	7.50E+00	4.61E+00
					Annual	1.50E+01	2.31E+00

Receptor.....: Composite Crit. Receptor - IP
Distance (meters).....: 800
Compass Point.....: SSE
Critical Pathway.....: Vegetation (VEG)
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
H-3	0.00E+00
C-14	1.00E+02

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 1

=== PERIOD ORGAN DOSE BY AGE GROUP AND PATHWAY (mrem) ==========

Age/Path	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
AINHL	1.10E-03	4.85E-04	4.85E-04	4.85E-04	4.85E-04	4.85E-04	0.00E+00	4.85E-04
AVEG	5.43E-02	1.13E-02	1.13E-02	1.13E-02	1.13E-02	1.13E-02	0.00E+00	1.13E-02
ACMEAT	2.01E-02	4.10E-03	4.10E-03	4.10E-03	4.10E-03	4.10E-03	0.00E+00	4.10E-03
ACMILK	2.20E-02	4.56E-03	4.56E-03	4.56E-03	4.56E-03	4.56E-03	0.00E+00	4.56E-03
TINHL	1.57E-03	5.76E-04	5.76E-04	5.76E-04	5.76E-04	5.76E-04	0.00E+00	5.76E-04
TVEG	8.77E-02	1.82E-02	1.82E-02	1.82E-02	1.82E-02	1.82E-02	0.00E+00	1.82E-02
TCMEAT	1.70E-02	3.44E-03	3.44E-03	3.44E-03	3.44E-03	3.44E-03	0.00E+00	3.44E-03
TCMILK	4.05E-02	8.33E-03	8.33E-03	8.33E-03	8.33E-03	8.33E-03	0.00E+00	8.33E-03
CINHL	2.17E-03	6.56E-04	6.56E-04	6.56E-04	6.56E-04	6.56E-04	0.00E+00	6.56E-04
CVEG	2.12E-01	4.33E-02	4.33E-02	4.33E-02	4.33E-02	4.33E-02	0.00E+00	4.33E-02
CCMEAT	3.20E-02	6.47E-03	6.47E-03	6.47E-03	6.47E-03	6.47E-03	0.00E+00	6.47E-03
CCMILK	9.98E-02	2.03E-02	2.03E-02	2.03E-02	2.03E-02	2.03E-02	0.00E+00	2.03E-02
IINHL	1.60E-03	4.64E-04	4.64E-04	4.64E-04	4.64E-04	4.64E-04	0.00E+00	4.64E-04
ICMILK	1.95E-01	4.22E-02	4.22E-02	4.22E-02	4.22E-02	4.22E-02	0.00E+00	4.22E-02
TOTALS								
ADULT	9.75E-02	2.05E-02	2.05E-02	2.05E-02	2.05E-02	2.05E-02	0.00E+00	2.05E-02
TEEN	1.47E-01	3.05E-02	3.05E-02	3.05E-02	3.05E-02	3.05E-02	0.00E+00	3.05E-02
CHILD	3.46E-01	7.07E-02	7.07E-02	7.07E-02	7.07E-02	7.07E-02	0.00E+00	7.07E-02
INFANT	1.97E-01	4.27E-02	4.27E-02	4.27E-02	4.27E-02	4.27E-02	0.00E+00	4.27E-02

=== AGE GROUP / PATHWAY DESCRIPTIONS ==========

Abbreviation	Age Group	Pathway
AINHL	ADULT	Inhalation (INHL)
AVEG	ADULT	Vegetation (VEG)
ACMEAT	ADULT	Grs/Cow/Meat (CMEAT)
ACMILK	ADULT	Grs/Cow/Milk (CMILK)
TINHL	TEEN	Inhalation (INHL)
TVEG	TEEN	Vegetation (VEG)
TCMEAT	TEEN	Grs/Cow/Meat (CMEAT)
TCMILK	TEEN	Grs/Cow/Milk (CMILK)
CINHL	CHILD	Inhalation (INHL)
CVEG	CHILD	Vegetation (VEG)
CCMEAT	CHILD	Grs/Cow/Meat (CMEAT)
CCMILK	CHILD	Grs/Cow/Milk (CMILK)
IINHL	INFANT	Inhalation (INHL)
ICMILK	INFANT	Grs/Cow/Milk (CMILK)

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 1

=== MAXIMUM NG DOSE FOR PERIOD ===

Limit Type	Dose Type	Dose (mrad)	Limit Period	Limit (mrad)	Percent of Limit
Admin	Gamma	1.76E-02	31-day	1.50E-01	1.18E+01
			Quarter	3.75E+00	4.70E-01
			Annual	7.50E+00	2.35E-01
Admin	Beta	8.48E-04	31-day	3.00E-01	2.83E-01
			Quarter	7.50E+00	1.13E-02
			Annual	1.50E+01	5.65E-03
T.Spec	Gamma	1.76E-02	31-day	2.00E-01	8.82E+00
			Quarter	5.00E+00	3.53E-01
			Annual	1.00E+01	1.76E-01

Receptor.....: Composite Crit. Receptor - NG
Distance (meters).....: 800
Compass Point.....: SSE
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
AR-41	1.53E-01
KR-85M	9.64E-06
KR-88	9.97E+01
XE-133M	2.02E-05
XE-133	9.75E-02
XE-135	1.14E-03

T.Spec	Beta	8.48E-04	31-day	4.00E-01	2.12E-01
			Quarter	1.00E+01	8.48E-03
			Annual	2.00E+01	4.24E-03

Receptor.....: Composite Crit. Receptor - NG
Distance (meters).....: 800
Compass Point.....: SSE
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
AR-41	2.75E-01
KR-85M	7.89E-05
KR-88	9.82E+01

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 1

Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
XE-133M	4.68E-04
XE-133	1.48E+00
XE-135	7.47E-03

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 2

=== RELEASE DATA ==========

Total Release Duration (minutes)	6.107E+05
Total Release Volume (cf)	8.233E+10
Average Release Flowrate (cfm)	1.348E+05
Average Period Flowrate (cfm)	1.566E+05

=== NUCLIDE DATA ==========

Nuclide	uCi	Average uCi/cc	EC Ratio	EC
AR-41	1.21E+04	5.20E-12	5.20E-04	1.00E-08
KR-85M	2.38E+01	1.02E-14	1.02E-07	1.00E-07
XE-133M	1.88E+02	8.07E-14	1.34E-07	6.00E-07
XE-133	3.98E+05	1.71E-10	3.42E-04	5.00E-07
XE-135	1.42E+03	6.07E-13	8.68E-06	7.00E-08
F&AG	4.12E+05	1.77E-10	8.71E-04	
I-131	4.45E+00	1.91E-15	9.54E-06	2.00E-10
Iodine	4.45E+00	1.91E-15	9.54E-06	
C-14	4.61E+06	1.98E-09	6.60E-01	3.00E-09
Other	4.61E+06	1.98E-09	6.60E-01	
H-3	5.32E+07	2.28E-08	2.28E-01	1.00E-07
H-3	5.32E+07	2.28E-08	2.28E-01	
CR-51	1.01E+00	4.35E-16	1.45E-08	3.00E-08
P>=8	1.01E+00	4.35E-16	1.45E-08	
Total	5.82E+07	2.50E-08	8.89E-01	

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 2

=== MAXIMUM I&P DOSE FOR PERIOD ===

Limit Type	Organ Type	Age Group	Organ	Dose (mrem)	Limit Period	Limit (mrem)	Percent of Limit
Admin	Any Organ	CHILD	BONE	3.76E-01	31-day	2.25E-01	1.67E+02
					Quarter	5.63E+00	6.68E+00
					Annual	1.13E+01	3.34E+00
T.Spec	Any Organ	CHILD	BONE	3.76E-01	31-day	3.00E-01	1.25E+02
					Quarter	7.50E+00	5.01E+00
					Annual	1.50E+01	2.51E+00

Receptor.....: Composite Crit. Receptor - IP
Distance (meters).....: 800
Compass Point.....: SSE
Critical Pathway.....: Vegetation (VEG)
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
H-3	0.00E+00
C-14	1.00E+02
CR-51	1.50E-07
I-131	2.10E-04

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 2

=== PERIOD ORGAN DOSE BY AGE GROUP AND PATHWAY (mrem) ==========

Age/Path	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
AGPD	9.69E-09	9.69E-09	9.69E-09	9.69E-09	9.69E-09	9.69E-09	0.00E+00	9.69E-09
AINHL	1.20E-03	7.69E-04	7.70E-04	7.69E-04	7.69E-04	7.69E-04	0.00E+00	7.69E-04
AVEG	5.90E-02	1.28E-02	1.28E-02	1.28E-02	1.28E-02	1.28E-02	0.00E+00	1.28E-02
ACMEAT	2.19E-02	4.52E-03	4.52E-03	4.52E-03	4.52E-03	4.52E-03	0.00E+00	4.52E-03
ACMILK	2.39E-02	5.11E-03	5.18E-03	5.11E-03	5.11E-03	5.11E-03	0.00E+00	5.11E-03
TGPD	9.69E-09	9.69E-09	9.69E-09	9.69E-09	9.69E-09	9.69E-09	0.00E+00	9.69E-09
TINHL	1.71E-03	8.70E-04	8.71E-04	8.70E-04	8.70E-04	8.70E-04	0.00E+00	8.70E-04
TVEG	9.54E-02	2.03E-02	2.03E-02	2.03E-02	2.03E-02	2.03E-02	0.00E+00	2.03E-02
TCMEAT	1.85E-02	3.78E-03	3.78E-03	3.78E-03	3.78E-03	3.78E-03	0.00E+00	3.78E-03
TCMILK	4.41E-02	9.24E-03	9.36E-03	9.24E-03	9.24E-03	9.24E-03	0.00E+00	9.24E-03
CGPD	9.69E-09	9.69E-09	9.69E-09	9.69E-09	9.69E-09	9.69E-09	0.00E+00	9.69E-09
CINHL	2.36E-03	9.28E-04	9.29E-04	9.28E-04	9.28E-04	9.28E-04	0.00E+00	9.28E-04
CVEG	2.30E-01	4.78E-02	4.79E-02	4.78E-02	4.78E-02	4.78E-02	0.00E+00	4.78E-02
CCMEAT	3.48E-02	7.07E-03	7.08E-03	7.07E-03	7.07E-03	7.07E-03	0.00E+00	7.07E-03
CCMILK	1.09E-01	2.23E-02	2.26E-02	2.23E-02	2.23E-02	2.23E-02	0.00E+00	2.23E-02
IGPD	9.69E-09	9.69E-09	9.69E-09	9.69E-09	9.69E-09	9.69E-09	0.00E+00	9.69E-09
IINHL	1.74E-03	6.28E-04	6.29E-04	6.28E-04	6.28E-04	6.28E-04	0.00E+00	6.28E-04
ICMILK	2.12E-01	4.64E-02	4.69E-02	4.64E-02	4.64E-02	4.64E-02	0.00E+00	4.64E-02
TOTALS								
ADULT	1.06E-01	2.31E-02	2.32E-02	2.31E-02	2.31E-02	2.31E-02	0.00E+00	2.31E-02
TEEN	1.60E-01	3.42E-02	3.43E-02	3.42E-02	3.42E-02	3.42E-02	0.00E+00	3.42E-02
CHILD	3.76E-01	7.82E-02	7.84E-02	7.82E-02	7.82E-02	7.82E-02	0.00E+00	7.82E-02
INFANT	2.14E-01	4.70E-02	4.75E-02	4.70E-02	4.70E-02	4.70E-02	0.00E+00	4.70E-02

=== AGE GROUP / PATHWAY DESCRIPTIONS ==========

Abbreviation	Age Group	Pathway
AGPD	ADULT	Ground Plane Deposition (GPD)
AINHL	ADULT	Inhalation (INHL)
AVEG	ADULT	Vegetation (VEG)
ACMEAT	ADULT	Grs/Cow/Meat (CMEAT)
ACMILK	ADULT	Grs/Cow/Milk (CMILK)
TGPD	TEEN	Ground Plane Deposition (GPD)
TINHL	TEEN	Inhalation (INHL)
TVEG	TEEN	Vegetation (VEG)
TCMEAT	TEEN	Grs/Cow/Meat (CMEAT)
TCMILK	TEEN	Grs/Cow/Milk (CMILK)
CGPD	CHILD	Ground Plane Deposition (GPD)
CINHL	CHILD	Inhalation (INHL)

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 2

=== AGE GROUP / PATHWAY DESCRIPTIONS ==========

Abbreviation	Age Group	Pathway
CVEG	CHILD	Vegetation (VEG)
CCMEAT	CHILD	Grs/Cow/Meat (CMEAT)
CCMILK	CHILD	Grs/Cow/Milk (CMILK)
IGPD	INFANT	Ground Plane Deposition (GPD)
IINHL	INFANT	Inhalation (INHL)
ICMILK	INFANT	Grs/Cow/Milk (CMILK)

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 2

=== MAXIMUM NG DOSE FOR PERIOD ===

Limit Type	Dose Type	Dose (mrad)	Limit Period	Limit (mrad)	Percent of Limit
Admin	Gamma	1.49E-05	31-day	1.50E-01	9.91E-03
			Quarter	3.75E+00	3.96E-04
			Annual	7.50E+00	1.98E-04
Admin	Beta	6.59E-06	31-day	3.00E-01	2.20E-03
			Quarter	7.50E+00	8.78E-05
			Annual	1.50E+01	4.39E-05
T.Spec	Gamma	1.49E-05	31-day	2.00E-01	7.43E-03
			Quarter	5.00E+00	2.97E-04
			Annual	1.00E+01	1.49E-04

Receptor.....: Composite Crit. Receptor - NG
Distance (meters).....: 800
Compass Point.....: SSE
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
AR-41	4.40E+01
KR-85M	1.14E-02
XE-133M	2.40E-02
XE-133	5.49E+01
XE-135	1.06E+00

T.Spec	Beta	6.59E-06	31-day	4.00E-01	1.65E-03
			Quarter	1.00E+01	6.59E-05
			Annual	2.00E+01	3.29E-05

Receptor.....: Composite Crit. Receptor - NG
Distance (meters).....: 800
Compass Point.....: SSE
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
AR-41	8.61E+00
KR-85M	1.02E-02
XE-133M	6.03E-02
XE-133	9.06E+01

GASEOUS RELEASE AND DOSE SUMMARY REPORT - BY UNIT
(Composite Critical Receptor - Limited Analysis)

Release ID.....: All Gas Release Types
Period Start Date....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (min): 5.256E+05
Coefficient Type.....: Historical
Unit.....: 2

Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
XE-135	7.54E-01

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05
Unit.....: 1

=== MULTIPLE RELEASE POINT MESSAGE ==========
Undiluted and Diluted Flowrate(s) and Concentration(s) cannot be combined.

=== RELEASE DATA ==========
Total Release Duration (minutes)..... 5.435E+05
Total Undiluted Volume Released (gallons)..... NA
Average Undiluted Flowrate (gpm)..... NA

Total Dilution Volume (gallons)..... NA
Average Dilution Flowrate (gpm)..... NA

=== NUCLIDE DATA ==========

Nuclide	uCi
CO-57	1.40E+01
SB-122	5.08E+00
SB-124	2.69E+01
SB-125	7.12E+01
TE-123M	2.05E+01
CR-51	1.92E+02
MN-54	3.94E+00
FE-59	4.47E+00
CO-58	2.76E+03
CO-60	1.09E+03
ZR-95	5.34E+00
NB-95	1.42E+01
TE-132	1.32E+01
I-132	1.95E+01
I-133	1.93E+00
Gamma	4.24E+03
XE-133	2.54E+02
D&EG	2.54E+02
H-3	1.66E+09
Beta	1.66E+09
Total	1.66E+09

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05
Unit.....: 1
Receptor.....: Liquid Receptor

=== PERMIT ORGAN DOSE BY AGE GROUP AND PATHWAY (mrem) ==========

Age/Path	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
APWtr	6.08E-08	1.95E-02	1.95E-02	1.95E-02	1.95E-02	1.95E-02	0.00E+00	1.95E-02
AFWFSp	1.21E-05	5.03E-02	5.02E-02	5.02E-02	5.01E-02	5.93E-02	0.00E+00	5.05E-02
TPWtr	5.87E-08	1.37E-02	1.37E-02	1.37E-02	1.37E-02	1.37E-02	0.00E+00	1.37E-02
TFWFSp	1.27E-05	3.87E-02	3.85E-02	3.86E-02	3.85E-02	4.49E-02	0.00E+00	3.89E-02
CPWtr	1.69E-07	2.63E-02	2.63E-02	2.63E-02	2.63E-02	2.64E-02	0.00E+00	2.64E-02
CFWFSp	1.57E-05	3.20E-02	3.19E-02	3.19E-02	3.19E-02	3.41E-02	0.00E+00	3.23E-02
IPWtr	2.02E-07	2.59E-02	2.59E-02	2.59E-02	2.59E-02	2.59E-02	0.00E+00	2.59E-02
TOTALS								
ADULT	1.22E-05	6.98E-02	6.96E-02	6.97E-02	6.96E-02	7.88E-02	0.00E+00	7.00E-02
TEEN	1.27E-05	5.24E-02	5.22E-02	5.23E-02	5.22E-02	5.86E-02	0.00E+00	5.26E-02
CHILD	1.58E-05	5.84E-02	5.83E-02	5.83E-02	5.82E-02	6.05E-02	0.00E+00	5.86E-02
INFANT	2.02E-07	2.59E-02	2.59E-02	2.59E-02	2.59E-02	2.59E-02	0.00E+00	2.59E-02

=== AGE GROUP / PATHWAY DESCRIPTIONS ==========

Abbreviation	Age Group	Pathway
APWtr	ADULT	Potable Water (PWtr)
AFWFSp	ADULT	Fresh Water Fish - Sport (FFSP)
TPWtr	TEEN	Potable Water (PWtr)
TFWFSp	TEEN	Fresh Water Fish - Sport (FFSP)
CPWtr	CHILD	Potable Water (PWtr)
CFWFSp	CHILD	Fresh Water Fish - Sport (FFSP)
IPWtr	INFANT	Potable Water (PWtr)

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05
Unit.....: 1
Receptor.....: Liquid Receptor

=== PERMIT ORGAN DOSE BY AGE GROUP AND NUCLIDE (mrem) ==========

Agegroup	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
ADULT								
H-3	0.00E+00	6.96E-02	6.96E-02	6.96E-02	6.96E-02	6.96E-02	0.00E+00	6.96E-02
CR-51	0.00E+00	0.00E+00	4.07E-08	1.50E-08	9.04E-08	1.71E-05	0.00E+00	6.82E-08
MN-54	0.00E+00	4.80E-06	0.00E+00	1.43E-06	0.00E+00	1.47E-05	0.00E+00	9.16E-07
FE-59	1.30E-06	3.05E-06	0.00E+00	0.00E+00	8.52E-07	1.02E-05	0.00E+00	1.17E-06
CO-58	0.00E+00	6.90E-05	0.00E+00	0.00E+00	0.00E+00	1.40E-03	0.00E+00	1.55E-04
CO-60	0.00E+00	7.83E-05	0.00E+00	0.00E+00	0.00E+00	1.47E-03	0.00E+00	1.73E-04
ZR-95	3.95E-10	1.27E-10	0.00E+00	1.99E-10	0.00E+00	4.01E-07	0.00E+00	8.57E-11
NB-95	1.77E-06	9.84E-07	0.00E+00	9.73E-07	0.00E+00	5.97E-03	0.00E+00	5.29E-07
SB-124	6.77E-08	1.28E-09	1.65E-10	0.00E+00	5.28E-08	1.93E-06	0.00E+00	2.69E-08
SB-125	1.15E-07	1.28E-09	1.17E-10	0.00E+00	8.85E-08	1.26E-06	0.00E+00	2.73E-08
TE-132	8.88E-06	5.75E-06	6.35E-06	5.53E-05	0.00E+00	2.72E-04	0.00E+00	5.39E-06
I-132	4.05E-08	1.08E-07	3.79E-06	1.72E-07	0.00E+00	2.03E-08	0.00E+00	3.79E-08
I-133	2.80E-08	4.88E-08	7.17E-06	8.51E-08	0.00E+00	4.38E-08	0.00E+00	1.49E-08
TEEN								
H-3	0.00E+00	5.22E-02	5.22E-02	5.22E-02	5.22E-02	5.22E-02	0.00E+00	5.22E-02
CR-51	0.00E+00	0.00E+00	3.90E-08	1.54E-08	1.00E-07	1.18E-05	0.00E+00	7.02E-08
MN-54	0.00E+00	4.72E-06	0.00E+00	1.41E-06	0.00E+00	9.69E-06	0.00E+00	9.37E-07
FE-59	1.34E-06	3.12E-06	0.00E+00	0.00E+00	9.83E-07	7.38E-06	0.00E+00	1.20E-06
CO-58	0.00E+00	6.86E-05	0.00E+00	0.00E+00	0.00E+00	9.45E-04	0.00E+00	1.58E-04
CO-60	0.00E+00	7.83E-05	0.00E+00	0.00E+00	0.00E+00	1.02E-03	0.00E+00	1.76E-04
ZR-95	4.04E-10	1.28E-10	0.00E+00	1.87E-10	0.00E+00	2.94E-07	0.00E+00	8.77E-11
NB-95	1.78E-06	9.88E-07	0.00E+00	9.58E-07	0.00E+00	4.23E-03	0.00E+00	5.44E-07
SB-124	6.98E-08	1.29E-09	3.83E-07	0.00E+00	6.10E-08	1.41E-06	0.00E+00	9.33E-09
SB-125	1.18E-07	1.30E-09	1.13E-10	0.00E+00	1.04E-07	9.23E-07	0.00E+00	2.77E-08
TE-132	9.37E-06	5.93E-06	6.26E-06	5.69E-05	0.00E+00	1.88E-04	0.00E+00	5.59E-06
I-132	4.23E-08	1.11E-07	3.73E-06	1.74E-07	0.00E+00	4.82E-08	0.00E+00	3.97E-08
I-133	3.02E-08	5.12E-08	7.15E-06	8.98E-08	0.00E+00	3.87E-08	0.00E+00	1.56E-08
CHILD								
H-3	0.00E+00	5.82E-02	5.82E-02	5.82E-02	5.82E-02	5.82E-02	0.00E+00	5.82E-02
CR-51	0.00E+00	0.00E+00	4.17E-08	1.14E-08	7.61E-08	3.98E-06	0.00E+00	7.50E-08
MN-54	0.00E+00	3.70E-06	0.00E+00	1.04E-06	0.00E+00	3.10E-06	0.00E+00	9.85E-07
FE-59	1.63E-06	2.63E-06	0.00E+00	0.00E+00	7.63E-07	2.74E-06	0.00E+00	1.31E-06
CO-58	0.00E+00	5.52E-05	0.00E+00	0.00E+00	0.00E+00	3.22E-04	0.00E+00	1.69E-04
CO-60	0.00E+00	6.41E-05	0.00E+00	0.00E+00	0.00E+00	3.55E-04	0.00E+00	1.89E-04
ZR-95	5.48E-10	1.20E-10	0.00E+00	1.72E-10	0.00E+00	1.26E-07	0.00E+00	1.07E-10
NB-95	2.10E-06	8.19E-07	0.00E+00	7.69E-07	0.00E+00	1.51E-03	0.00E+00	5.85E-07
SB-124	1.14E-07	1.47E-09	2.52E-10	0.00E+00	6.32E-08	7.13E-07	0.00E+00	3.99E-08

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05

=== PERMIT ORGAN DOSE BY AGE GROUP AND NUCLIDE (mrem) ==========

Agegroup	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
SB-125	1.95E-07	1.50E-09	1.80E-10	0.00E+00	1.08E-07	4.65E-07	0.00E+00	4.07E-08
TE-132	1.17E-05	5.18E-06	7.55E-06	4.81E-05	0.00E+00	5.22E-05	0.00E+00	6.26E-06
I-132	5.37E-08	9.87E-08	4.58E-06	1.51E-07	0.00E+00	1.16E-07	0.00E+00	4.54E-08
I-133	3.94E-08	4.87E-08	9.05E-06	8.11E-08	0.00E+00	1.96E-08	0.00E+00	1.84E-08
INFANT								
H-3	0.00E+00	2.59E-02	2.59E-02	2.59E-02	2.59E-02	2.59E-02	0.00E+00	2.59E-02
CR-51	0.00E+00	0.00E+00	1.85E-10	4.04E-11	3.60E-10	8.26E-09	0.00E+00	2.83E-10
MN-54	0.00E+00	8.21E-09	0.00E+00	1.82E-09	0.00E+00	3.02E-09	0.00E+00	1.86E-09
FE-59	1.44E-08	2.52E-08	0.00E+00	0.00E+00	7.44E-09	1.20E-08	0.00E+00	9.92E-09
CO-58	0.00E+00	1.04E-06	0.00E+00	0.00E+00	0.00E+00	2.59E-06	0.00E+00	2.60E-06
CO-60	0.00E+00	1.23E-06	0.00E+00	0.00E+00	0.00E+00	2.93E-06	0.00E+00	2.91E-06
ZR-95	1.15E-10	2.81E-11	0.00E+00	3.03E-11	0.00E+00	1.40E-08	0.00E+00	1.99E-11
NB-95	6.26E-11	2.58E-11	0.00E+00	1.85E-11	0.00E+00	2.18E-08	0.00E+00	1.49E-11
SB-124	6.04E-08	8.92E-10	1.60E-10	0.00E+00	3.78E-08	1.87E-07	0.00E+00	1.87E-08
SB-125	9.19E-08	8.89E-10	1.15E-10	0.00E+00	5.32E-08	1.23E-07	0.00E+00	1.89E-08
TE-132	2.88E-08	1.43E-08	2.10E-08	8.91E-08	0.00E+00	5.27E-08	0.00E+00	1.33E-08
I-132	3.39E-09	6.88E-09	3.22E-07	7.68E-09	0.00E+00	5.57E-09	0.00E+00	2.45E-09
I-133	2.53E-09	3.68E-09	6.69E-07	4.33E-09	0.00E+00	6.23E-10	0.00E+00	1.08E-09

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05
Unit.....: 1
Receptor.....: Liquid Receptor

=== MAXIMUM DOSE FOR PERIOD ==========

Limit Type	Organ Type	Age Group	Organ	Dose (mrem)	Limit Period	Limit (mrem)	Percent of Limit
Admin	Any Organ	ADULT	GILLI	7.88E-02	31-day	1.50E-01	5.25E+01
					Quarter	3.75E+00	2.10E+00
					Annual	7.50E+00	1.05E+00
Admin	Tot Body	ADULT	TBODY	7.00E-02	31-day	4.50E-02	1.55E+02
					Quarter	1.13E+00	6.22E+00
					Annual	2.25E+00	3.11E+00
T.Spec	Any Organ	ADULT	GILLI	7.88E-02	31-day	2.00E-01	3.94E+01
					Quarter	5.00E+00	1.58E+00
					Annual	1.00E+01	7.88E-01

Critical Pathway.....: Fresh Water Fish - Sport (FFSP)
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
SB-125	1.60E-03
SB-124	2.45E-03
H-3	8.84E+01
CR-51	2.18E-02
MN-54	1.87E-02
FE-59	1.29E-02
CO-58	1.77E+00
CO-60	1.87E+00
ZR-95	5.09E-04
NB-95	7.58E+00
TE-132	3.45E-01
I-132	2.58E-05
I-133	5.56E-05

T.Spec	Tot Body	ADULT	TBODY	7.00E-02	31-day	6.00E-02	1.17E+02
					Quarter	1.50E+00	4.66E+00
					Annual	3.00E+00	2.33E+00

Critical Pathway.....: Fresh Water Fish - Sport (FFSP)
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05

Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
SB-125	3.90E-05
SB-124	3.84E-05
H-3	9.95E+01
CR-51	9.74E-05
MN-54	1.31E-03
FE-59	1.67E-03
CO-58	2.21E-01
CO-60	2.47E-01
ZR-95	1.22E-07
NB-95	7.56E-04
TE-132	7.71E-03
I-132	5.41E-05
I-133	2.13E-05

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05
Unit.....: 2

=== MULTIPLE RELEASE POINT MESSAGE ==========
Undiluted and Diluted Flowrate(s) and Concentration(s) cannot be combined.

=== RELEASE DATA ==========
Total Release Duration (minutes)..... 5.435E+05
Total Undiluted Volume Released (gallons)..... NA
Average Undiluted Flowrate (gpm)..... NA

Total Dilution Volume (gallons)..... NA
Average Dilution Flowrate (gpm)..... NA

=== NUCLIDE DATA ==========

Nuclide	uCi
CO-57	1.40E+01
SB-122	5.08E+00
SB-124	2.69E+01
SB-125	7.12E+01
TE-123M	2.05E+01
CR-51	1.92E+02
MN-54	3.94E+00
FE-59	4.47E+00
CO-58	2.76E+03
CO-60	1.09E+03
ZR-95	5.34E+00
NB-95	1.42E+01
TE-132	1.32E+01
I-132	1.95E+01
I-133	1.93E+00
Gamma	4.24E+03
XE-133	2.54E+02
D&EG	2.54E+02
H-3	1.66E+09
Beta	1.66E+09
Total	1.66E+09

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05
Unit.....: 2
Receptor.....: Liquid Receptor

=== PERMIT ORGAN DOSE BY AGE GROUP AND PATHWAY (mrem) ==========

Age/Path	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
APWtr	6.08E-08	1.95E-02	1.95E-02	1.95E-02	1.95E-02	1.95E-02	0.00E+00	1.95E-02
AFWFSp	1.21E-05	5.03E-02	5.02E-02	5.02E-02	5.01E-02	5.93E-02	0.00E+00	5.05E-02
TPWtr	5.87E-08	1.37E-02	1.37E-02	1.37E-02	1.37E-02	1.37E-02	0.00E+00	1.37E-02
TFWFSp	1.27E-05	3.87E-02	3.85E-02	3.86E-02	3.85E-02	4.49E-02	0.00E+00	3.89E-02
CPWtr	1.69E-07	2.63E-02	2.63E-02	2.63E-02	2.63E-02	2.64E-02	0.00E+00	2.64E-02
CFWFSp	1.57E-05	3.20E-02	3.19E-02	3.19E-02	3.19E-02	3.41E-02	0.00E+00	3.23E-02
IPWtr	2.02E-07	2.59E-02	2.59E-02	2.59E-02	2.59E-02	2.59E-02	0.00E+00	2.59E-02
TOTALS								
ADULT	1.22E-05	6.98E-02	6.96E-02	6.97E-02	6.96E-02	7.88E-02	0.00E+00	7.00E-02
TEEN	1.27E-05	5.24E-02	5.22E-02	5.23E-02	5.22E-02	5.86E-02	0.00E+00	5.26E-02
CHILD	1.58E-05	5.84E-02	5.83E-02	5.83E-02	5.82E-02	6.05E-02	0.00E+00	5.86E-02
INFANT	2.02E-07	2.59E-02	2.59E-02	2.59E-02	2.59E-02	2.59E-02	0.00E+00	2.59E-02

=== AGE GROUP / PATHWAY DESCRIPTIONS ==========

Abbreviation	Age Group	Pathway
APWtr	ADULT	Potable Water (PWtr)
AFWFSp	ADULT	Fresh Water Fish - Sport (FFSP)
TPWtr	TEEN	Potable Water (PWtr)
TFWFSp	TEEN	Fresh Water Fish - Sport (FFSP)
CPWtr	CHILD	Potable Water (PWtr)
CFWFSp	CHILD	Fresh Water Fish - Sport (FFSP)
IPWtr	INFANT	Potable Water (PWtr)

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05
Unit.....: 2
Receptor.....: Liquid Receptor

=== PERMIT ORGAN DOSE BY AGE GROUP AND NUCLIDE (mrem) ==========

Agegroup	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
ADULT								
H-3	0.00E+00	6.96E-02	6.96E-02	6.96E-02	6.96E-02	6.96E-02	0.00E+00	6.96E-02
CR-51	0.00E+00	0.00E+00	4.07E-08	1.50E-08	9.04E-08	1.71E-05	0.00E+00	6.82E-08
MN-54	0.00E+00	4.80E-06	0.00E+00	1.43E-06	0.00E+00	1.47E-05	0.00E+00	9.16E-07
FE-59	1.30E-06	3.05E-06	0.00E+00	0.00E+00	8.52E-07	1.02E-05	0.00E+00	1.17E-06
CO-58	0.00E+00	6.90E-05	0.00E+00	0.00E+00	0.00E+00	1.40E-03	0.00E+00	1.55E-04
CO-60	0.00E+00	7.83E-05	0.00E+00	0.00E+00	0.00E+00	1.47E-03	0.00E+00	1.73E-04
ZR-95	3.95E-10	1.27E-10	0.00E+00	1.99E-10	0.00E+00	4.01E-07	0.00E+00	8.57E-11
NB-95	1.77E-06	9.84E-07	0.00E+00	9.73E-07	0.00E+00	5.97E-03	0.00E+00	5.29E-07
SB-124	6.77E-08	1.28E-09	1.65E-10	0.00E+00	5.28E-08	1.93E-06	0.00E+00	2.69E-08
SB-125	1.15E-07	1.28E-09	1.17E-10	0.00E+00	8.85E-08	1.26E-06	0.00E+00	2.73E-08
TE-132	8.88E-06	5.75E-06	6.35E-06	5.53E-05	0.00E+00	2.72E-04	0.00E+00	5.39E-06
I-132	4.05E-08	1.08E-07	3.79E-06	1.72E-07	0.00E+00	2.03E-08	0.00E+00	3.79E-08
I-133	2.80E-08	4.88E-08	7.17E-06	8.51E-08	0.00E+00	4.38E-08	0.00E+00	1.49E-08
TEEN								
H-3	0.00E+00	5.22E-02	5.22E-02	5.22E-02	5.22E-02	5.22E-02	0.00E+00	5.22E-02
CR-51	0.00E+00	0.00E+00	3.90E-08	1.54E-08	1.00E-07	1.18E-05	0.00E+00	7.02E-08
MN-54	0.00E+00	4.72E-06	0.00E+00	1.41E-06	0.00E+00	9.69E-06	0.00E+00	9.37E-07
FE-59	1.34E-06	3.12E-06	0.00E+00	0.00E+00	9.83E-07	7.38E-06	0.00E+00	1.20E-06
CO-58	0.00E+00	6.86E-05	0.00E+00	0.00E+00	0.00E+00	9.45E-04	0.00E+00	1.58E-04
CO-60	0.00E+00	7.83E-05	0.00E+00	0.00E+00	0.00E+00	1.02E-03	0.00E+00	1.76E-04
ZR-95	4.04E-10	1.28E-10	0.00E+00	1.87E-10	0.00E+00	2.94E-07	0.00E+00	8.77E-11
NB-95	1.78E-06	9.88E-07	0.00E+00	9.58E-07	0.00E+00	4.23E-03	0.00E+00	5.44E-07
SB-124	6.98E-08	1.29E-09	3.83E-07	0.00E+00	6.10E-08	1.41E-06	0.00E+00	9.33E-09
SB-125	1.18E-07	1.30E-09	1.13E-10	0.00E+00	1.04E-07	9.23E-07	0.00E+00	2.77E-08
TE-132	9.37E-06	5.93E-06	6.26E-06	5.69E-05	0.00E+00	1.88E-04	0.00E+00	5.59E-06
I-132	4.23E-08	1.11E-07	3.73E-06	1.74E-07	0.00E+00	4.82E-08	0.00E+00	3.97E-08
I-133	3.02E-08	5.12E-08	7.15E-06	8.98E-08	0.00E+00	3.87E-08	0.00E+00	1.56E-08
CHILD								
H-3	0.00E+00	5.82E-02	5.82E-02	5.82E-02	5.82E-02	5.82E-02	0.00E+00	5.82E-02
CR-51	0.00E+00	0.00E+00	4.17E-08	1.14E-08	7.61E-08	3.98E-06	0.00E+00	7.50E-08
MN-54	0.00E+00	3.70E-06	0.00E+00	1.04E-06	0.00E+00	3.10E-06	0.00E+00	9.85E-07
FE-59	1.63E-06	2.63E-06	0.00E+00	0.00E+00	7.63E-07	2.74E-06	0.00E+00	1.31E-06
CO-58	0.00E+00	5.52E-05	0.00E+00	0.00E+00	0.00E+00	3.22E-04	0.00E+00	1.69E-04
CO-60	0.00E+00	6.41E-05	0.00E+00	0.00E+00	0.00E+00	3.55E-04	0.00E+00	1.89E-04
ZR-95	5.48E-10	1.20E-10	0.00E+00	1.72E-10	0.00E+00	1.26E-07	0.00E+00	1.07E-10
NB-95	2.10E-06	8.19E-07	0.00E+00	7.69E-07	0.00E+00	1.51E-03	0.00E+00	5.85E-07
SB-124	1.14E-07	1.47E-09	2.52E-10	0.00E+00	6.32E-08	7.13E-07	0.00E+00	3.99E-08

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05

=== PERMIT ORGAN DOSE BY AGE GROUP AND NUCLIDE (mrem) ==========

Agegroup	Bone	Liver	Thyroid	Kidney	Lung	GI-Lli	Skin	TB
SB-125	1.95E-07	1.50E-09	1.80E-10	0.00E+00	1.08E-07	4.65E-07	0.00E+00	4.07E-08
TE-132	1.17E-05	5.18E-06	7.55E-06	4.81E-05	0.00E+00	5.22E-05	0.00E+00	6.26E-06
I-132	5.37E-08	9.87E-08	4.58E-06	1.51E-07	0.00E+00	1.16E-07	0.00E+00	4.54E-08
I-133	3.94E-08	4.87E-08	9.05E-06	8.11E-08	0.00E+00	1.96E-08	0.00E+00	1.84E-08
INFANT								
H-3	0.00E+00	2.59E-02	2.59E-02	2.59E-02	2.59E-02	2.59E-02	0.00E+00	2.59E-02
CR-51	0.00E+00	0.00E+00	1.85E-10	4.04E-11	3.60E-10	8.26E-09	0.00E+00	2.83E-10
MN-54	0.00E+00	8.21E-09	0.00E+00	1.82E-09	0.00E+00	3.02E-09	0.00E+00	1.86E-09
FE-59	1.44E-08	2.52E-08	0.00E+00	0.00E+00	7.44E-09	1.20E-08	0.00E+00	9.92E-09
CO-58	0.00E+00	1.04E-06	0.00E+00	0.00E+00	0.00E+00	2.59E-06	0.00E+00	2.60E-06
CO-60	0.00E+00	1.23E-06	0.00E+00	0.00E+00	0.00E+00	2.93E-06	0.00E+00	2.91E-06
ZR-95	1.15E-10	2.81E-11	0.00E+00	3.03E-11	0.00E+00	1.40E-08	0.00E+00	1.99E-11
NB-95	6.26E-11	2.58E-11	0.00E+00	1.85E-11	0.00E+00	2.18E-08	0.00E+00	1.49E-11
SB-124	6.04E-08	8.92E-10	1.60E-10	0.00E+00	3.78E-08	1.87E-07	0.00E+00	1.87E-08
SB-125	9.19E-08	8.89E-10	1.15E-10	0.00E+00	5.32E-08	1.23E-07	0.00E+00	1.89E-08
TE-132	2.88E-08	1.43E-08	2.10E-08	8.91E-08	0.00E+00	5.27E-08	0.00E+00	1.33E-08
I-132	3.39E-09	6.88E-09	3.22E-07	7.68E-09	0.00E+00	5.57E-09	0.00E+00	2.45E-09
I-133	2.53E-09	3.68E-09	6.69E-07	4.33E-09	0.00E+00	6.23E-10	0.00E+00	1.08E-09

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05
Unit.....: 2
Receptor.....: Liquid Receptor

=== MAXIMUM DOSE FOR PERIOD ==========

Limit Type	Organ Type	Age Group	Organ	Dose (mrem)	Limit Period	Limit (mrem)	Percent of Limit
Admin	Any Organ	ADULT	GILLI	7.88E-02	31-day	1.50E-01	5.25E+01
					Quarter	3.75E+00	2.10E+00
					Annual	7.50E+00	1.05E+00
Admin	Tot Body	ADULT	TBODY	7.00E-02	31-day	4.50E-02	1.55E+02
					Quarter	1.13E+00	6.22E+00
					Annual	2.25E+00	3.11E+00
T.Spec	Any Organ	ADULT	GILLI	7.88E-02	31-day	2.00E-01	3.94E+01
					Quarter	5.00E+00	1.58E+00
					Annual	1.00E+01	7.88E-01

Critical Pathway.....: Fresh Water Fish - Sport (FFSP)
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
SB-125	1.60E-03
SB-124	2.45E-03
H-3	8.84E+01
CR-51	2.18E-02
MN-54	1.87E-02
FE-59	1.29E-02
CO-58	1.77E+00
CO-60	1.87E+00
ZR-95	5.09E-04
NB-95	7.58E+00
TE-132	3.45E-01
I-132	2.58E-05
I-133	5.56E-05

T.Spec	Tot Body	ADULT	TBODY	7.00E-02	31-day	6.00E-02	1.17E+02
					Quarter	1.50E+00	4.66E+00
					Annual	3.00E+00	2.33E+00

Critical Pathway.....: Fresh Water Fish - Sport (FFSP)
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage

LIQUID RELEASE AND DOSE SUMMARY REPORT
------ (PERIOD BASIS - BY UNIT) ------

Release ID.....: All Liquid Releases
Period Start Date.....: 01/01/2015 00:00
Period End Date.....: 01/01/2016 00:00
Period Duration (mins): 5.256E+05

Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
SB-125	3.90E-05
SB-124	3.84E-05
H-3	9.95E+01
CR-51	9.74E-05
MN-54	1.31E-03
FE-59	1.67E-03
CO-58	2.21E-01
CO-60	2.47E-01
ZR-95	1.22E-07
NB-95	7.56E-04
TE-132	7.71E-03
I-132	5.41E-05
I-133	2.13E-05

OFFSITE DOSE CALCULATION MANUAL FOR BYRON STATION UNITS 1 AND 2

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PART II - ODCM

Part 1 - RADIOLOGICAL EFFLUENTS

1. DEFINITIONS

1.1. **ACTIONS** shall be that part of a Requirement that prescribes Required Actions to be taken under designated Conditions within specified Completion Times.

1.2. **CHANNEL CALIBRATION** shall be the adjustment, as necessary, of the channel so that it responds within the required range and accuracy to known inputs. The CHANNEL CALIBRATION shall encompass the entire channel, including the required sensor, alarm, interlock, display, and trip functions. Calibration of instrument channels with Resistance Temperature Detector (RTD) or thermocouple sensors may consist of an in place qualitative assessment of sensor behavior and normal calibration of the remaining adjustable devices in the channel. The CHANNEL CALIBRATION may be performed by means of any series of sequential, overlapping calibrations or total channel steps so that the entire channel is calibrated.

1.3. **CHANNEL CHECK** shall be the quantitative assessment, by observation, of channel behavior during operation. This determination shall include, where possible, comparison of the channel indication and status to other indications or status derived from independent instrument channels measuring the same parameter.

1.4. **CHANNEL OPERATIONAL TEST** (COT) shall be the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify the OPERABILITY of required alarm, interlock, display and trip functions. The COT shall include adjustments, as necessary, of the required alarm, interlock, and trip setpoints so that the setpoints are within the required range and accuracy.

1.5. **DOSE EQUIVALENT I-131** shall be that concentration of I-131 (microcuries/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 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, pages 192-212, Table Titled, "Committed Dose Equivalent in Target Organs or Tissues per Intake of Unit Activity, or Federal Guidance Report 11, “Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion,” 1988, (Table 2.1, Exposure-to-Dose Conversion Factors for Inhalation).

1.6. **FREQUENCY** - Table 1-a provides the definitions of various frequencies for which surveillances, sampling, etc., are performed unless defined otherwise. The 25% variance shall not be applied to Operability Action statements. The bases to Surveillance Requirement 3.0.2 provide clarifications to this requirement.

1.7. **IMMEDIATELY** – When "immediately" is used as a completion time the Required Action should be pursued without delay and in a controlled manner.

1.8. **MEMBER(S) OF THE PUBLIC** shall include all persons who are not occupationally associated with the plant. This category does not include employees of the licensee, its contractors or vendors and persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plant.

1.9. **MODE** shall correspond to any one inclusive combination of core reactivity condition, power level, average reactor coolant temperature, and reactor vessel head closure bolt tensioning specified in TRM Table T1.1-1 with fuel in the reactor vessel.

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 and/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 from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.

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

1.12. **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, and 71, State regulations, burial ground requirements and other requirements governing the disposal of solid radioactive waste.

1.13. **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.

1.14. **RATED THERMAL POWER** shall be a total core heat transfer rate to the reactor coolant of 3586.6 MWT. (3645 MWT following NRC approval of License Amendment Request submitted under Exelon letter RS-11-099 and implementation of power uprate per Byron Unit 1 EC 378382 and Unit 2 EC 378383)

1.15. **RADIOLOGICAL EFFLUENTS (RE)** are in accordance with Byron Technical Requirements Manual (TRM) and the Code of Federal Regulations.

1.16. **RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)** are in accordance with Byron Technical Requirements Manual (TRM) and the Code of Federal Regulations.

1.17. **SITE BOUNDARY** shall be that line beyond which, the land is neither owned, nor leased, nor otherwise controlled by the licensee.

1.18. **SOLIDIFICATION** shall be the conversion of wet wastes into a form that meets shipping and burial ground requirements.

1.19. **SOURCE CHECK** shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

1.20. **THERMAL POWER** shall be the total reactor core heat transfer rate to the reactor coolant.

1.21. **TLCO-TECHNICAL LIMITING CONDITION FOR OPERATION** Limiting Condition for Operation as listed in the TRM.

1.22. **TECHNICAL REQUIREMENTS MANUAL (TRM)** Chapter 3.11 contains the Radiological Effluents (RE). Chapter 3.12 contains the Radiological Environmental Monitoring Program (REMP).

1.23. **UNRESTRICTED AREA** means an area, access to which is neither limited nor controlled by the licensee.

1.24. **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 VENTILATION EXHAUST TREATMENT SYSTEM components.

1.25. **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.

1.26. **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.

1.27. Definitions Peculiar to Estimating Dose to Members of the Public using the OFFSITE DOSE CALCULATION MANUAL (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 the ODCM.

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 1-a

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
B- Biweekly	At least once every 14 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 - Refuel Cycle	At least once per 18 months
S/U - Startup	Prior to each reactor startup
N.A.	Not applicable
P - Prior	Prior to each radioactive release

*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 TSR 3.0.b provide clarifications to this requirement. These frequency notations do not apply to the Radiological Environmental Monitoring Program as described in TRM 3.12.

Table 1-b
COMPLIANCE MATRIX

Regulation	Dose Component Limit	ODCM Equation	TRM	Technical Specification
10 CFR 50 Appendix I	1. Gamma air dose and beta air dose due to airborne radioactivity in effluent plume.	4-4 4-5	3.11.g	5.5.4.h
	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.	4-6 4-7	N/A	N/A
	2. Dose for all organs and all four age groups due to iodines and particulates in effluent plume. All pathways are considered.	4-8	3.11.h	5.5.4.i
	3. Dose for all organs and all four age groups due to radioactivity in liquid effluents.	3-3	3.11.d	5.5.4.d
10 CFR 20	1. Total Dose, totaling all external dose components (direct, ground and plume shine) and internal dose (all pathways, both airborne and liquid-borne).	5-2	N/A	5.5.4.c
40 CFR 190 (now by reference, also part of 10 CFR 20)	1. Total body dose due to direct dose, ground and plume shine from all sources at a station.	5-1	3.11.k	5.5.4.j
	2. Organ doses to an adult due to all pathways.	3-3 4-8		
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.	4-1 4-2 4-3	3.11.f	5.5.4.g
	2. "Instantaneous" concentration limits for liquid effluents.	3-1	3.11.c	5.5.4.b
Technical Specifications	1. Radioactive Effluent Release Report	N/A	N/A	5.6.3
10CFR50 Appendix I Section IV.B.2	1. Implement Environmental Monitoring Program.	N/A	3.12.a	N/A
10CFR50 Appendix I Section IV.B.3	1. Land Use Census	N/A	3.12.b	N/A
10CFR50 Appendix I Section IV.B.2	1. Interlaboratory Comparison Program	N/A	3.12.c	N/A
10CFR50 Appendix I Section IV.B.2 and Technical Specifications	1. Annual Radiological Environmental Operating Report	N/A	N/A	5.6.2

NOTE: 2.0 through 3.10 are not used.

3.11. Radiological Effluents and Radiological Environmental Monitoring Program

NOTE: SEE TRM Chapter 3.11 for Radiological Effluents (RE) and TRM Chapter 3.12 for Radiological Environmental Monitoring Program (REMP).

3.13. METEOROLOGICAL MONITORING PROGRAM

3.13.1. METEOROLOGICAL MONITORING

1. Meteorological parameters are measured in the vicinity of each nuclear power station in order to provide data for calculating radiation doses due to airborne effluent radioactivity. Some nuclear power stations' Technical Specifications state applicable requirements (typically under the subheading, “Meteorological Instrumentation,” in the instrumentation section). Regulatory guidance is given in Regulatory Guide 1.23 (Reference 5). Wind speed, wind direction and the temperature gradient are measured using instruments at two or more elevations on a meteorological tower at each Exelon Nuclear station. The elevations are chosen to provide meteorological data representative of the elevations of the airborne releases from the station. The Annual Radiological Environmental Operating Report includes a summary of meteorological data collected over the reporting year.

3.13.2. METEOROLOGICAL CONTRACTOR

1. The meteorological contractor operates and maintains the meteorological tower instrumentation at each nuclear power station. The contractor collects and analyzes the data and issues periodic reports. The contractor prepares the meteorological data summary required for the Annual Radiological Environmental Operating Report (AREOR).

4. BASES

4.1. RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION (TRM 3.11.a)

1. 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 10 times the EFFLUENT CONCENTRATION values specified in Appendix B, Table 2, Column 2 to 10 CFR 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50. The purpose of tank level indicating devices is to assure the detection and control of leaks that if not controlled could potentially result in the transport of radioactive materials to UNRESTRICTED AREAS.

4.2. RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION (TRM 3.11.b)

1. 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 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

4.3. CONCENTRATION LIMITS FOR EFFLUENTS (TRM 3.11.c)

1. This Control 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 EFFLUENT CONCENTRATION values specified in Appendix B, Table 2, Column 2 to 10 CFR 20. The Control provides operational flexibility for releasing liquid effluents in concentrations to follow the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. This limitation provides reasonable 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, 10 CFR Part 50, to a MEMBER OF THE PUBLIC and (2) the restrictions authorized by 10 CFR Part 20.1301(e). The concentration limit for the dissolved or entrained noble gases is based upon the assumption that Xe-133 is the controlling radionuclide and its EFFLUENT CONCENTRATION in air (submersion) was converted to an equivalent concentration in water. This control does not affect the requirement to comply with the annual limitations of 10 CFR Part 20.1301(a).

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

3. 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 Currie, L.A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and in the HASL Procedures Manual, HASL-300 (revised annually).

4.4. DOSE FROM LIQUID EFFLUENTS (TRM 3.11.d)

1. This Control is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control statement implements 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 will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. 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 10 CFR Part 50, 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.

2. This Control applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

4.5. LIQUID RADWASTE TREATMENT SYSTEM (TRM 3.11.e)

1. 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 Control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR part 50. 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, 10 CFR Part 50, for liquid effluents.

2. This Control applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

4.6. DOSE RATE FOR GASEOUS EFFLUENT (TRM 3.11.f)

1. This Control 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 Control 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.C design objectives of Appendix I to 10 CFR Part 50. 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 the reduced atmospheric dispersion of gaseous effluents relative to 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 dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/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 mrem/year. This Control does not affect the requirement to comply with the annual limitations of 10 CFR 20.1301(a).

2. This Control applies to the release of gaseous effluents from all units at the site.

3. The required detection capabilities for radioactive materials in gaseous 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 Currie, L.A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and in the HASL Procedures Manual, HASL-300 (revised annually).

4.7. DOSE - NOBLE GASES (TRM 3.11.g)

1. This Control is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control statements 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 will be kept "as low as is reasonably 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.

2. The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases 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 10 CFR Part 50, 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.

3. This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared system are proportioned among the units sharing that system.

4.8. DOSE - IODINE-131, TRITIUM, AND RADIOACTIVE MATERIAL IN PARTICULATE FORM (TRM 3.11.h)

1. This Control is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Controls 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 materials in gaseous effluents will be kept "as low as is reasonably 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.

2. 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 10 CFR Part 50, 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 controls for Iodine-131, 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 animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

3. This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared systems are proportioned among the units sharing that system.

4.9. GASEOUS RADWASTE TREATMENT SYSTEM (TRM 3.11.i)

1. The OPERABILITY of the Gaseous Radwaste Treatment System ensures that the system will be available for use whenever gaseous effluents require treatment prior to release of the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the release of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This Control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50.

2. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

3. This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared systems are proportioned among the units sharing that system.

4.10. TOTAL DOSE (TRM 3.11.k)

1. This Control is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20.1301(d). The Control 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 total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

2. For sites containing up to 4 reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 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, etc., 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 40 CFR Part 190 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 40 CFR Part 190, submittal of the Special Report within 30 days with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed.

3. Demonstration of compliance with the limits of 40 CFR Part 190 or with the design objectives of Appendix I to 10 CFR Part 50 will be considered to demonstrate compliance with the 0.1 rem limit of 10 CFR Part 20.1301.

4.11. RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (TRM 3.12)

1. The Radiological Environmental Monitoring Program required by this Control 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.

2. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 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. Isotopes identified in REMP are compared to those identified in the applicable Annual Effluent Report. Program changes may be initiated based on these operational experiences.

3. The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table T3.12.a-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

4. Detailed discussion of the LLD and other detection limits can be found in Currie, L.A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and in the HASL Procedures Manual, HASL-300 (revised annually).

4.12. LAND USE CENSUS (TRM 3.12.b)

1. This Control 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 are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 m^2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: 1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and 2) a vegetation yield of 2 kg/m^2.

4.13. INTERLABORATORY COMPARISON PROGRAM (TRM 3.12.c)

1. The requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

5. ADMINISTRATIVE REQUIREMENTS

5.1. Annual Radiological Environmental Operating Report*

1. 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.

2. 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 operational controls as appropriate, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment.

3. 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 Part II Section 6 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.

4. 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.

5. 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 TLCO 3.12.a, a Table of Missed Samples and a Table of Sample Anomalies for all deviations from the sampling schedule of TRM Table T3.12.a-1; discussion of environmental sample measurements that exceed the reporting levels of TRM Table T3.12.a-2 but are not the result of plant effluents, discussion of all analyses in which the LLD required by TRM Table T3.12.a-3 was not achievable; result of the Land Use Census required by TRM TLCO 3.12.b; 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 TRM TLCO 3.12.c.

6. 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.

7. 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 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation."

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

5.2. Annual Radioactive Effluent Release Report**

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

2. 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.

3. For solid wastes, the format for Table 3 in Appendix B of the report shall be supplemented with three additional categories: class of solid wastes (as defined by 10 CFR Part 61), 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 UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

4. 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 Part I Section 5.3.

5. 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 TRM TLCO 3.11.a or TLCO 3.11.b, respectively; and description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of TS 5.5.12.

** 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.

5.3. ODCM

5.3.1. The ODCM shall be submitted to the Commission following proper approval through station processes.

5.3.2. Licensee-initiated changes to the ODCM:

1. Shall be documented and records of reviews performed shall be retained as required by UFSAR Chapter 17. This documentation shall contain:

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

    B. A determination that the change will maintain the level of radioactive effluent control required by 10 CFR Part 20, 40 CFR Part 190, 10 CFR 50.36a, and Appendix I to 10 CFR Part 50 and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

2. Shall become effective after review and acceptance by the Independent Technical Review and PORC and the approval of the Plant Manager on the date specified by the Independent Technical Review and PORC.

3. Shall be submitted to the Commission in the form of the 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 a 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 (eg. month/year) the change was implemented.

5.4. Major Changes to Liquid and Gaseous Radwaste Treatment Systems***

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

1. Shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Independent Technical Review and PORC. The discussion of each change shall contain:

    A. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;

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

    C. A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems.

    D. An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents that differ from those previously predicted in the License application and amendments thereto;

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

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

    G. An estimate of the exposure to plant operating personnel as a result of the change; and

    H. Documentation of the fact that the change was reviewed and found acceptable by the Independent Technical Review and PORC.

2. Shall become effective upon review and acceptance by the Independent Technical Review and PORC.

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

Part 2 – ODCM

1. INTRODUCTION - ODCM GENERAL INFORMATION

1. The Offsite Dose Calculation Manual (ODCM) presents a discussion of the following:

   A. The basic concepts applied in calculating offsite doses from plant effluents.

   B. The regulations and requirements for the ODCM and related programs.

   C. The methodology and parameters for the offsite dose calculations to assess impact on the environment and compliance with regulations.

2. The methodology detailed in this manual is intended for the calculation of radiation doses during routine (i.e., non-accident) conditions. The calculations are normally performed using a computer program. Manual calculations may be performed in lieu of the computer program.

3. The dose effects of airborne radioactivity releases predominately depend on meteorological conditions (wind speed, wind direction, and atmospheric stability). For airborne effluents, the dose calculations prescribed in this manual are based on historical average atmospheric conditions. This methodology is appropriate for estimating annual average dose effects and is stipulated in the Bases Section of the Radiological Effluents (RE).

1.1. Structure of the ODCM

1.1.1. Part I of the ODCM is considered to be the Radiological Effluents (RE), and contains the former Radiological Effluent Technical Specifications that have been removed from the Technical Specifications. Part I is organized as follows:

1. Definitions
2. Radiological Effluents and Radiological Environmental Monitoring Program
3. Meteorological Monitoring Program
4. Bases
5. Administrative Requirements

1.1.2. Part II of the ODCM is considered to be the Offsite Dose Calculation Manual (ODCM), and contains methods, equations, assumptions, and parameters for calculation of radiation doses from plant effluents. Part II is organized as follows:

1. Introduction

2. Instrumentation and Systems

3. Liquid Effluents

4. Gaseous Effluents

5. Total Dose

6. Radiological Environmental Monitoring Program

1.2. Regulations

1. This section serves to illustrate the regulations and requirements that define and are applicable to the ODCM. Any information provided in the ODCM concerning specific regulations are not a substitute for the regulations as found in the Code of Federal Regulations (CFR) or Technical Specifications.

1.2.1. Code of Federal Regulations

1. Various sections of the Code of Federal Regulations (CFR) require nuclear power stations to be designed and operated in a manner that limits the radiation exposure to members of the public. These sections specify limits on offsite radiation doses and on effluent radioactivity concentrations and they also require releases of radioactivity to be "As Low As Reasonably Achievable". These requirements are contained in 10CFR20, 10CFR50 and 40CFR190. In addition, 40CFR141 imposes limits on the concentration of radioactivity in drinking water provided by the operators of public water systems.

A. 10CFR20, Standards for Protection Against Radiation

1. This revision of the ODCM addresses the requirements of 10CFR20. The 10CFR20 dose limits are summarized in Table 1-1.

B. Design Criteria (Appendix A of 10CFR50)

1. Section 50.36 of 10CFR50 requires that an application for an operating license include proposed Technical Specifications. Final Technical Specifications for each station are developed through negotiation between the applicant and the NRC. The Technical Specifications are then issued as a part of the operating license, and the licensee is required to operate the facility in accordance with them.

2. Section 50.34 of 10CFR50 states that an application for a license must state the principal design criteria of the facility. Minimum requirements are contained in Appendix A of 10CFR50.

C. ALARA Provisions (Appendix I of 10CFR50)

1. Sections 50.34a and 50.36a of 10CFR50 require that the nuclear plant design and the station RECS have provisions to keep levels of radioactive materials in effluents to unrestricted areas "As Low As Reasonably Achievable" (ALARA). Although 10CFR50 does not impose specific limits on releases, Appendix I of 10CFR50 does provide numerical design objectives and suggested limiting conditions for operation. According to Section I of Appendix I of 10CFR50, design objectives and limiting conditions for operation, conforming to the guidelines of Appendix I "shall be deemed a conclusive showing of compliance with the "As Low As Reasonably Achievable" requirements of 10CFR50.34a and 50.36a."

   An applicant must use calculations to demonstrate conformance with the design objective dose limits of Appendix I. The calculations are to be based on models and data such that the actual radiation exposure of an individual is "unlikely to be substantially underestimated" (see 10CFR50 Appendix I, Section III.A.1).

   The guidelines in Appendix I call for an investigation, corrective action and a report to the NRC whenever the calculated dose due to the radioactivity released in a calendar quarter exceeds one-half of an annual design objective. The guidelines also require a surveillance program to monitor releases, monitor the environment and identify changes in land use.

D. 40CFR190, Environmental Radiation Protection Standards for Nuclear Power Operations

1. Under an agreement between the NRC and the EPA, the NRC stipulated to its licensees in Generic Letter 79-041 that "Compliance with Radiological Effluent Technical Specifications (RETS), NUREG-0472 (Rev.2) for PWR's, implements the LWR provisions to meet 40CFR190". (See References 49 and 103.)

2. The regulations of 40CFR190 limit radiation doses received by members of the public as a result of operations that are part of the uranium fuel cycle. Operations must be conducted in such a manner as to provide reasonable assurance that the annual dose equivalent to any member of the public due to radiation and to planned discharges of radioactive materials does not exceed the following limits:

   - 25 mrem to the total body
   - 75 mrem to the thyroid
   - 25 mrem to any other organ

3. An important difference between the design objectives of 10CFR50 and the limits of 40CFR190 is that 10CFR50 addresses only doses due to radioactive effluents. 40CFR190 limits doses due to effluents and to radiation sources maintained on site. See Section 1.2.4 for further discussion of the differences between the requirements of 10CFR50 Appendix I and 40CFR190.

E. 40CFR141, National Primary Drinking Water Regulations

1. The following radioactivity limits for community water systems were established in the July, 1976 Edition of 40CFR141:

   - Combined Ra-226 and Ra-228: $\leq$ 5 pCi/L.
   - Gross alpha (particle activity including Ra-226 but excluding radon and uranium): $\leq$ 15 pCi/L.
   - The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/yr.

2. The regulations specify procedures for determining the values of annual average radionuclide concentration that produce an annual dose equivalent of 4 mrem. Radiochemical analysis methods are also specified. The responsibility for monitoring radioactivity in a community water system falls on the supplier of the water. The Byron Station has requirements related to 40CFR141 in the RECS.

F. 10CFR72.104 states that annual dose to any real individual located beyond the controlled area must not exceed the following:

- 25 mrem to the total body
- 75 mrem to the thyroid
- 25 mrem to any other critical organ

1. as a result of planned discharges of radioactive material to the environment , direct radiation from ISFSI operation, and other radiation from uranium fuel cycle operation (40CFR190). These requirements are consistent with the requirements of 40CFR190.

1.2.2. Radiological Effluent Technical Standards

1. The Radiological Effluent Technical Standards (RETS) were formerly a subset of the Technical Specifications. They implement provisions of the Code of Federal Regulations aimed at limiting offsite radiation dose. The NRC published Standard RETS for PWRs (Reference 2) as guidance to assist in the development of technical specifications. These documents have undergone frequent minor revisions to reflect changes in plant design and evolving regulatory concerns. The RETS have been removed from the Technical Specifications and placed in the TRM as the Radiological Effluents (RE) (see Reference 90). The RE are similar but not identical to the guidance of the Standard Radiological Effluent Technical Specifications.

1.2.3. Offsite Dose Calculation Manual

1. The NRC in Generic Letter 89-01 defines the ODCM as follows (not verbatim) (see Reference 90):

    A. The Offsite Dose Calculation Manual (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Radiological Environmental Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs and (2) descriptions of the Information that should be included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports.

2. Additional requirements for the content of the ODCM are contained throughout the text of the RECS.

1.2.4. Overlapping Requirements

1. In 10CFR20, 10CFR50 and 40CFR190, there are overlapping requirements regarding offsite radiation dose and dose commitment to the total body. In 10CFR20.1301, the total effective dose equivalent (TEDE) to a member of the public is limited to 100 mrem per calendar year. In addition, Appendix I to 10CFR50 establishes design objectives on annual total body dose or dose commitment of 3 mrem per reactor for liquid effluents and 5 mrem per reactor for gaseous effluents (see 10CFR50 Appendix I, Sections II.A and II.B.2(a)). Finally, 40CFR190 limits annual total body dose or dose commitment to a member of the public to 25 mrem due to all uranium fuel cycle operations.

2. While these dose limits/design objectives appear to overlap, they are different and each is addressed separately by the RE. Calculations are made and reports are generated to demonstrate compliance to all regulations. Refer to Table 1-1 and Table 1-2 for additional information regarding instantaneous effluent limits, design objectives and regulatory compliance.

1.2.5. Dose Receiver Methodology

1. Table 1-2 lists the location of the dose recipient and occupancy factors, if applicable. Dose is assessed at the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the maximum potential exposures. The dose calculation methodology is consistent with the methodology of Regulatory Guide 1.109 (Reference 6) and NUREG 0133 (Reference 14). Dose is therefore calculated to a maximum individual. The maximum individual is characterized as "maximum" with regard to food consumption, occupancy and other usage of the area in the vicinity of the plant site. Such a "maximum individual" represents reasonable deviation from the average for the population in general. In all physiological and metabolic respects, the maximum individual is assumed to have those characteristics that represent averages for their corresponding age group. Thus, the dose calculated is very conservative compared to the "average" (or typical) dose recipient who does not go out of the way to maximize radioactivity uptakes and exposure.

Table 1 - 1
Regulatory Dose Limit Matrix

REGULATION	DOSE TYPE		DOSE LIMIT(s)		TRM Section
Airborne Releases:			(quarterly)	(annual)	
10CFR50 App. I[3]	Gamma Dose to Air due to Noble Gas Radionuclides (per reactor unit)		5 mrad	10 mrad	3.11.g
	Beta Dose to Air Due to Noble Gas Radionuclides (per reactor unit)		10 mrad	20 mrad	3.11.g
	Organ Dose Due to Specified Non-Noble Gas Radionuclides (per reactor unit)		7.5 mrem	15 mrem	3.11.h
	Total Body and Skin Dose (if air dose is exceeded)	Total Body	2.5 mrem	5 mrem	N/A
		Skin	7.5 mrem	15 mrem	N/A
Technical Specifications	Total Body Dose Rate Due to Noble Gas Radionuclides (instantaneous limit, per site)		500 mrem/yr		3.11.f
	Skin Dose Rate Due to Noble Gas Radionuclides (instantaneous limit, per site)		3,000 mrem/yr		3.11.f
	Organ Dose Rate Due to Specified Non-Noble Gas Radionuclides (instantaneous limit, per site)		1,500 mrem/yr		3.11.f
Liquid Releases:			(quarterly)	(annual)	
10CFR50 App. I[3]	Whole (Total) Body Dose (per reactor unit)		1.5 mrem	3 mrem	3.11.d
	Organ Dose (per reactor unit)		5 mrem	10 mrem	3.11.d
Technical Specifications	The concentration of radioactivity in liquid effluents released to unrestricted areas		Ten times the values listed in 10CFR20 Appendix B; Table 2, Column 2, and note 5 below for Noble Gases		3.11.c
Total Doses [1]:					ODCM PART II
10 CFR 20.1301 (a)(1)	Total Effective Dose Equivalent [4]		100 mrem/yr		5.5
10CFR20.1301 (d) And 40CFR190	Total Body Dose		25 mrem/yr		5.5
	Thyroid Dose		75 mrem/yr		5.5
	Other Organ Dose		25 mrem/yr		5.5
Other Limits [2]:					
40CFR141	Total Body Dose Due to Drinking Water From Public Water Systems		4 mrem/yr		3.4
	Organ Dose Due to Drinking Water From Public Water Systems		4 mrem/yr		3.4

1 These doses are calculated considering all sources of radiation and radioactivity in effluents.

2 These limits are not directly applicable to nuclear power stations. They are applicable to the owners or operators of public water systems. However, the Byron RECS requires assessment of compliance with these limits.

3 Note that 10CFR50 provides design objectives, not limits.

4 Compliance with 10CFR20.1301(a)(1) is demonstrated by compliance with 40CFR190. Note that it may be necessary to address dose from on-site activity by members of the public as well.

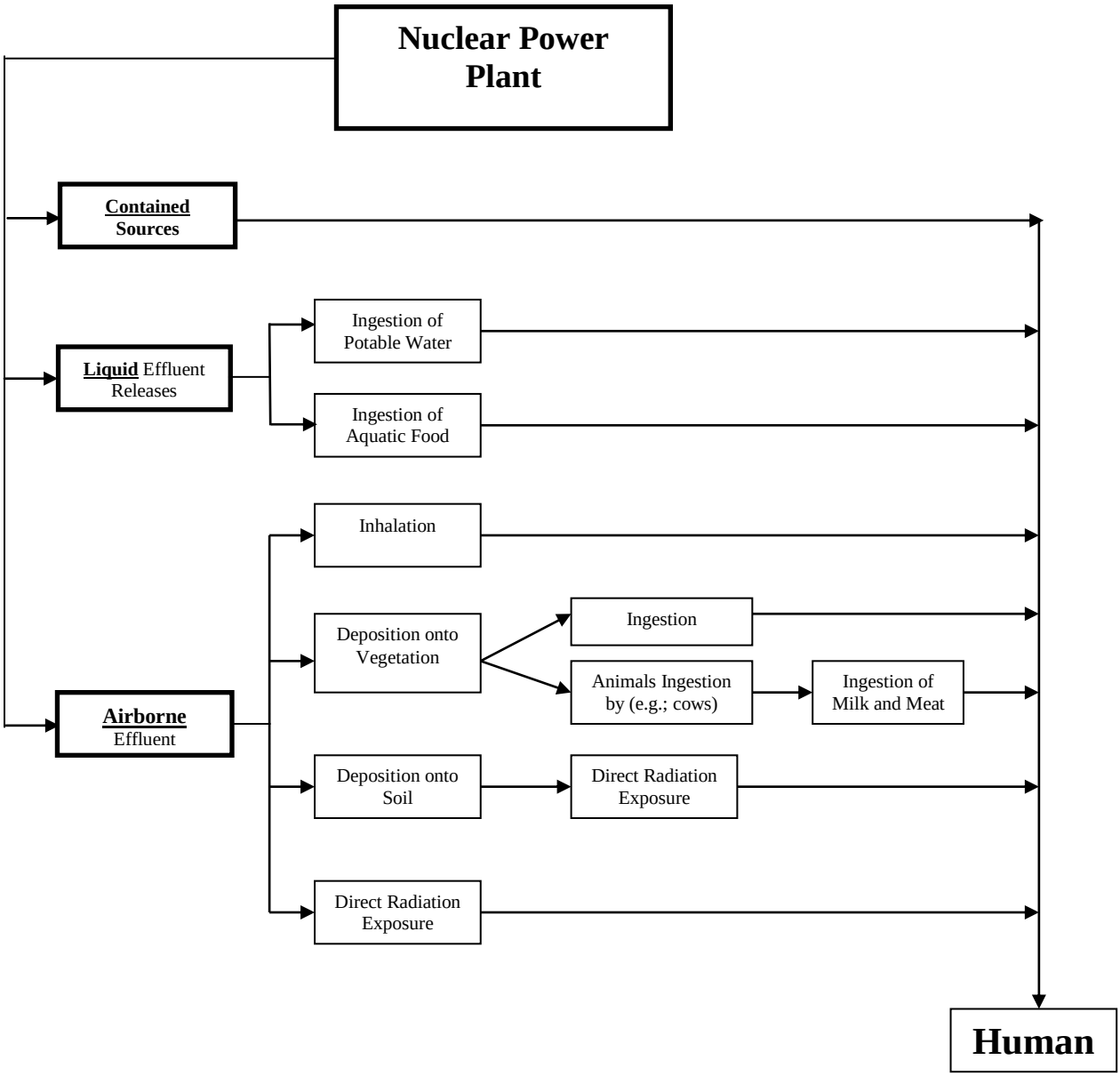
5 Kr-85m, Kr-85, Kr-87, Kr-88, Ar-41, Xe-131m, Xe-133m, Xe-133, Xe-135m and Xe-135 allowable concentration is 2E-4 µCi/ml computed from Equation 17 of ICRP Publication 2 adjusted for infinite cloud submersion in water, and R = 0.01 rem/wk, ρ_w = 1.0 g/cm3, and P_w/P_t = 1.0.

Table 1 - 2
Dose Assessment Receivers

Dose Component or Pathway	Location; Occupancy if Different than 100%
"Instantaneous" dose rates from airborne radioactivity	Unrestricted area boundary location that results in the maximum dose rate
"Instantaneous" concentration limits in liquid effluents	Point where liquid effluents enter the unrestricted area
Annual average concentration limits for liquid effluents	Point where liquid effluents enter the unrestricted area
Direct dose from contained sources	Receiver spends part of this time in the controlled area and the remainder at his residence or fishing nearby; occupancy factor is considered and is site-specific.
Direct dose from airborne plume	Receiver is at the unrestricted area boundary location that results in the maximum dose.
Dose due to radioiodines, tritium and particulates with half-lives greater than 8 days for inhalation, ingestion of vegetation, milk and meat, and ground plane exposure pathways.	Receiver is at the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the highest potential exposures.
Ingestion dose from drinking water	The drinking water pathway is considered as an additive dose component in this assessment only if the public water supply serves the community immediately adjacent to the plant.
Ingestion dose from eating fish	The receiver eats fish from the receiving body of water
Total Organ Doses	Summation of ingestion/inhalation doses
Total Dose	Summation of above data (Note it may also be necessary to address dose from on-site activity by members of the public.)

Figure 1-1 illustrates some of the potential radiation exposure pathways to humans due to routine operation of a nuclear power station.

Figure 1 - 1
Radiation Exposure Pathways to Humans



1.3. Offsite Dose Calculation Parameters

1. This section contains offsite dose calculation parameter factors, or values not specific only to one of the gas, liquid, or total dose chapters. Additional parameters are provided in the Sections 2, 4 and 5 of the ODCM.

2. 10CFR50 Dose Commitment Factors

A. 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

B. 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, and Table E-5 lists Miscellaneous Dose Assessment Factors - Consumption Parameters. 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).

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Table 1 - 3
Miscellaneous Dose Assessment Factors: Environmental Parameters

Parameter	Value	Comment	Equation	Basis[a]
f_g	0.76		4-11, 4-12	A
f_L	1.0		4-11, 4-12	A
f_p	1.0		4-13, 4-15	A
f_s	1.0		4-13, 4-15	A
t_b	262,800 hrs	30 years	4-9	C
t_f	48 hrs	Cow Milk Pathway	4-13	A
t_f	480 hrs	Cow Meat Pathway	4-15	A
t_h	1440 hrs	60 days for produce	4-11	A
t_h	2160 hrs	90 days for produce	4-13, 4-15	A
t_L	24 hrs	1 day for leafy vegetables	4-11	A
Q_F	50 Kg/day		4-13, 4-14, 4-15, 4-16	B
r	1.0	For Iodines	4-11, 4-13, 4-15	A
r	0.2	For Particulates	4-11, 4-13, 4-15	A
Y_p	0.7 Kg/m^2		4-13, 4-15	A
Y_s	2.0 Kg/m^2		4-13, 4-15	A
Y_v	2.0 Kg/m^2		4-11	A
λ_w	0.0021 hr-1		4-11, 4-13, 4-15	A
H	8 gm/m^3	Absolute Atmospheric Humidity	4-12, 4-14, 4-16	D
p	1.0	Fractional Equilibrium Ratio	4-12a, 4-14a, 4-16a	E

[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.
E: Reference 6, Appendix C

Table 1 - 4
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 1-4 (Cont'd)
Stable Element Transfer Data

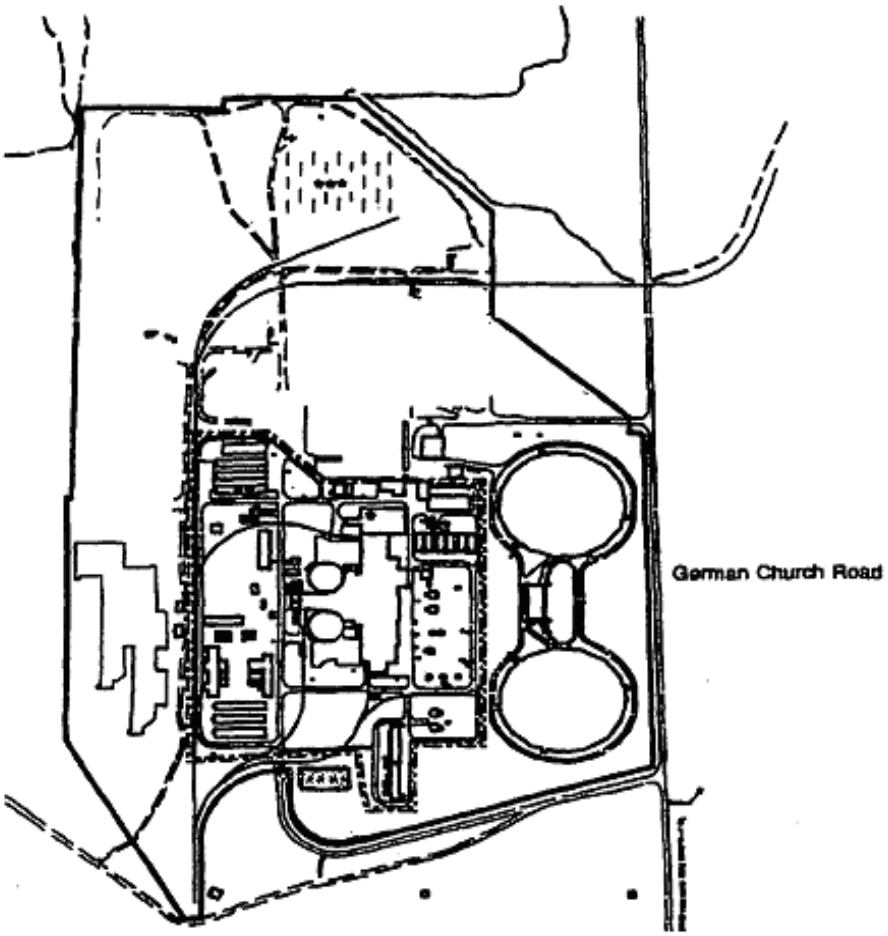
Element	F_f Meat (d/kg)	F_M (Cow) Milk (d/L)	Reference
Pm	2.9E-04	2.0E-05	16
Sm	2.9E-04	2.0E-05	16
Eu	2.9E-04	2.0E-05	16
Gd	2.9E-04	2.0E-05	16
Dy	2.9E-04	2.0E-05	16
Er	2.9E-04	2.0E-05	16
Tm	2.9E-04	2.0E-05	16
Yb	2.9E-04	2.0E-05	16
Lu	2.9E-04	2.0E-05	16
Hf	3.4E-02	5.0E-06	Footnote 5
Ta	2.8E-01	1.3E-03	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.

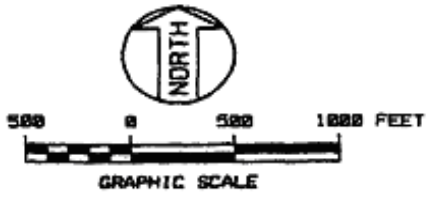
Footnotes:

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 no values 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.



* Future Process Radwaste Storage Building
** DAW Building (Warehouse #3)
*** Future DAW & 48 Pack Locations
—— Restricted Area Boundary
**** ISFSI Pad



OFFSITE DOSE CALCULATION MANUAL
BYRON STATION

FIGURE 1-3
RESTRICTED AREA BOUNDARY

2. INSTRUMENTATION AND SYSTEMS

2.1. Liquid Effluents System Description

1. A simplified liquid release flowpath diagram is provided in Figure 2-3. A simplified liquid radwaste processing diagram is provided in Figure 2-2.

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 for the purpose of reducing the total radioactivity prior to release to the environment. The system is described in Chapter 11 of the Byron Updated Final Safety Analysis Report.

2.1.1. Release Tanks

1. There are two radwaste release tanks (0WX0IT and 0WX26T 30,000-gallon capacity each) that receive liquid waste before discharge to the Rock River.

2.1.2. Turbine Building Fire and Oil Sump

1. The turbine building fire and oil sump receives water from selected turbine building sumps, the tendon tunnel sumps, and the diesel fuel oil storage sumps, all of which are normally non-radioactive but potentially contaminated. The effluent from this sump is monitored, and if radioactive contamination exceeds a predetermined level pump operation is automatically terminated. The water may then be sent to the liquid radwaste treatment system.

2.1.3. Condensate Polisher Sump

1. The condensate polisher sump receives wastewater from the condensate polisher system, which is normally non-radioactive but potentially contaminated. The effluent from this sump is monitored and if radioactive contamination exceeds a predetermined level sump discharge is terminated and major condensate polisher inputs to the sump are automatically isolated. The water may then be sent to the liquid radwaste treatment system.

2.2. Liquid Effluent Radiation Monitors

Pertinent information on the Liquid Radioactive Effluent Monitors and associated control devices are shown in Table 2-1; additional information is provided in the Byron UFSAR Chapter 11.

2.2.1. Liquid Radwaste Effluent Monitor

1. 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-869 to terminate the release.

2.2.2. Station Blowdown Monitor

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

2.2.3. Reactor Containment Fan Cooler (RCFC) and Essential Service Water (SX) Outlet Line Monitors.

1. Monitors 1RE-PR002, 2RE-PR002, 1RE-PR003, and 2RE-PR003 continuously monitor the RCFC and SX outlet lines. No control device is initiated by these channels.

2.2.4. Turbine Building Fire and Oil Sump Monitor

1. 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.

2.2.5. Condensate Polisher Sump Monitor

1. 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.

2.2.6. Component Cooling Water Monitors

1. Monitors 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.

2.3. Liquid Radiation Effluent Monitors Alarm and Trip Setpoints

1. Alarm and trip setpoints of liquid effluent monitors at the principal release points are established to ensure that the limits of TRM Section 3.11.a are not exceeded in the unrestricted area.

2. Setpoint calculations normally consist of identified release mixtures, dilution factors, conversion factors (detector sensitivity), maximum release flow rates, and conservatism factors.

2.3.1. Station Blowdown Monitor

During release, the monitor setpoint is found by solving equation 2-1

$$P \leq C^{CW} + (1.50 \times C^{T}) \times (F^{r}_{max}/(F^{CW} + F^{r}_{max})) \quad \textbf{(2-1)}$$

P	Release Setpoint	[μCi/ml]
1.50	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 (excluding tritium)	[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	[gpm]

1. The release mixture used for the setpoint determination is the radionuclide mix identified in the release tank grab sample isotopic analysis.

2.3.2. Liquid Radwaste Effluent Monitor

1. During release, the setpoint is established at 1.5 times the analyzed tank activity plus the background reading. However, per procedure, the maximum discharge flow rate is limited to a value that will result in less than 50% of 10*ECL at the discharge point. (See Section 1)

2.3.2.1 Radwaste Tank Discharge Flow Rate

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

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

$$F^{r}_{\max} = 0.5\left(F^{d}_{act} / \Sigma\left(C_i / 10 * ECL_i \right)\right) \quad \textbf{(2-2)}$$

The summation is over radionuclides i.

$F^{r}_{\max}$ Maximum Permitted Discharge Flow Rate [gpm]

The maximum permitted flow rate from the radwaste discharge tank based on radiological limits (not chemistry limits which may be more restrictive)

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

C_i 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.

ECL_i Effluent Concentration Limit [μCi/ml]

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

10 Multiplier

2.3.2.2 Release Mixture

1. The release mixture used for the setpoint determination is the radionuclide mix identified in the release tank grab sample isotopic analysis.

2.3.2.3 Liquid Dilution Flow Rates

1. Dilution flow rates are obtained from the main control board in the control room. If this information is unavailable, releases may continue for up to 30 days provided the dilution flow rates are estimated every 4 hours during the release, in accordance with TRM Table T 3.11.a-1.

2.3.2.4 Projected Concentrations for Releases

1. After determining $F^r_{\max}$ from Equation 2-2, RE compliance is verified using Equations 2-3 and 2-4.

$$C_i^a = C_i^T [F^r_{\max} / (F^r_{\max} + F^d_{act})] \quad \textbf{(2-3)}$$

$$\Sigma\{ C_i^a / 10 * \mathrm{ECL}_i \} \leq 1 \quad \textbf{(2-4)}$$

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 2-3.

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.

ECL_i Effluent Concentration Limit [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 Flow Rate [gpm]

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

2.3.3. Other Liquid Effluent Monitors

1. 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 ECL 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 2-4.

2.3.4. Conversion Factors

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

2.3.5. Allocation of Effluents from Common Release Points

1. 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.

2.3.6. Solidification of Waste/Process Control Program

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

2.4. Gaseous Effluents System Description

1. A simplified HVAC and gaseous effluent flow diagram is provided in Figure 2-1. The principal release points for potentially radioactive airborne effluents are the two auxiliary building vent stacks (designated Stack 1 and Stack 2 in Figure 2-1). In the classification scheme of Section 4.1.4, each is classified as a vent release point. Engineered safety features atmospheric cleanup systems are not considered to be ventilation exhaust treatment system components.

2.4.1. Waste Gas Holdup System

1. 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 radioactive decay prior to release to the environment.

2.4.2. Ventilation Exhaust Treatment System

1. 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 charcoal absorbers and/or HEPA filters 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 2-1.

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

2.5. Gaseous Effluent Radiation Monitors

1. Pertinent information on the Gaseous Effluent Radiation Monitors and associated control devices are shown in Table 2-2, additional information is provided in Byron UFSAR Chapter 11.

2.5.1. Auxiliary Building Vent Effluent Monitors

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

2. Both vent stack monitors feature automatic noble gas monitoring, isokinetic sampling, grab sampling, and sampling for iodine, particulate, and tritium.

3. These monitors perform no automatic isolation or control functions.

2.5.2. Containment Purge Effluent Monitors

1. 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.

2. These monitors perform no automatic isolation or control functions.

3. Monitors 1RE-AR011, 2RE-AR011, 1RE-AR012 and 2RE-AR012 continuously monitor the containment atmosphere for radioactive gas and particulates. On high alarm during a containment purge, these monitors will automatically terminate the purge.

2.5.3. Waste Gas Decay Tank Monitors

1. Monitors 0RE-PR002A and 0RE-PR002B continuously monitor the noble gas activity released from the gas decay tanks.

2. On high alarm, the monitors automatically initiate closure of the valve 0GW104 thus terminating the release.

2.5.4. Gland Steam and Condenser Air Ejector Monitors

1. Monitors 1RE-PR027 and 2RE-PR027 continuously monitor the condenser air ejector gas from Units 1 and 2, respectively. This monitor performs no automatic isolation or control functions.

2.5.5. Radwaste Building Ventilation Monitor

1. Monitor 0RE-PR026 continuously monitors radioactivity in the radwaste building ventilation system. On high alarm, 0RE-PR026 initiates isolation of the radwaste building ventilation system.

2.5.5.1 Miscellaneous Ventilation Monitors

1. Monitor 0RE-PR003 continuously monitors radioactivity in the ventilation exhaust from the laboratory fume hoods. This monitor performs no automatic isolation or control functions.

2.6. Gaseous Effluent Monitor Alarm and Trip Setpoints

2.6.1. Auxiliary Building Vent Effluent Monitors

1. The setpoints for the low range noble gas channel are conservatively established at 2.5% of the maximum permissible release rate for the high alarm and 0.25% of the maximum release rate for the alert alarm.

2. The setpoints for the high range noble gas channel are conservatively established at 50% of the maximum permissible release rate for the high alarm and 5% of the maximum release rate for the alert alarm.

3. The setpoint methodology must ensure simultaneous releases do not exceed the off-site dose rate limits set forth in TRM3.11. Setpoints can be adjusted based upon operational requirements with the restriction that the sum of the percentages between the Unit 1 and Unit 2 noble gas channels does not exceed 90% of the maximum permissible release rate.

2.6.2. Containment Purge Effluent Monitors

1. Under normal conditions when the containment atmosphere monitor gas detector is operational, the setpoints are established at 1.25 times the containment noble gas activity during purge based on a grab sample obtained from the rad monitor.

2. When the containment atmosphere monitor gas detector is not operational, the setpoints are established at 1.5 times the containment noble gas activity during purge to prevent a spurious alarm based on a grab sample that may not be as representative of the containment atmosphere as monitored by the containment purge rad monitor during non-release periods.

2.6.3. Waste Gas Decay Tank Effluent Monitors

1. The setpoints are established at 1.25 times the analyzed waste gas tank activity during release.

2.6.4. Gaseous Effluent Release Limits

1. Alarm and trip setpoints of gaseous effluent monitors are established to ensure that the dose rate limits of TRM Section 3.11.f are not exceeded. The release limits are found by solving Equations 2-5 and 2-6 for the total allowed release rate of vent releases, Q_{tv}.

$$(\chi/Q)_v^\gamma Q_{tv} \sum_i K_i \, f_i < 500 \text{ mrem/yr} \qquad \textbf{(2-5)}$$

$$Q_{tv} \sum_i f_i \left\{ L_i \, (\chi/Q)_v + (1.11) \, M_i \, (\chi/Q)_v^\gamma \right\} < 3000 \text{ mrem/yr} \qquad \textbf{(2-6)}$$

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 [□Ci/sec]

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

2. The remaining parameters in Equation 2-5 have the same definitions as in Equation 4-1 of Part II Section 4. The remaining parameters in Equation 2-6 have the same definition as in Equation 4-2 of Part II Section 4.

3. Equation 2-5 is based on Equation 4-1 of Section 4 and the RE restriction on whole body dose rate (500 mrem/yr) due to noble gases released in gaseous effluents (see Part II Section 4.2.1.1). Equation 2-6 is based on Equation 4-2 of Section 4 and the RE restriction on skin dose rate (3000 mrem/yr) due to noble gases released in gaseous effluents (see Part II Section 4.2.1.2).

4. Since the solution to Equation 2-6 is more conservative than the solution to Equation 2-5, the value of Equation 2-6 (1.02×10^7 μCi/sec) is used as the limiting noble gas release rate. During evolutions involving releases from the containment or waste gas decay tanks, the total station release rate is procedurally limited such that the maximum permissible release rate is not exceeded.

2.6.5. Release Mixture

1. In the determination of alarm and trip setpoints, the radioactivity mixture in exhaust air is assumed to have the radionuclide composition of Table 2-3.

2.6.6. Conversion Factors.

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

2.6.7. HVAC Dilution Flow Rates

1. The plant vent stack flow rates are obtained from the RM-11 (or equivalent) console in the control room. If the values cannot be obtained from RM-11 (or equivalent), flow rates can be estimated from the operating fan combinations.

2.6.8. Allocation of Effluents from Common Release Points

1. 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.

2.6.9. Dose Projections for Batch Releases

1. The 10CFR20 dose limits have been converted into a station administrative release rate limit using the methodology in the ODCM. Compliance is verified prior to each 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.

Table 2-1 Liquid Radioactive Effluent Monitors

Channel	Monitor Description	Sampling Locations	Effluent Control Functions	Alarm Setpoint Used
0RE-PR001	Radwaste Release Tank Monitor	Common release point from Radwaste Release Tanks 0WX01T, 0WX26T	Radwaste release termination	Yes
0RE-PR010	Station Blowdown Monitor	Circulating Water Blowdown	None	No
1RE-PR002 2RE-PR002 1RE-PR003 2RE-PR003	Reactor Containment Fan Cooler and Essential Service Water Outlet Line Monitors	RCFC and SX outlet lines	None	No
0RE-PR005	Turbine Building Fire and Oil Sump Monitor	Fire and Oil Sump discharge	Terminates release from Fire and Oil Sump	Yes
0RE-PR041	Condensate Polisher Sump Monitor	Condensate Polisher Sump discharge	Terminates release from Condensate Polisher Sump	Yes
0RE-PR009 1RE-PR009 2RE-PR009	Component Cooling Water (CCW) Monitors	0RE-PR009: CCW Heat Exchangers, common discharge 1RE-PR009: Unit 1 CCW Heat Exchanger discharge 2RE-PR009: Unit 2 CCW Heat Exchanger discharge	0RE-PR009: Closes both CCW surge tank vents 1RE-PR009: Closes Unit 1 CCW surge tank vent 2RE-PR009: Closes Unit 2 CCW surge tank vent	Yes

Table 2-2 Gaseous Radioactive Effluent Monitors

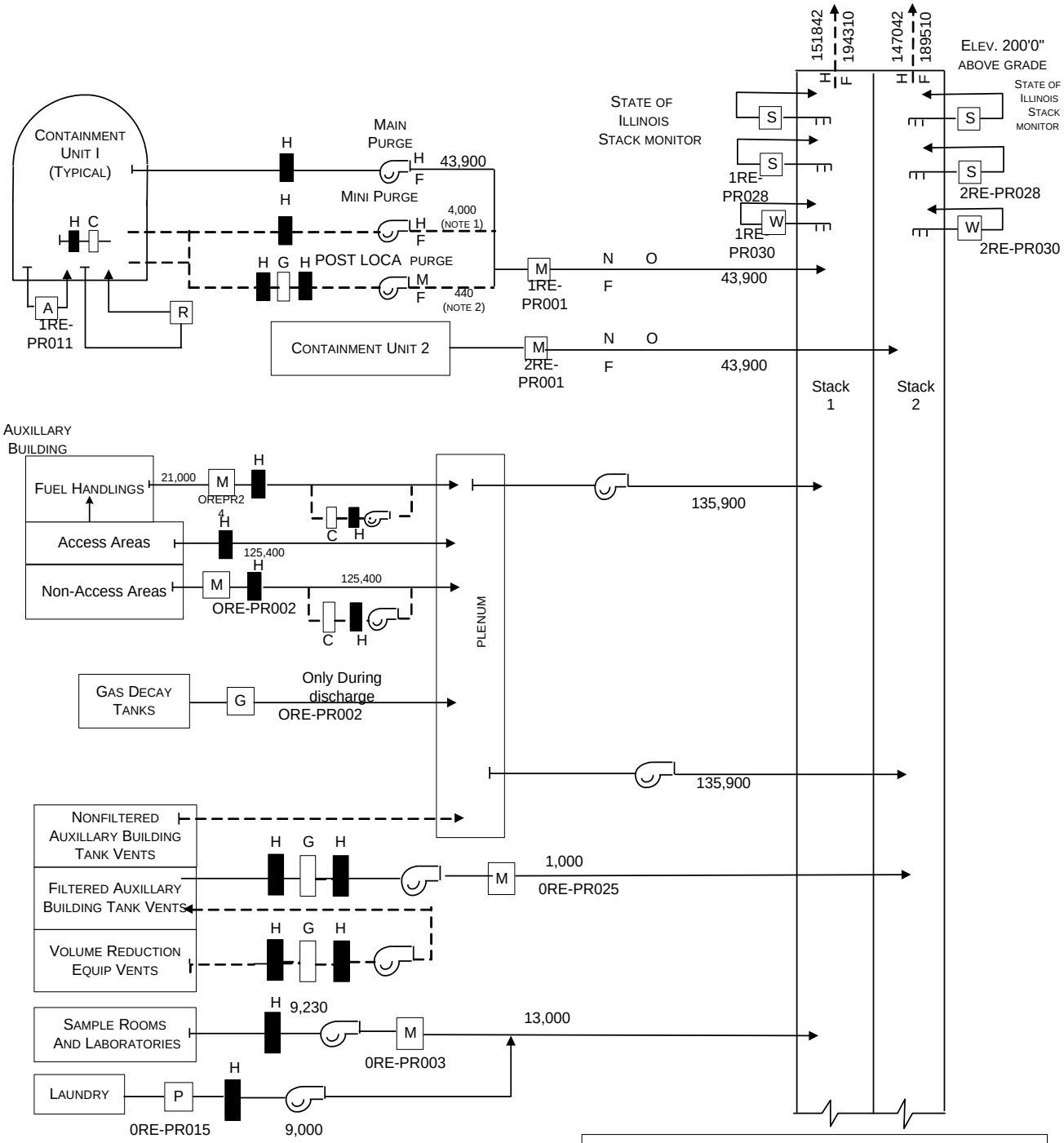
Channel	Monitor Description	Sampling Locations	Effluent Control Functions	Alarm Setpoint Used
1RE-PR028 2RE-PR028	Auxiliary Building Vent Effluent Monitors	Final effluent from auxiliary building vent stack from Unit 1 (1RE-PR028) and from Unit 2 (2RE-PR028)	None	Yes
1RE-PR001 2RE-PR001	Containment Purge Effluent Monitors	Effluent from Unit 1 Containment (1RE-PR001) Effluent from Unit 2 Containment (2RE-PR001)	None	Yes
1RE-AR011 2RE-AR011 1RE-AR012 2RE-AR012	Reactor Containment Particulate and Gas Monitors	Unit 1 Containment (1RE-AR011, 1RE-AR012) Unit 2 Containment (2RE-AR011, 2RE-AR012) *Note: not effluent monitors, but have effluent control functions*	Terminate containment purge	Yes
0RE-PR002A 0RE-PR002B	Waste Gas Decay Tank Monitors	Release line from Waste Gas Decay Tanks	Closes valve 0GW104, terminates release	Yes
1RE-PR027 2RE-PR027	Gland Steam and Condenser Air Ejector Monitors	Condenser Air Ejector (CAE) gas from Unit 1 (1RE-PR027) and CAE gas from Unit 2 (2RE-PR027)	None	No
0RE-PR026	Radwaste Building Ventilation	Radwaste Building Ventilation System	Isolates Radwaste Building ventilation system	Yes
0RE-PR003	Laboratory Fume Hood Exhaust Monitor	Common line from laboratory fume hoods	None	No

Table 2-3 Assumed Composition of the Byron Station Noble Gas Effluent

Isotope	Percent of Effluent
Ar-41	0.89
Kr-85m	0.18
Kr-85	24.9
Kr-87	0.04
Kr-88	0.28
Xe-131m	1.42
Xe-133m	0.57
Xe-133	71.1
Xe-135	0.53
Xe-138	0.04

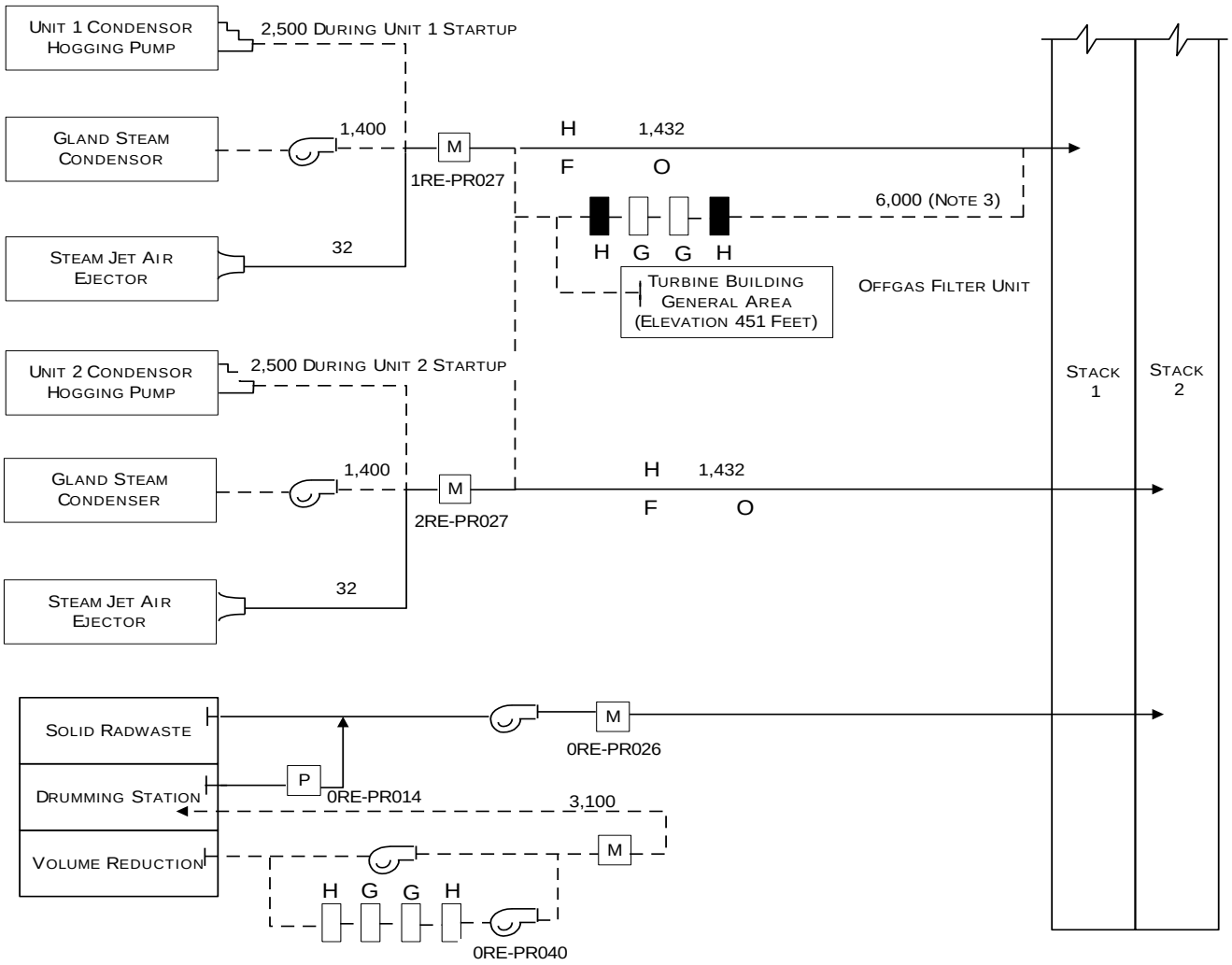
Table 2-4 Assumed Composition of the Byron Station Liquid Effluent

Isotope	Concentration (uCi/ml)	Isotope	Concentration (uCi/ml)
H-3	1.16E-05	Ag-110m	1.70E-11
Cr-51	2.39E-12	Te-127	5.40E-13
Mn-54	3.86E-11	Te-129m	1.78E-12
Fe-55	2.08E-12	Te-129	1.16E-12
Fe-59	1.35E-12	Te-131m	1.27E-12
Co-58	1.74E-10	Te-132	2.39E-11
Co-60	3.40E-10	I-130	4.24E-12
Br-83	6.59E-13	I-131	3.09E-09
Rb-86	1.81E-12	I-132	6.95E-11
Sr-89	5.02E-13	I-133	1.43E-09
Zr-95	5.40E-11	I-135	1.66E-10
Nb-95	7.72E-11	Cs-134	1.08E-09
Mo-99	7.72E-11	Cs-136	2.66E-10
Tc-99m	8.88E-11	Cs-137	1.35E-09
Ru-103	5.40E-12	Ce-144	2.01E-10
Ru-106	9.26E-11	Np-239	8.88E-13



OFFSITE DOSE CALCULATION MANUAL
BYRON STATION

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



LEGEND

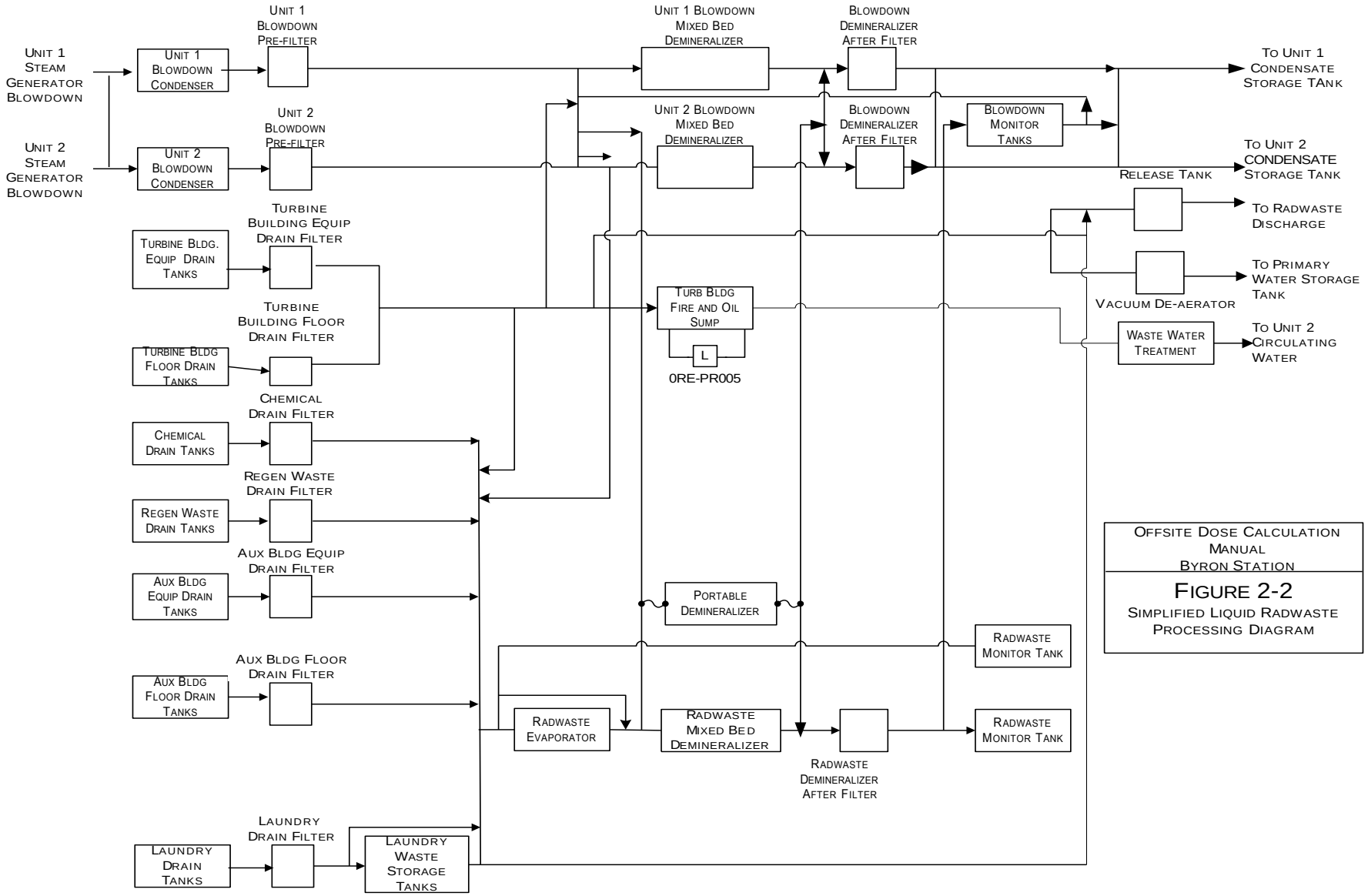
———	NORMAL OR FREQUENT FLOW PATH
– – –	OCCASIONAL FLOW PATH
A	CONTAIMENT ATMOSPHERE RADIATION MONITOR
C	CHARCOAL FILTER
F	REFUELING
G	NOBLE GAS RADIATION MONITOR
H	HEPA FILTER
M	THREE-CHANNEL RADIATION MONITOR FOR PARTICULATE, IODINE, AND NOBLE GAS (OFFLINE)
N	NORMAL OPERATION
P	PARTICULATE MONITOR (OFFLINE)
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 POST ACCIDENT OPERATION
3. FILTER UNIT OPERATES ONLY WHEN HIGH RADIATION IS DETECTED IN OFFGAS SYSTEM EFFLUENT DISCHARGE

OFFSITE DOSE CALCULATION MANUAL
BYRON STATION

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



Offsite Dose Calculation Manual
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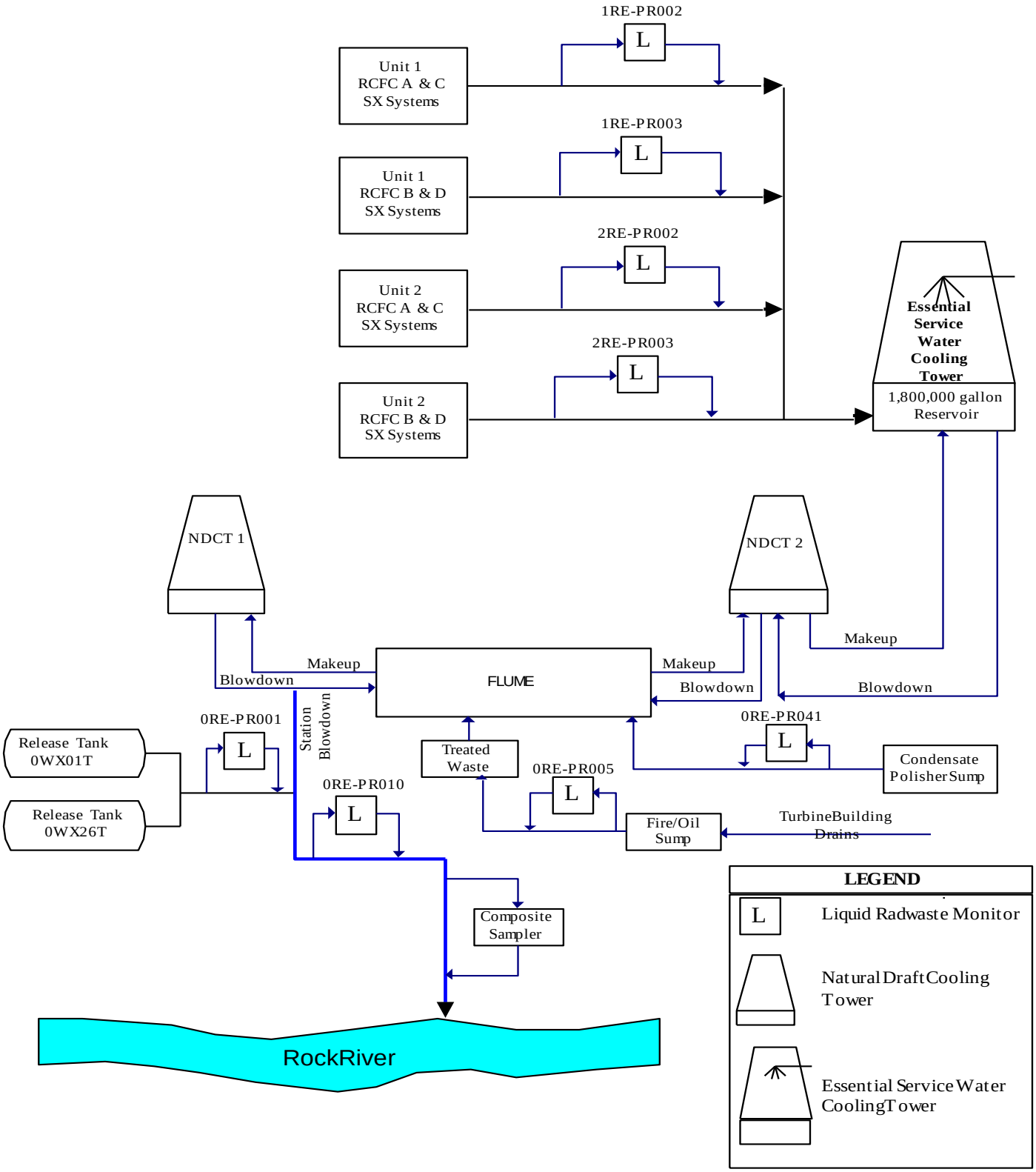
Figure 2-2
Simplified Liquid Radwaste Processing Diagram


1RE-PR002
L
Unit 1
RCFC A & C
SX Systems
1RE-PR003
L
Unit 1
RCFC B & D
SX Systems
2RE-PR002
L
Unit 2
RCFC A & C
SX Systems
2RE-PR003
L
Unit 2
RCFC B & D
SX Systems
Essential
Service
Water
Cooling
Tower
1,800,000 gallon
Reservoir
NDCT 1
NDCT 2
Makeup
Blowdown
FLUME
Makeup
Blowdown
Makeup
Blowdown
0RE-PR001
L
Station
Blowdown
Release Tank
0WX01T
Release Tank
0WX26T
Treated
Waste
0RE-PR005
L
0RE-PR041
L
Condensate
Polisher Sump
0RE-PR010
L
Fire/Oil
Sump
TurbineBuilding
Drains
Composite
Sampler
RockRiver
LEGEND
L
Liquid Radwaste Monitor
Natural Draft Cooling
Tower
Essential Service Water
Cooling Tower

3. LIQUID EFFLUENTS

3.1. Liquid Effluent Releases – General Information

3.1.1. The design objectives of 10CFR50, Appendix I and RE provide the following limits on the dose to a member of the public from radioactive materials in liquid effluents released from each reactor unit to restricted area boundaries:

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

2. During any calendar year, less than or equal to 3 mrem to the total body and less than or equal to 10 mrem to any organ.

3.1.2. The organ doses due to radioactivity in liquid effluents are also used as part of the 40CFR190 compliance and are included in the combination of doses to determine the total dose used to demonstrate 10CFR20 compliance. (See Section 5.0, Total Dose)

3.1.3. Dose assessments for 10CFR50 Appendix I compliance are made for four age groups (adult, teenager, child, infant) using NUREG 0133 (Reference 14) methodology and Regulatory Guide 1.109 (Reference 6) dose conversion factors.

3.1.4. To limit the consequences of tank overflow, Technical Specification 5.5.12 limits the quantity of radioactivity that may be stored in unprotected outdoor tanks to 10 Curies.

1. Unprotected tanks are tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system.

2. The specific objective is to provide assurance that in the event of an uncontrolled release of a tank's contents, the resulting radioactivity concentrations beyond the unrestricted area boundary, at the nearest potable water supply and at the nearest surface water supply, will be less than the limits of 10CFR20 Appendix B, Table 2; Column 2.

3.1.5. Cases in which normally non-radioactive liquid streams (such as the Service Water) are found to contain radioactive material are non-routine and will be treated on a case specific basis if and when this occurs. Since the station has sufficient capacity to delay a liquid release for reasonable periods of time, it is expected that planned releases will not take place under these circumstances. Therefore, the liquid release setpoint calculations need not and do not contain provisions for treating multiple simultaneous release pathways.

3.1.6. 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.

3.2. Liquid Effluent Concentrations

3.2.1. One method of demonstrating compliance to the requirements of 10CFR20.1301 is to demonstrate that the annual average concentrations of radioactive material released in gaseous and liquid effluents do not exceed the values specified in 10CFR20 Appendix B, Table 2, Column 2. (See 10CFR 20.1302(b)(2).) However, as noted in Section 5.5, this mode of 10CFR20.1301 compliance has not been elected.

1. As a means of assuring that annual concentration limits will not be exceeded, and as a matter of policy assuring that doses by the liquid pathway will be ALARA; RE provides the following restriction:

    A. "The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to ten times the concentration values in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402."

2. This also meets the requirement of Station Technical Specifications and RE.

3.2.2. According to the footnotes to 10CFR20 Appendix B, Table 2, Column 2, if a radionuclide mix of known composition is released, the concentrations must be such that

$$\sum_i \left(\frac{C_i}{10\,ECL_i} \right) \leq 1 \qquad \textbf{(3-1)}$$

where the summation is over radionuclide **i**.

C_i Radioactivity Concentration in Liquid Effluents to the Unrestricted Area [μCi/ml]

Concentration of radionuclide **i** in liquid released to the unrestricted area.

ECL_i Effluent Concentration Limit in Liquid Effluents Released to the Unrestricted Area [μCi/ml]

1. The allowable annual average concentration of radionuclide **i** in liquid effluents released to the unrestricted area. This concentration is specified in 10CFR20 Appendix B, Table 2, Column 2. Concentrations for noble gases are different and are specified in the stations' Technical Specifications and RE.

    10 Multiplier to meet the requirements of Technical Specifications.

2. If either the identity or concentration of any radionuclide in the mixture is not known, special rules apply. These are given in the footnotes in 10CFR20 Appendix B, Table 2, Column 2.

3.2.3. When radioactivity is released to the unrestricted area with liquid discharge from a tank (e.g., a radwaste discharge tank), the concentration of a radionuclide in the effluent is calculated as follows:

$$C_i = C_i^t \frac{\text{Waste Flow}}{\text{Dilution Flow}} \qquad \textbf{(3- 2)}$$

C_i Concentration of radionuclide **i** in liquid released to the unrestricted area. [μCi/ml]

C_i^t Concentration in the Discharge Tank [μCi/ml]

Measured concentration of radionuclide **i** in the discharge tank.

1. The RE and Technical Specifications require a specified sampling and analysis program to assure that liquid radioactivity concentrations at the point of release are maintained within the required limits. To comply with this provision, samples are analyzed in accordance with the radioactive liquid waste (or effluent) sampling and analysis program in the TRM 3.11.c. Radioactivity concentrations in tank effluents are determined in accordance with Equation 3-2. Comparison with the Effluent Concentration Limit is made using Equation 3-1.

3.3. Liquid Effluent Dose Calculation Requirements

3.3.1. RE require determination of cumulative and projected dose contributions from liquid effluents for the current calendar quarter and the current calendar year at least once per 31 days. (See TRM Chapter 3.11.)

1. For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system. The allocation procedure is specified in section 3.1.6.

3.3.2. Operability and Use of the Liquid Radwaste Treatment System

1. The design objectives of 10CFR50, Appendix I, RE and Technical Specifications require that the liquid radwaste treatment system be operable and that appropriate portions be used to reduce releases of radioactivity when projected doses due to the liquid effluent from each reactor unit to restricted area boundaries exceed either of the following (see TRM Chapter 3.11, RE);

    - 0.06 mrem to the total body in a 31-day period.
    - 0.2 mrem to any organ in a 31-day period.

3.4. Dose Methodology

3.4.1. Liquid Effluent Dose Method: General

1. The dose from radioactive materials in liquid effluents considers the contributions for consumption of fish and potable water. All of these pathways are considered in the dose assessment unless demonstrated not to be present. While the adult is normally considered the maximum individual, the methodology provides for dose to be calculated for all four age groups. The dose to each organ (and to the total body) is calculated by the following expression:

$$D_{aj}^{Liq} = F\,\Delta t \sum_{p}\sum_{i} A_{aipj} C_i \qquad \textbf{(3-3)}$$

The summation is over exposure pathways **p** and radionuclides **i**.

D_{aj}^{Liq} Organ and Total Body Dose Due to Liquid Effluents [mrem]

Dose to organ **j** (including total body) of age group **a** due to radioactivity in liquid effluents.

F Near Field Average Dilution Factor [dimensionless]
Dilution in the near field averaged over the period of interest.

Defined as:

$$F = \frac{\textbf{Waste Flow}}{\textbf{Dilution Flow} \times Z} \qquad \textbf{(3-4)}$$

Waste Flow Liquid Radioactive Waste Flow [gpm]

The average flow during disposal from the discharge structure release point into the receiving water body.

Dilution Flow Dilution Water Flow During Period of Interest [gpm]

Z Discharge Structure Mixing Factor [dimensionless]

1. Site-specific factor to account for the mixing effect of the discharge structure. The factor addresses the dilution that occurs in the near field between the discharge structure and the body of water containing the fish in the liquid ingestion pathway (See section 0).

   Δt Duration of Release [hrs]

   C_i Average Radionuclide Concentration [μCi/ml]

   Average concentration of radionuclide **i**, in the undiluted liquid effluent during time period Δt.

   A_{aipj} Site-Specific Liquid Dose Factor [(mrem/hr)/(μCi/ml)]

2. Site-specific dose factor for age group **a**, nuclide **i**, liquid pathway **p** and organ **j**. The pathways included are potable water and fish ingestion. A_{aipj} is defined for these pathways in the following sections. Values for A_{aipj} are provided in Part II Section 3.5 of this ODCM.

3.4.2. Potable Water Pathway

1. The site-specific potable water pathway dose factor is calculated by the following expression:

$$A_{ai(PW)j} = k_o \left\{ \frac{U_a^w}{D^w} \right\} DFL_{aij} \qquad \textbf{(3-5)}$$

Where:

$A_{ai(PW)j}$ Site-Specific Dose Factor for Potable Water Pathway [(mrem/hr)/(μCi/ml)]

Site-specific potable water ingestion dose factor for age group **a**, nuclide **i** and organ **j**.

k_o Conversion Constant (1.14E05) [(yr-pCi-ml)/(hr-μCi-l)]

Units constant to convert years to hours, pCi to μCi and liters to ml.

U_a^w Potable Water Consumption Rate [l/yr]

Potable water consumption rate for age group **a**. Taken from Table E-5 of Regulatory Guide 1.109.

D^w Potable Water Dilution Factor [dimensionless]

Dilution factor from the near field area within one-quarter mile of the release point to the potable water intake (See section 0).

DFL_{aij} Ingestion Dose Conversion Factor [mrem/pCi]

Ingestion dose conversion factor for age group **a**, nuclide **i** and organ **j**. Converts pCi ingested to mrem. Taken from Tables E-11 though E-14 of Regulatory Guide 1.109. The value for H-3 is taken from NUREG 4013 (Reference 107).

3.4.3. Fish Ingestion Pathway

1. The site-specific fish ingestion pathway dose factor is calculated by the following expression:

$$\mathbf{A_{ai(Fish)j} = k_o U_a^F BF_i DFL_{aij}} \qquad \textbf{(3-6)}$$

Where:

$\mathbf{A_{ai(Fish)j}}$ Site-Specific Dose Factor for Fish Ingestion Pathway [(mrem/hr)/(μCi/ml)]

Site-specific fish ingestion dose factor for age group **a**, nuclide **i** and organ **j**.

$\mathbf{U_a^F}$ Fish Consumption Rate [kg/yr]

Fish consumption rate for age group **a**. Taken from Table E-5 of Regulatory Guide 1.109.

$\mathbf{BF_i}$ Bioaccumulation Factor [(pCi/kg)/(pCi/l)]

Bioaccumulation factor for nuclide **i** in fresh water fish. Taken from Table 3-8.

All other terms have been previously defined.

3.4.4. Offsite doses due to projected releases of radioactive materials in liquid effluents are calculated using Equation 3-3. Projected radionuclide release concentrations are used in place of measured concentrations, C_i.

3.5. Site Specific Dose Factors and Bioaccumulation Factors

3.5.1. There are no public potable water intakes on the Rock River downstream of the station.

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

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

3.5.4. 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 and two at Sterling.

3.5.5. Water and Fish Ingestion Parameters

3.5.5.1 $D^w = 10$ (potable water dilution factor, dimensionless)

3.5.5.2 $Z = 32$ (discharge structure mixing factor, dimensionless)

3.5.6. Site-specific dose factors for potable water consumption are shown in Table 3-1 for adult, Table 3-2 for teen, Table 3-3 for child, and Table 3-4 for infant age groups. These tables include dose factors for the bone, liver, total body, thyroid, kidney, lung, and GI (lower large intestines).

3.5.7. Site-specific dose factors for fish ingestion are shown in Table 3-5 for adult, Table 3-6 for teen, and Table 3-7 for child age groups. These tables include dose factors for the bone, liver, total body, thyroid, kidney, lung, and GI (lower large intestines).

Table 3-1
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	4.98E-01	4.98E-01	4.98E-01	4.98E-01	4.98E-01	4.98E-01
Na-24	1.41E+01	1.41E+01	1.41E+01	1.41E+01	1.41E+01	1.41E+01	1.41E+01
Cr-51	0.00E+00	0.00E+00	2.21E-02	1.32E-02	4.88E-03	2.94E-02	5.57E+00
Mn-54	0.00E+00	3.80E+01	7.26E+00	0.00E+00	1.13E+01	0.00E+00	1.17E+02
Mn-56	0.00E+00	9.57E-01	1.70E-01	0.00E+00	1.22E+00	0.00E+00	3.05E+01
Fe-55	2.29E+01	1.58E+01	3.69E+00	0.00E+00	0.00E+00	8.82E+00	9.07E+00
Fe-59	3.61E+01	8.49E+01	3.25E+01	0.00E+00	0.00E+00	2.37E+01	2.83E+02
Co-58	0.00E+00	6.20E+00	1.39E+01	0.00E+00	0.00E+00	0.00E+00	1.26E+02
Co-60	0.00E+00	1.78E+01	3.93E+01	0.00E+00	0.00E+00	0.00E+00	3.35E+02
Ni-63	1.08E+03	7.50E+01	3.63E+01	0.00E+00	0.00E+00	0.00E+00	1.56E+01
Ni-65	4.39E+00	5.71E-01	2.60E-01	0.00E+00	0.00E+00	0.00E+00	1.45E+01
Cu-64	0.00E+00	6.93E-01	3.25E-01	0.00E+00	1.75E+00	0.00E+00	5.91E+01
Zn-65	4.03E+01	1.28E+02	5.79E+01	0.00E+00	8.57E+01	0.00E+00	8.07E+01
Zn-69	8.57E-02	1.64E-01	1.14E-02	0.00E+00	1.07E-01	0.00E+00	2.46E-02
Br-83	0.00E+00	0.00E+00	3.35E-01	0.00E+00	0.00E+00	0.00E+00	4.82E-01
Br-84	0.00E+00	0.00E+00	4.34E-01	0.00E+00	0.00E+00	0.00E+00	3.40E-06
Br-85	0.00E+00	0.00E+00	1.78E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.76E+02	8.18E+01	0.00E+00	0.00E+00	0.00E+00	3.46E+01
Rb-88	0.00E+00	5.03E-01	2.67E-01	0.00E+00	0.00E+00	0.00E+00	6.96E-12
Rb-89	0.00E+00	3.34E-01	2.35E-01	0.00E+00	0.00E+00	0.00E+00	1.94E-14
Sr-89	2.56E+03	0.00E+00	7.36E+01	0.00E+00	0.00E+00	0.00E+00	4.11E+02
Sr-90	7.25E+04	0.00E+00	1.46E+03	0.00E+00	0.00E+00	0.00E+00	1.82E+03
Sr-91	4.72E+01	0.00E+00	1.91E+00	0.00E+00	0.00E+00	0.00E+00	2.25E+02
Sr-92	1.79E+01	0.00E+00	7.74E-01	0.00E+00	0.00E+00	0.00E+00	3.55E+02
Y-90	8.01E-02	0.00E+00	2.15E-03	0.00E+00	0.00E+00	0.00E+00	8.49E+02
Y-91M	7.56E-04	0.00E+00	2.93E-05	0.00E+00	0.00E+00	0.00E+00	2.22E-03
Y-91	1.17E+00	0.00E+00	3.14E-02	0.00E+00	0.00E+00	0.00E+00	6.46E+02
Y-92	7.03E-03	0.00E+00	2.06E-04	0.00E+00	0.00E+00	0.00E+00	1.23E+02
Y-93	2.23E-02	0.00E+00	6.16E-04	0.00E+00	0.00E+00	0.00E+00	7.07E+02
Zr-95	2.53E-01	8.11E-02	5.49E-02	0.00E+00	1.27E-01	0.00E+00	2.57E+02
Zr-97	1.40E-02	2.82E-03	1.29E-03	0.00E+00	4.26E-03	0.00E+00	8.74E+02
Nb-95	5.18E-02	2.88E-02	1.55E-02	0.00E+00	2.85E-02	0.00E+00	1.75E+02
Mo-99	0.00E+00	3.59E+01	6.82E+00	0.00E+00	8.12E+01	0.00E+00	8.31E+01
Tc- 99M	2.06E-03	5.81E-03	7.40E-02	0.00E+00	8.82E-02	2.85E-03	3.44E+00
Tc-101	2.11E-03	3.05E-03	2.99E-02	0.00E+00	5.48E-02	1.56E-03	9.15E-15
Ru-103	1.54E+00	0.00E+00	6.63E-01	0.00E+00	5.88E+00	0.00E+00	1.80E+02
Ru-105	1.28E-01	0.00E+00	5.06E-02	0.00E+00	1.66E+00	0.00E+00	7.84E+01
Ru-106	2.29E+01	0.00E+00	2.90E+00	0.00E+00	4.42E+01	0.00E+00	1.48E+03
Ag-110M	1.33E+00	1.23E+00	7.32E-01	0.00E+00	2.42E+00	0.00E+00	5.03E+02
Te-125M	2.23E+01	8.08E+00	2.99E+00	6.71E+00	9.07E+01	0.00E+00	8.90E+01

Table 3-1 (continued)
Site Specific Potable Water Dose Factors for Adult Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	5.63E+01	2.01E+01	6.87E+00	1.44E+01	2.29E+02	0.00E+00	1.89E+02
Te-127	9.15E-01	3.29E-01	1.98E-01	6.78E-01	3.73E+00	0.00E+00	7.22E+01
Te-129M	9.57E+01	3.57E+01	1.51E+01	3.29E+01	3.99E+02	0.00E+00	4.82E+02
Te-129	2.61E-01	9.82E-02	6.37E-02	2.01E-01	1.10E+00	0.00E+00	1.97E-01
Te-131M	1.44E+01	7.04E+00	5.87E+00	1.12E+01	7.13E+01	0.00E+00	6.99E+02
Te-131	1.64E-01	6.85E-02	5.18E-02	1.35E-01	7.18E-01	0.00E+00	2.32E-02
Te-132	2.10E+01	1.36E+01	1.27E+01	1.50E+01	1.31E+02	0.00E+00	6.42E+02
I-130	6.29E+00	1.86E+01	7.32E+00	1.57E+03	2.90E+01	0.00E+00	1.60E+01
I-131	3.46E+01	4.95E+01	2.84E+01	1.62E+04	8.49E+01	0.00E+00	1.31E+01
I-132	1.69E+00	4.52E+00	1.58E+00	1.58E+02	7.20E+00	0.00E+00	8.49E-01
I-133	1.18E+01	2.06E+01	6.27E+00	3.02E+03	3.59E+01	0.00E+00	1.85E+01
I-134	8.82E-01	2.40E+00	8.57E-01	4.15E+01	3.81E+00	0.00E+00	2.09E-03
I-135	3.69E+00	9.65E+00	3.56E+00	6.37E+02	1.55E+01	0.00E+00	1.09E+01
Cs-134	5.18E+02	1.23E+03	1.01E+03	0.00E+00	3.99E+02	1.32E+02	2.16E+01
Cs-136	5.42E+01	2.14E+02	1.54E+02	0.00E+00	1.19E+02	1.63E+01	2.43E+01
Cs-137	6.63E+02	9.07E+02	5.94E+02	0.00E+00	3.08E+02	1.02E+02	1.76E+01
Cs-138	4.59E-01	9.07E-01	4.49E-01	0.00E+00	6.67E-01	6.58E-02	3.87E-06
Ba-139	8.07E-01	5.75E-04	2.36E-02	0.00E+00	5.38E-04	3.26E-04	1.43E+00
Ba-140	1.69E+02	2.12E-01	1.11E+01	0.00E+00	7.22E-02	1.22E-01	3.48E+02
Ba-141	3.92E-01	2.96E-04	1.32E-02	0.00E+00	2.75E-04	1.68E-04	1.85E-10
Ba-142	1.77E-01	1.82E-04	1.12E-02	0.00E+00	1.54E-04	1.03E-04	2.50E-19
La-140	2.08E-02	1.05E-02	2.77E-03	0.00E+00	0.00E+00	0.00E+00	7.70E+02
La-142	1.07E-03	4.84E-04	1.21E-04	0.00E+00	0.00E+00	0.00E+00	3.54E+00
Ce-141	7.79E-02	5.27E-02	5.98E-03	0.00E+00	2.45E-02	0.00E+00	2.01E+02
Ce-143	1.37E-02	1.02E+01	1.12E-03	0.00E+00	4.47E-03	0.00E+00	3.79E+02
Ce-144	4.06E+00	1.70E+00	2.18E-01	0.00E+00	1.01E+00	0.00E+00	1.37E+03
Pr-143	7.66E-02	3.07E-02	3.79E-03	0.00E+00	1.77E-02	0.00E+00	3.35E+02
Pr-144	2.50E-04	1.04E-04	1.27E-05	0.00E+00	5.87E-05	0.00E+00	3.60E-11
Nd-147	5.23E-02	6.05E-02	3.62E-03	0.00E+00	3.54E-02	0.00E+00	2.90E+02
W-187	8.57E-01	7.17E-01	2.50E-01	0.00E+00	0.00E+00	0.00E+00	2.35E+02
Np-239	9.90E-03	9.74E-04	5.37E-04	0.00E+00	3.04E-03	0.00E+00	2.00E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 3-2
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	3.51E-01	3.51E-01	3.51E-01	3.51E-01	3.51E-01	3.51E-01
Na-24	1.34E+01	1.34E+01	1.34E+01	1.34E+01	1.34E+01	1.34E+01	1.34E+01
Cr-51	0.00E+00	0.00E+00	2.09E-02	1.16E-02	4.59E-03	2.99E-02	3.52E+00
Mn-54	0.00E+00	3.43E+01	6.80E+00	0.00E+00	1.02E+01	0.00E+00	7.03E+01
Mn-56	0.00E+00	9.19E-01	1.63E-01	0.00E+00	1.16E+00	0.00E+00	6.05E+01
Fe-55	2.20E+01	1.56E+01	3.63E+00	0.00E+00	0.00E+00	9.88E+00	6.74E+00
Fe-59	3.41E+01	7.97E+01	3.08E+01	0.00E+00	0.00E+00	2.51E+01	1.88E+02
Co-58	0.00E+00	5.65E+00	1.30E+01	0.00E+00	0.00E+00	0.00E+00	7.79E+01
Co-60	0.00E+00	1.63E+01	3.68E+01	0.00E+00	0.00E+00	0.00E+00	2.13E+02
Ni-63	1.03E+03	7.27E+01	3.49E+01	0.00E+00	0.00E+00	0.00E+00	1.16E+01
Ni-65	4.35E+00	5.56E-01	2.53E-01	0.00E+00	0.00E+00	0.00E+00	3.02E+01
Cu-64	0.00E+00	6.69E-01	3.15E-01	0.00E+00	1.69E+00	0.00E+00	5.19E+01
Zn-65	3.35E+01	1.16E+02	5.42E+01	0.00E+00	7.44E+01	0.00E+00	4.92E+01
Zn-69	8.55E-02	1.63E-01	1.14E-02	0.00E+00	1.06E-01	0.00E+00	3.00E-01
Br-83	0.00E+00	0.00E+00	3.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.77E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.73E+02	8.14E+01	0.00E+00	0.00E+00	0.00E+00	2.56E+01
Rb-88	0.00E+00	4.95E-01	2.64E-01	0.00E+00	0.00E+00	0.00E+00	4.24E-08
Rb-89	0.00E+00	3.20E-01	2.26E-01	0.00E+00	0.00E+00	0.00E+00	4.90E-10
Sr-89	2.56E+03	0.00E+00	7.33E+01	0.00E+00	0.00E+00	0.00E+00	3.05E+02
Sr-90	5.93E+04	0.00E+00	1.19E+03	0.00E+00	0.00E+00	0.00E+00	1.35E+03
Sr-91	4.69E+01	0.00E+00	1.87E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+02
Sr-92	1.77E+01	0.00E+00	7.56E-01	0.00E+00	0.00E+00	0.00E+00	4.52E+02
Y-90	7.97E-02	0.00E+00	2.15E-03	0.00E+00	0.00E+00	0.00E+00	6.57E+02
Y-91M	7.50E-04	0.00E+00	2.87E-05	0.00E+00	0.00E+00	0.00E+00	3.54E-02
Y-91	1.17E+00	0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00	4.79E+02
Y-92	7.03E-03	0.00E+00	2.03E-04	0.00E+00	0.00E+00	0.00E+00	1.93E+02
Y-93	2.23E-02	0.00E+00	6.10E-04	0.00E+00	0.00E+00	0.00E+00	6.80E+02
Zr-95	2.40E-01	7.56E-02	5.20E-02	0.00E+00	1.11E-01	0.00E+00	1.74E+02
Zr-97	1.38E-02	2.73E-03	1.26E-03	0.00E+00	4.13E-03	0.00E+00	7.38E+02
Nb-95	4.78E-02	2.65E-02	1.46E-02	0.00E+00	2.57E-02	0.00E+00	1.13E+02
Mo-99	0.00E+00	3.51E+01	6.69E+00	0.00E+00	8.02E+01	0.00E+00	6.28E+01
Tc- 99M	1.93E-03	5.38E-03	6.98E-02	0.00E+00	8.02E-02	2.99E-03	3.53E+00
Tc-101	2.09E-03	2.98E-03	2.92E-02	0.00E+00	5.38E-02	1.81E-03	5.09E-10
Ru-103	1.48E+00	0.00E+00	6.34E-01	0.00E+00	5.23E+00	0.00E+00	1.24E+02
Ru-105	1.27E-01	0.00E+00	4.92E-02	0.00E+00	1.60E+00	0.00E+00	1.02E+02
Ru-106	2.28E+01	0.00E+00	2.87E+00	0.00E+00	4.40E+01	0.00E+00	1.09E+03
Ag-110M	1.19E+00	1.13E+00	6.86E-01	0.00E+00	2.15E+00	0.00E+00	3.17E+02
Te-125M	2.23E+01	8.02E+00	2.98E+00	6.22E+00	0.00E+00	0.00E+00	6.57E+01

Table 3-2 (continued)
Site Specific Potable Water Dose Factors for Teen Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	5.62E+01	1.99E+01	6.69E+00	1.34E+01	2.28E+02	0.00E+00	1.40E+02
Te-127	9.19E-01	3.26E-01	1.98E-01	6.34E-01	3.72E+00	0.00E+00	7.09E+01
Te-129M	9.48E+01	3.52E+01	1.50E+01	3.06E+01	3.97E+02	0.00E+00	3.56E+02
Te-129	2.60E-01	9.71E-02	6.34E-02	1.86E-01	1.09E+00	0.00E+00	1.42E+00
Te-131M	1.42E+01	6.80E+00	5.67E+00	1.02E+01	7.09E+01	0.00E+00	5.46E+02
Te-131	1.62E-01	6.69E-02	5.07E-02	1.25E-01	7.09E-01	0.00E+00	1.33E-02
Te-132	2.03E+01	1.28E+01	1.21E+01	1.35E+01	1.23E+02	0.00E+00	4.07E+02
I-130	5.99E+00	1.73E+01	6.92E+00	1.41E+03	2.67E+01	0.00E+00	1.33E+01
I-131	3.40E+01	4.76E+01	2.56E+01	1.39E+04	8.20E+01	0.00E+00	9.42E+00
I-132	1.62E+00	4.24E+00	1.52E+00	1.43E+02	6.69E+00	0.00E+00	1.85E+00
I-133	1.17E+01	1.98E+01	6.05E+00	2.77E+03	3.48E+01	0.00E+00	1.50E+01
I-134	8.49E-01	2.25E+00	8.08E-01	3.75E+01	3.55E+00	0.00E+00	2.97E-02
I-135	3.55E+00	9.13E+00	3.38E+00	5.87E+02	1.44E+01	0.00E+00	1.01E+01
Cs-134	4.87E+02	1.15E+03	5.31E+02	0.00E+00	3.64E+02	1.39E+02	1.42E+01
Cs-136	4.99E+01	1.97E+02	1.32E+02	0.00E+00	1.07E+02	1.69E+01	1.58E+01
Cs-137	6.51E+02	8.66E+02	3.02E+02	0.00E+00	2.95E+02	1.15E+02	1.23E+01
Cs-138	4.51E-01	8.66E-01	4.33E-01	0.00E+00	6.40E-01	7.44E-02	3.93E-04
Ba-139	8.08E-01	5.69E-04	2.35E-02	0.00E+00	5.36E-04	3.92E-04	7.21E+00
Ba-140	1.65E+02	2.02E-01	1.06E+01	0.00E+00	6.86E-02	1.36E-01	2.55E+02
Ba-141	3.90E-01	2.91E-04	1.30E-02	0.00E+00	2.70E-04	1.99E-04	8.31E-07
Ba-142	1.74E-01	1.74E-04	1.07E-02	0.00E+00	1.47E-04	1.16E-04	5.34E-13
La-140	2.02E-02	9.94E-03	2.65E-03	0.00E+00	0.00E+00	0.00E+00	5.71E+02
La-142	1.04E-03	4.62E-04	1.15E-04	0.00E+00	0.00E+00	0.00E+00	1.41E+01
Ce-141	7.73E-02	5.16E-02	5.93E-03	0.00E+00	2.43E-02	0.00E+00	1.48E+02
Ce-143	1.37E-02	9.94E+00	1.11E-03	0.00E+00	4.46E-03	0.00E+00	2.99E+02
Ce-144	4.05E+00	1.67E+00	2.17E-01	0.00E+00	1.00E+00	0.00E+00	1.02E+03
Pr-143	7.62E-02	3.04E-02	3.79E-03	0.00E+00	1.77E-02	0.00E+00	2.51E+02
Pr-144	2.50E-04	1.02E-04	1.27E-05	0.00E+00	5.87E-05	0.00E+00	2.76E-07
Nd-147	5.45E-02	5.93E-02	3.55E-03	0.00E+00	3.48E-02	0.00E+00	2.14E+02
W-187	8.49E-01	6.92E-01	2.42E-01	0.00E+00	0.00E+00	0.00E+00	1.87E+02
Np-239	1.02E-02	9.65E-04	5.36E-04	0.00E+00	3.03E-03	0.00E+00	1.55E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 3-3
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	6.74E-01	6.74E-01	6.74E-01	6.74E-01	6.74E-01	6.74E-01
Na-24	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01	3.37E+01
Cr-51	0.00E+00	0.00E+00	5.17E-02	2.87E-02	7.85E-03	5.24E-02	2.74E+00
Mn-54	0.00E+00	6.22E+01	1.66E+01	0.00E+00	1.74E+01	0.00E+00	5.22E+01
Mn-56	0.00E+00	1.94E+00	4.38E-01	0.00E+00	2.35E+00	0.00E+00	2.81E+02
Fe-55	6.69E+01	3.55E+01	1.10E+01	0.00E+00	0.00E+00	2.01E+01	6.57E+00
Fe-59	9.59E+01	1.55E+02	7.73E+01	0.00E+00	0.00E+00	4.50E+01	1.62E+02
Co-58	0.00E+00	1.05E+01	3.20E+01	0.00E+00	0.00E+00	0.00E+00	6.10E+01
Co-60	0.00E+00	3.08E+01	9.07E+01	0.00E+00	0.00E+00	0.00E+00	1.70E+02
Ni-63	3.13E+03	1.67E+02	1.06E+02	0.00E+00	0.00E+00	0.00E+00	1.13E+01
Ni-65	1.29E+01	1.22E+00	7.09E-01	0.00E+00	0.00E+00	0.00E+00	1.49E+02
Cu-64	0.00E+00	1.42E+00	8.60E-01	0.00E+00	3.44E+00	0.00E+00	6.69E+01
Zn-65	7.97E+01	2.12E+02	1.32E+02	0.00E+00	1.34E+02	0.00E+00	3.73E+01
Zn-69	2.55E-01	3.68E-01	3.40E-02	0.00E+00	2.23E-01	0.00E+00	2.32E+01
Br-83	0.00E+00	0.00E+00	9.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.15E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	5.30E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	3.90E+02	2.40E+02	0.00E+00	0.00E+00	0.00E+00	2.51E+01
Rb-88	0.00E+00	1.10E+00	7.67E-01	0.00E+00	0.00E+00	0.00E+00	5.42E-02
Rb-89	0.00E+00	6.80E-01	6.05E-01	0.00E+00	0.00E+00	0.00E+00	5.93E-03
Sr-89	7.67E+03	0.00E+00	2.19E+02	0.00E+00	0.00E+00	0.00E+00	2.97E+02
Sr-90	1.49E+05	0.00E+00	2.99E+03	0.00E+00	0.00E+00	0.00E+00	1.33E+03
Sr-91	1.40E+02	0.00E+00	5.27E+00	0.00E+00	0.00E+00	0.00E+00	3.08E+02
Sr-92	5.25E+01	0.00E+00	2.10E+00	0.00E+00	0.00E+00	0.00E+00	9.94E+02
Y-90	2.39E-01	0.00E+00	6.40E-03	0.00E+00	0.00E+00	0.00E+00	6.80E+02
Y-91M	2.22E-03	0.00E+00	8.08E-05	0.00E+00	0.00E+00	0.00E+00	4.35E+00
Y-91	3.50E+00	0.00E+00	9.36E-02	0.00E+00	0.00E+00	0.00E+00	4.66E+02
Y-92	2.09E-02	0.00E+00	5.99E-04	0.00E+00	0.00E+00	0.00E+00	6.05E+02
Y-93	6.63E-02	0.00E+00	1.82E-03	0.00E+00	0.00E+00	0.00E+00	9.88E+02
Zr-95	6.74E-01	1.48E-01	1.32E-01	0.00E+00	2.12E-01	0.00E+00	1.55E+02
Zr-97	4.06E-02	5.87E-03	3.47E-03	0.00E+00	8.43E-03	0.00E+00	8.90E+02
Nb-95	1.31E-01	5.09E-02	3.64E-02	0.00E+00	4.78E-02	0.00E+00	9.42E+01
Mo-99	0.00E+00	7.73E+01	1.91E+01	0.00E+00	1.65E+02	0.00E+00	6.40E+01
Tc- 99M	5.37E-03	1.05E-02	1.74E-01	0.00E+00	1.53E-01	5.34E-03	5.99E+00
Tc-101	6.22E-03	6.51E-03	8.26E-02	0.00E+00	1.11E-01	3.44E-03	2.07E-02
Ru-103	4.25E+00	0.00E+00	1.63E+00	0.00E+00	1.07E+01	0.00E+00	1.10E+02
Ru-105	3.75E-01	0.00E+00	1.36E-01	0.00E+00	3.30E+00	0.00E+00	2.45E+02
Ru-106	6.80E+01	0.00E+00	8.49E+00	0.00E+00	9.19E+01	0.00E+00	1.06E+03
Ag-110M	3.13E+00	2.12E+00	1.69E+00	0.00E+00	3.94E+00	0.00E+00	2.52E+02
Te-125M	6.63E+01	1.80E+01	8.84E+00	1.86E+01	0.00E+00	0.00E+00	6.40E+01

Table 3-3 (continued)
Site Specific Potable Water Dose Factors for Child Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	1.68E+02	4.52E+01	1.99E+01	4.02E+01	4.79E+02	0.00E+00	1.36E+02
Te-127	2.74E+00	7.38E-01	5.87E-01	1.90E+00	7.79E+00	0.00E+00	1.07E+02
Te-129M	2.83E+02	7.91E+01	4.40E+01	9.13E+01	8.31E+02	0.00E+00	3.45E+02
Te-129	7.79E-01	2.17E-01	1.85E-01	5.56E-01	2.28E+00	0.00E+00	4.85E+01
Te-131M	4.19E+01	1.45E+01	1.54E+01	2.98E+01	1.40E+02	0.00E+00	5.87E+02
Te-131	4.83E-01	1.47E-01	1.44E-01	3.69E-01	1.46E+00	0.00E+00	2.53E+00
Te-132	5.87E+01	2.60E+01	3.14E+01	3.78E+01	2.41E+02	0.00E+00	2.62E+02
I-130	1.70E+01	3.43E+01	1.77E+01	3.78E+03	5.13E+01	0.00E+00	1.60E+01
I-131	1.00E+02	1.01E+02	5.72E+01	3.33E+04	1.65E+02	0.00E+00	8.95E+00
I-132	4.65E+00	8.55E+00	3.93E+00	3.97E+02	1.31E+01	0.00E+00	1.01E+01
I-133	3.44E+01	4.26E+01	1.61E+01	7.91E+03	7.09E+01	0.00E+00	1.72E+01
I-134	2.44E+00	4.52E+00	2.08E+00	1.04E+02	6.92E+00	0.00E+00	3.00E+00
I-135	1.02E+01	1.83E+01	8.66E+00	1.62E+03	2.81E+01	0.00E+00	1.40E+01
Cs-134	1.36E+03	2.23E+03	4.71E+02	0.00E+00	6.92E+02	2.48E+02	1.20E+01
Cs-136	1.37E+02	3.76E+02	2.43E+02	0.00E+00	2.00E+02	2.98E+01	1.32E+01
Cs-137	1.90E+03	1.82E+03	2.69E+02	0.00E+00	5.93E+02	2.13E+02	1.14E+01
Cs-138	1.33E+00	1.84E+00	1.17E+00	0.00E+00	1.30E+00	1.40E-01	8.49E-01
Ba-139	2.41E+00	1.28E-03	6.98E-02	0.00E+00	1.12E-03	7.56E-04	1.39E+02
Ba-140	4.83E+02	4.23E-01	2.82E+01	0.00E+00	1.38E-01	2.52E-01	2.45E+02
Ba-141	1.16E+00	6.51E-04	3.78E-02	0.00E+00	5.63E-04	3.83E-03	6.63E-01
Ba-142	5.08E-01	3.66E-04	2.84E-02	0.00E+00	2.96E-04	2.15E-04	6.63E-03
La-140	5.87E-02	2.05E-02	6.92E-03	0.00E+00	0.00E+00	0.00E+00	5.72E+02
La-142	3.05E-03	9.71E-04	3.04E-04	0.00E+00	0.00E+00	0.00E+00	1.92E+02
Ce-141	2.31E-01	1.15E-01	1.71E-02	0.00E+00	5.05E-02	0.00E+00	1.44E+02
Ce-143	4.06E-02	2.20E+01	3.19E-03	0.00E+00	9.24E-03	0.00E+00	3.23E+02
Ce-144	1.21E+01	3.79E+00	6.45E-01	0.00E+00	2.10E+00	0.00E+00	9.88E+02
Pr-143	2.28E-01	6.86E-02	1.13E-02	0.00E+00	3.72E-02	0.00E+00	2.47E+02
Pr-144	7.50E-04	2.32E-04	3.77E-05	0.00E+00	1.23E-04	0.00E+00	4.99E-01
Nd-147	1.62E-01	1.31E-01	1.02E-02	0.00E+00	7.21E-02	0.00E+00	2.08E+02
W-187	2.49E+00	1.48E+00	6.63E-01	0.00E+00	0.00E+00	0.00E+00	2.08E+02
Np-239	3.05E-02	2.19E-03	1.54E-03	0.00E+00	6.34E-03	0.00E+00	1.62E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 3-4
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	6.62E-01	6.62E-01	6.62E-01	6.62E-01	6.62E-01	6.62E-01
Na-24	3.80E+01	3.80E+01	3.80E+01	3.80E+01	3.80E+01	3.80E+01	3.80E+01
Cr-51	0.00E+00	0.00E+00	5.30E-02	3.46E-02	7.56E-03	6.73E-02	1.55E+00
Mn-54	0.00E+00	7.49E+01	1.70E+01	0.00E+00	1.66E+01	0.00E+00	2.75E+01
Mn-56	0.00E+00	3.08E+00	5.30E-01	0.00E+00	2.64E+00	0.00E+00	2.80E+02
Fe-55	5.23E+01	3.38E+01	9.03E+00	0.00E+00	0.00E+00	1.65E+01	4.29E+00
Fe-59	1.16E+02	2.02E+02	7.98E+01	0.00E+00	0.00E+00	5.98E+01	9.67E+01
Co-58	0.00E+00	1.35E+01	3.38E+01	0.00E+00	0.00E+00	0.00E+00	3.37E+01
Co-60	0.00E+00	4.06E+01	9.59E+01	0.00E+00	0.00E+00	0.00E+00	9.67E+01
Ni-63	2.39E+03	1.47E+02	8.28E+01	0.00E+00	0.00E+00	0.00E+00	7.34E+00
Ni-65	1.77E+01	2.00E+00	9.10E-01	0.00E+00	0.00E+00	0.00E+00	1.52E+02
Cu-64	0.00E+00	2.29E+00	1.06E+00	0.00E+00	3.87E+00	0.00E+00	4.70E+01
Zn-65	6.92E+01	2.37E+02	1.09E+02	0.00E+00	1.15E+02	0.00E+00	2.01E+02
Zn-69	3.51E-01	6.32E-01	4.70E-02	0.00E+00	2.63E-01	0.00E+00	5.15E+01
Br-83	0.00E+00	0.00E+00	1.37E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.44E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	7.30E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	6.40E+02	3.16E+02	0.00E+00	0.00E+00	0.00E+00	1.64E+01
Rb-88	0.00E+00	1.87E+00	1.03E+00	0.00E+00	0.00E+00	0.00E+00	1.82E+00
Rb-89	0.00E+00	1.08E+00	7.41E-01	0.00E+00	0.00E+00	0.00E+00	3.66E-01
Sr-89	9.44E+03	0.00E+00	2.71E+02	0.00E+00	0.00E+00	0.00E+00	1.94E+02
Sr-90	1.06E+05	0.00E+00	2.16E+03	0.00E+00	0.00E+00	0.00E+00	8.69E+02
Sr-91	1.88E+02	0.00E+00	6.81E+00	0.00E+00	0.00E+00	0.00E+00	2.23E+02
Sr-92	7.22E+01	0.00E+00	2.68E+00	0.00E+00	0.00E+00	0.00E+00	7.79E+02
Y-90	3.27E-01	0.00E+00	8.77E-03	0.00E+00	0.00E+00	0.00E+00	4.51E+02
Y-91M	3.05E-03	0.00E+00	1.04E-04	0.00E+00	0.00E+00	0.00E+00	1.02E+01
Y-91	4.25E+00	0.00E+00	1.13E-01	0.00E+00	0.00E+00	0.00E+00	3.05E+02
Y-92	2.88E-02	0.00E+00	8.09E-04	0.00E+00	0.00E+00	0.00E+00	5.49E+02
Y-93	9.14E-02	0.00E+00	2.49E-03	0.00E+00	0.00E+00	0.00E+00	7.22E+02
Zr-95	7.75E-01	1.89E-01	1.34E-01	0.00E+00	2.04E-01	0.00E+00	9.41E+01
Zr-97	5.57E-02	9.56E-03	4.36E-03	0.00E+00	9.63E-03	0.00E+00	6.09E+02
Nb-95	1.58E-01	6.51E-02	3.76E-02	0.00E+00	4.66E-02	0.00E+00	5.49E+01
Mo-99	0.00E+00	1.28E+02	2.49E+01	0.00E+00	1.91E+02	0.00E+00	4.21E+01
Tc- 99M	7.22E-03	1.49E-02	1.92E-01	0.00E+00	1.60E-01	7.79E-03	4.33E+00
Tc-101	8.54E-03	1.08E-02	1.06E-01	0.00E+00	1.28E-01	5.87E-03	1.83E+00
Ru-103	5.57E+00	0.00E+00	1.86E+00	0.00E+00	1.16E+01	0.00E+00	6.77E+01
Ru-105	5.12E-01	0.00E+00	1.72E-01	0.00E+00	3.76E+00	0.00E+00	2.04E+02
Ru-106	9.07E+01	0.00E+00	1.13E+01	0.00E+00	1.07E+02	0.00E+00	6.88E+02
Ag-110M	3.75E+00	2.73E+00	1.81E+00	0.00E+00	3.91E+00	0.00E+00	1.42E+02
Te-125M	8.77E+01	2.93E+01	1.19E+01	2.95E+01	0.00E+00	0.00E+00	4.18E+01

Table 3-4 (continued)
Site Specific Potable Water Dose Factors for Infant Age Group

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Te-127M	2.20E+02	7.30E+01	2.66E+01	6.36E+01	5.42E+02	0.00E+00	8.88E+01
Te-127	3.76E+00	1.26E+00	8.09E-01	3.06E+00	9.18E+00	0.00E+00	7.90E+01
Te-129M	3.76E+02	1.29E+02	5.79E+01	1.44E+02	9.41E+02	0.00E+00	2.25E+02
Te-129	1.07E+00	3.68E-01	2.49E-01	8.95E-01	2.66E+00	0.00E+00	8.54E+01
Te-131M	5.72E+01	2.30E+01	1.90E+01	4.66E+01	1.58E+02	0.00E+00	3.87E+02
Te-131	6.62E-01	2.45E-01	1.86E-01	5.91E-01	1.69E+00	0.00E+00	2.67E+01
Te-132	7.82E+01	3.87E+01	3.62E+01	5.72E+01	2.42E+02	0.00E+00	1.43E+02
I-130	2.26E+01	4.97E+01	1.99E+01	5.57E+03	5.45E+01	0.00E+00	1.06E+01
I-131	1.35E+02	1.59E+02	7.00E+01	5.23E+04	1.86E+02	0.00E+00	5.68E+00
I-132	6.24E+00	1.27E+01	4.51E+00	5.94E+02	1.41E+01	0.00E+00	1.03E+01
I-133	4.70E+01	6.85E+01	2.01E+01	1.25E+04	8.05E+01	0.00E+00	1.16E+01
I-134	3.27E+00	6.70E+00	2.38E+00	1.56E+02	7.49E+00	0.00E+00	6.92E+00
I-135	1.37E+01	2.72E+01	9.93E+00	2.44E+03	3.04E+01	0.00E+00	9.86E+00
Cs-134	1.42E+03	2.64E+03	2.67E+02	0.00E+00	6.81E+02	2.79E+02	7.19E+00
Cs-136	1.73E+02	5.08E+02	1.90E+02	0.00E+00	2.02E+02	4.14E+01	7.71E+00
Cs-137	1.96E+03	2.30E+03	1.63E+02	0.00E+00	6.17E+02	2.50E+02	7.19E+00
Cs-138	1.81E+00	2.94E+00	1.43E+00	0.00E+00	1.47E+00	2.29E-01	4.70E+00
Ba-139	3.31E+00	2.20E-03	9.59E-02	0.00E+00	1.32E-03	1.33E-03	2.10E+02
Ba-140	6.43E+02	6.43E-01	3.31E+01	0.00E+00	1.53E-01	3.95E-01	1.58E+02
Ba-141	1.60E+00	1.09E-03	5.04E-02	0.00E+00	6.58E-04	6.66E-04	1.95E+01
Ba-142	6.92E-01	5.76E-04	3.41E-02	0.00E+00	3.31E-04	3.48E-04	2.86E+00
La-140	7.94E-02	3.13E-02	8.05E-03	0.00E+00	0.00E+00	0.00E+00	3.68E+02
La-142	4.14E-03	1.52E-03	3.64E-04	0.00E+00	0.00E+00	0.00E+00	2.58E+02
Ce-141	2.96E-01	1.81E-01	2.13E-02	0.00E+00	5.57E-02	0.00E+00	9.33E+01
Ce-143	5.57E-02	3.69E+01	4.21E-03	0.00E+00	1.08E-02	0.00E+00	2.16E+02
Ce-144	1.12E+01	4.59E+00	6.28E-01	0.00E+00	1.85E+00	0.00E+00	6.43E+02
Pr-143	3.06E-01	1.14E-01	1.52E-02	0.00E+00	4.25E-02	0.00E+00	1.61E+02
Pr-144	1.03E-03	3.99E-04	5.19E-05	0.00E+00	1.44E-04	0.00E+00	1.85E+01
Nd-147	2.08E-01	2.14E-01	1.31E-02	0.00E+00	8.24E-02	0.00E+00	1.35E+02
W-187	3.40E+00	2.36E+00	8.16E-01	0.00E+00	0.00E+00	0.00E+00	1.39E+02
Np-239	4.18E-02	3.74E-03	2.11E-03	0.00E+00	7.45E-03	0.00E+00	1.08E+02

Notes:

1) Units are mrem/hr per μCi/ml.

Table 3-5
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 3-5 (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 3-6
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 3-6 (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 3-7
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 3-7 (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 3-8

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

Table 3-8 (cont.) Bioaccumulation Factors (BF_i) to be Used in the Absence of Site-Specific Data		
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
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 in the ODCM Training and Reference Material.

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.

4. GASEOUS EFFLUENTS

4.1. Gaseous Effluents – General Information
This section reviews the offsite radiological limits applicable to the nuclear power stations and presents in detail the equations and procedures used to assess compliance with these limits. This calculational approach uses the methodology of NUREG-0133 (Reference 14), and incorporates certain simplifications such as the use of average meteorology.

4.1.1. Pre-calculated atmospheric transport parameters are based on historical average atmospheric conditions. These historical meteorological conditions have resulted in the dispersion parameters shown in Table 4-1, Table 4-2 and Table 4-8.

4.1.2. The equations and parameters of this section are for use in calculating offsite radiation doses during routine operating conditions. They are not for use in calculating doses due to non-routine releases (e.g., accident releases).

4.1.3. An overview of the required compliance is given in Table 1-1. The dose components are itemized and referenced, and an indication of their regulatory application is noted. Additionally, the locations of dose receivers for each dose component are given in Table 1-2.

4.1.4. Airborne Release Point Classifications

1. The pattern of dispersion of airborne releases is dependent on the height of the release point relative to adjacent structures. Each release point is classified as one of the following three height-dependent types:

   A. Stack (or Elevated) Release Point (denoted by the letter S or subscript s)

   B. Ground Level Release Point (denoted by the letter G or subscript g)

   C. Vent (or Mixed Mode) Release Point (denoted by the letter V or subscript v)

4.1.5. Operability and Use of Gaseous Effluent Treatment Systems

1. 10CFR50 Appendix I and ODCM Part I require that the ventilation exhaust treatment system and the waste gas holdup system be used when projected offsite doses in 31 days, due to gaseous effluent releases, from each reactor unit, exceed any of the following limits:

    A. 0.2 mrad to air from gamma radiation.

    B. 0.4 mrad to air from beta radiation.

    C. 0.3 mrem to any organ of a member of the public.

2. The station must project doses due to gaseous releases from the site at least once per 31 days. The calculational methods shown in sections 4.2.2 and 4.2.3 are used for this dose projection.

4.1.6. For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

4.2. Gaseous Effluents – Dose and Dose Rate Calculation Requirements

4.2.1. Instantaneous Dose Rates

4.2.1.1 Noble Gas: Total Body Dose Rate

1. ODCM Part I limits the total body dose rate due to noble gases in gaseous effluents released from a site to areas at and beyond the site boundary to less than or equal to 500 mrem/yr at all times.

2. The total body dose rate due to noble gases released in gaseous effluents is calculated by the following expression:

$$\dot{D}_{TB} = \sum_i K_i \left\{ (\chi/Q)_s^{\gamma} Q_{is} + (\chi/Q)_v^{\gamma} Q_{iv} + (\chi/Q)_g^{\gamma} Q_{ig} \right\} \qquad \textbf{(4-1)}$$

The summation is over noble gas radionuclides **i**.

Since Byron does not have an elevated release point, the Q_{is} term is not used.

$\dot{D}_{TB}$ Total Body Dose Rate [mrem/yr]

Dose rate to the total body due to gamma radiation from noble gas radionuclides released in gaseous effluents.

Q_{is}, Q_{iv}, Q_{ig} Release Rate [μCi/sec]

Measured release rate of radionuclide **i** from a stack, vent or ground level release point, respectively.

K_i Gamma Total Body Dose Conversion Factor [(mrem/yr)/(μCi/m^3)]

Gamma total body dose factor due to gamma emissions for noble gas radionuclide i. K values are taken from Table 4-28.

$(\chi/Q)_s$ Relative Concentration Factor [sec/m^3]

$(\chi/Q)_v$ Radioactivity concentration based on semi-infinite cloud methodology at a specified location per unit of radioactivity release rate for a stack, vent, or ground level release, respectively. See Table 4-1.

$(\chi/Q)_g$

3. To comply with this specification, the effluent radiation monitor has a setpoint corresponding to an offsite total body dose rate at or below the limit (see Part II Section 2.6). In addition, compliance is assessed by calculating offsite total body dose rate based on periodic samples obtained per station procedures.

4.2.1.2 Noble Gas: Skin Dose Rate

1. ODCM Part I limits the skin dose rate due to noble gases in gaseous effluents released from a site to areas at and beyond the site boundary to less than or equal to a dose rate of 3000 mrem/yr at all times. (See TRM 3.11.f)

2. The skin dose rate due to noble gases released in gaseous effluents is calculated by the following expression:

$$\dot{D}_{SK} = \sum_i \left\{ L_i \left[(\chi/Q)_s Q_{is} + (\chi/Q)_v Q_{iv} + (\chi/Q)_g Q_{ig} \right] + (1.11) M_i \left[(\chi/Q)^{\gamma}_s Q_{is} + (\chi/Q)^{\gamma}_v Q_{iv} + (\chi/Q)^{\gamma}_g Q_{ig} \right] \right\} \quad \textbf{(4-2)}$$

The summation is over noble gas radionuclides **i**.

$\dot{D}_{SK}$ Skin Dose Rate [mrem/yr]

Dose rate to skin due to beta and gamma radiation from noble gas radionuclides released in gaseous effluents.

L_i Skin Dose Conversion Factor [(mrem/yr)/(µCi/m^3)]

Skin dose factor due to gamma emissions for noble gas radionuclide **i**. L values are taken from Table 4-28

M_i Gamma Air Dose Conversion Factor [(mrad/yr)/(□Ci/m^3)]

3. Gamma air dose rate factor per unit of radioactivity release rate for radionuclide **i**. See Table 4-28 for Gamma Air Dose conversion factors (From Table B-1 of Regulatory Guide 1.109).

4. Since Byron does not have an elevated release point, the Q_{is} term is not used.

5. To comply with this specification, gaseous effluent radiation monitors have setpoints corresponding to an offsite skin dose rate at or below the limit (see Part II Section 2.6). In addition, compliance is assessed by calculating offsite skin dose rate based on periodic samples obtained per station procedures.

4.2.1.3 Non-Noble Gas Radionuclides: Organ Dose Rate

1. ODCM Part I limits the dose rate to any organ, due to radioactive materials in gaseous effluents released from a site to areas at and beyond the site boundary, to less than or equal to a dose rate of 1500 mrem/yr (See TRM 3.11.f)

2. Typically the child is considered to be the limiting receptor in calculating dose rate to organs due to inhalation of non-noble gas radionuclides in gaseous effluents.

3. The dose rate to any child organ due to inhalation is calculated by the following expression:

$$\dot{D}^{NNG}_{(Child)i(Inhal)j} = \sum_i R_{(Child)i(Inhal)j}\left\{(\chi/Q)_s Q_{is} + (\chi/Q)_v Q_{iv} + (\chi/Q)_g Q_{ig}\right\} \qquad \textbf{(4-3)}$$

The summation is over non-noble gas radionuclides **i**.

$\dot{D}^{NNG}_{(Child)i(Inhal)j}$ Inhalation Dose Rate [mrem/yr]

Dose rate to the child age group from radionuclide **i**, via the inhalation pathway to organ **j** due to non-noble gas radionuclides.

$R_{(Child)i(Inhal)j}$ Inhalation Dose Factor [(mrem/yr)/(μCi/m^3)]

Inhalation dose factor for child age group for radionuclide **i**, and organ **j**. Inhalation dose factors for non-noble gas radionuclides (child) are shown in Table 4-11

4. Since Byron does not have an elevated release point, the Q_{is} term is not used.

5. ODCM Part I requires the dose rate due to non-noble gas radioactive materials in airborne effluents be determined to be within the above limit in accordance with a sampling and analysis program specified in TRM Table T3.11.f-1.

6. The child organ dose rate due to inhalation is calculated in each sector at the location of the highest offsite χ/Q (see Table 4-1). The result for the sector with the highest organ inhalation dose rate is compared to the limit.

4.2.2. Time Averaged Dose from Noble Gas

4.2.2.1 Gamma Air Dose

1. ODCM and TRM limits the gamma air dose due to noble gas effluents released from each reactor unit to areas at and beyond the unrestricted area boundary to the following:

   A. Less than or equal to 5 mrad per calendar quarter.

   B. Less than or equal to 10 mrad per calendar year.

   The gamma air dose due to noble gases released in gaseous effluents is calculated by the following expression:

$$\mathbf{D_\gamma = (3.17E-8)\sum_i M_i \left\{ (\chi/Q)_s^\gamma A_{is} + (\chi/Q)_v^\gamma A_{iv} + (\chi/Q)_g^\gamma A_{ig} \right\}} \qquad \mathbf{(4\text{-}4)}$$

   The summation is over noble gas radionuclides **i**.

   $\mathbf{D_\gamma}$ Gamma Air Dose [mrad]

   Dose to air due to gamma radiation from noble gas radionuclides released in gaseous effluents.

   3.17E-8 Conversion Constant (seconds to years) ..... [yr/sec]

   $\mathbf{M_i}$ Gamma Air Dose Conversion Factor [(mrad/yr)/(μCi/m^3)]

Gamma air dose rate factor per unit of radioactivity release rate for radionuclide **i**. See Table 4-28 for Gamma Air Dose conversion factors (From Table B-1 of Regulatory Guide 1.109).

$(\chi/Q)^{\gamma}_{s}, (\chi/Q)^{\gamma}_{v}, (\chi/Q)^{\gamma}_{g}$ Gamma-χ/Q Factor [sec/m^3]

Radioactivity concentration based on finite cloud methodology at a specific location per unit of radioactivity release rate from a stack, vent or ground level release, respectively. See Table 4-3 for Gamma-χ/Q Factors.

$\mathbf{A_{is}, A_{iv}, A_{ig}}$ Cumulative Radionuclide Release [μCi]

Measured cumulative release of radionuclide **i** over the time period of interest from a stack, vent, or ground level release point, respectively.

Since Byron does not have an elevated release point, the A_{is} term is not used.

2. TRM 3.11.g requires determination of cumulative and projected gamma air dose contributions due to noble gases for the current calendar quarter and the current calendar year at least once per 31 days.

3. Gamma air dose is calculated for the sector with the highest offsite $(\chi/Q)^{\gamma}$ and is compared with the Part I limits on gamma air dose.

4. For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

4.2.2.2 Beta Air Dose

1. TRM Chapter 3.11 limits beta air dose due to noble gases in gaseous effluents released from each reactor unit to areas at and beyond the unrestricted area boundary to the following:

    A. Less than or equal to 10 mrad per calendar quarter.

    B. Less than or equal to 20 mrad per calendar year.

2. The beta air dose due to noble gases released in gaseous effluents is calculated by the following expression:

$$D_\beta = (3.17E-8)\sum_i \{N_i[(\chi/Q)_s A_{is} + (\chi/Q)_v A_{iv} + (\chi/Q)_g A_{ig}]\} \qquad \textbf{(4-5)}$$

The summation is over noble gas radionuclides **i**.

D_β Beta Dose [mrad]

Dose to air due to beta radiation from noble gas radionuclides released in gaseous effluents.

3.17E-8 Conversion Constant (seconds to years) [yr/sec]

N_i Beta Air Dose Conversion Factor [(mrad/yr)/(μCi/m^3)]

Beta air dose rate per unit of radioactivity concentration for radionuclide **i**. See Table 4-28 for Beta Air Dose conversion factors (From Table B-1 of Regulatory Guide 1.109).

$(\chi/Q)_s$ Relative Concentration Factor [sec/m^3]

$(\chi/Q)_v$

$(\chi/Q)_g$ Radioactivity concentration based on semi-infinite cloud methodology at a specified location per unit of radioactivity release rate for a stack, vent, or ground level release, respectively. See Table 4-1.

A_{is}, A_{iv}, A_{ig} Cumulative Radionuclide Release [μCi]

Measured cumulative release of radionuclide **i** over the time period of interest from a stack, vent, or ground level release point, respectively.

Since Byron does not have an elevated release point, the A_{is} term is not used.

3. TRM 3.11.g requires determination of cumulative and projected beta air dose contributions due to noble gases for the current calendar quarter and the current calendar year at least once per 31 days.

4. Beta air dose is calculated for the sector with the highest offsite (χ**/Q)** and is compared with the ODCM Part I limit on beta air dose.

5. For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

4.2.2.3 Whole Body Dose

1. The total body dose, to any receiver is due, in part, to gamma radiation emitted from radioactivity in airborne effluents. This component is added to others to demonstrate compliance to the requirements of 40CFR190 and 10CFR20.

2. The total body dose component due to gamma radiation from noble gases released in gaseous effluents is calculated by the following expression:

$$D_{TB} = (3.17E-8)\sum_i K_i \left\{ (\chi/Q)_s^{\gamma} A_{is} + (\chi/Q)_v^{\gamma} A_{iv} + (\chi/Q)_g^{\gamma} A_{ig} \right\} \qquad \textbf{(4-6)}$$

The summation is over noble gas radionuclides **i**.

D_{TB} Total Body Dose [mrem]

Dose to the total body due to gamma radiation from noble gas radionuclides released in gaseous effluents.

3.17E-8 Conversion Constant (seconds to years) [yr/sec]

K_i Gamma Total Body Dose Conversion Factor [(mrem/yr)/(μCi/m^3)]

Gamma total body dose factor due to gamma emissions for noble gas radionuclide **i** released from a stack, vent or ground level release point, respectively. See Table 4-28 for Gamma total body dose conversion factors. (From Table B-1 of Regulatory Guide 1.109)

A_{is}, A_{iv}, A_{ig} Cumulative Radionuclide Release [μCi]

Measured cumulative release of radionuclide **i** over the time period of interest from a stack, vent, or ground level release point, respectively.

3. The total body dose is also calculated for the 40CFR190 and 10CFR20 compliance assessments. In some cases, the total body dose may be required in 10CFR50 Appendix I assessments (See Part II Table 1-1).

4.2.2.4 Skin Dose

1. There is no regulatory requirement to evaluate skin dose. However, this component is evaluated for reference as there is skin dose design objective contained in 10CFR50 Appendix I. Note that in the unlikely event that beta air dose guideline is exceeded, then the skin dose will require evaluation.

2. The part of skin dose due to noble gases released in gaseous effluents is calculated by the following expression:

$$D_{SK} = (3.17E-8)\sum_i \left\{ L_i \left[(\chi/Q)_s A_{is} + (\chi/Q)_v A_{iv} + (\chi/Q)_g A_{ig} \right] + (1.11) M_i \left[(\chi/Q)^{\gamma}_s A_{is} + (\chi/Q)^{\gamma}_v A_{iv} + (\chi/Q)^{\gamma}_g A_{ig} \right] \right\} \quad \textbf{(4-7)}$$

The summation is over noble gas radionuclides **i**.

D_{SK} Skin Dose [mrem]

Dose to the skin due to beta and gamma radiation from noble gas radionuclides released in gaseous effluents.

L_i Beta Skin Dose Conversion Factor [(mrem/yr)/(μCi/m^3)]

Beta skin dose rate per unit of radioactivity concentration for radionuclide **i**. Taken from Table 4-28.

1.11 Conversion Constant (rads in air to rem in tissue) [mrem/mrad]

All other terms have been previously defined.

The skin dose is calculated for reference only.

4.2.3. Time Averaged Dose from Non-Noble Gas Radionuclides

1. TRM 3.11 provides the following limits, based on 10CFR50 Appendix I, on the dose to a member of the public from specified non-noble gas radionuclides in gaseous effluents released from each reactor unit to areas at and beyond the unrestricted area boundary:

    A. Less than or equal to 7.5 mrem to any organ during any calendar quarter

    B. Less than or equal to 15 mrem to any organ during any calendar year

2. The individual dose components are also required as part of the 40CFR190 assessments and combined as part of the 10CFR20 assessment (Part II Table 1-1). The dose due to radionuclides deposited on the ground is considered to be a component of the deep dose equivalent for 10CFR20 compliance and an organ (and total body) dose component for 10CFR50 Appendix I and 40CFR190 compliance.

3. The dose is calculated for releases in the time period under consideration.

4. Specifically, the dose is calculated as follows:

$$D_{aj}^{NNG} = (3.17E-8)\sum_{p}\sum_{i}\left[W_s R_{aipj} A_{is} + W_v R_{aipj} A_{iv} + W_g R_{aipj} A_{ig}\right] \qquad \textbf{(4-8)}$$

The summation is over pathways **p** and non-noble gas radionuclides **i**.

D_{aj}^{NNG} Dose Due to Non-Noble Gas Radionuclides [mrem]

Dose due to non-noble gases (radioiodines, tritium and particulates) to age group **a**, and to organ **j**.

3.17E-8 Conversion Constant (seconds to years) [yr/sec]

W_s, W_v, W_g Relative Concentration Factor

Radioactive concentration at a specific location per unit of radioactivity release rate or concentration for stack, vent or ground level release, respectively.

W_s, W_v, or W_g = $(\chi/Q)_s$, $(\chi/Q)_v$ or $(\chi/Q)_g$ for immersion, inhalation and all tritium pathways.

W_s, W_v, or W_g = $(D/Q)_s$, $(D/Q)_v$ or $(D/Q)_g$ for ground plain and all ingestion pathways.

$(\chi/Q)_s$, $(\chi/Q)_v$, $(\chi/Q)_g$ Relative Concentration Factor [sec/m^3]

Radioactivity concentration based on semi-infinite cloud model at a specified location per unit of radioactivity release rate for a stack, vent, or ground level release, respectively. See Table 4-1 through Table 4-6.

$(D/Q)_s$, $(D/Q)_v$, $(D/Q)_g$ Relative Deposition Factor [$1/m^2$]

Radioactivity concentration at a specified location per unit of radioactivity release concentration for a stack, vent, or ground level release, respectively. See Table 4-1 through Table 4-6.

R_{aipj} Site-Specific Dose Factor [(m^2 mrem/yr)/(μCi/sec)]
or [(mrem/yr)/(μCi/m^3)]

Site-specific dose factor for age group **a**, nuclide **i**, pathway **p** and organ **j**. Pathways included are ground plane exposure, inhalation, vegetation ingestion, milk ingestion and meat ingestion. Values of R_{aipj} are provided in Table 4-7 and Table 4-9 through Table 4-26.

A_{is}, A_{iv}, A_{ig} Cumulative Radionuclide Release [μCi]

Measured cumulative release of radionuclide **i** over the time period of interest from a stack, vent, or ground level release point, respectively.

Since Byron does not have an elevated release point, the stack terms for **A_{is}, W_s, $(\chi/Q)_s$**, and **$(D/Q)_s$** are not used.

5. TRM 3.11.h requires cumulative and projected dose contributions for the current calendar quarter and the current calendar year for the specified non-noble gas radionuclides in airborne effluents to be determined at least once per 31 days.

6. To comply with this specification, Byron Station obtains and analyzes samples in accordance with the radioactive gaseous waste or gaseous effluent sampling and analysis program (TRM 3.11.f-1). In accordance with NUREG 0133 (Reference 14), dose due to non-noble gases is assessed at the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the maximum potential exposure. The inhalation and ground plane exposure pathways are considered to exist at all locations. The food ingestion pathways at a specific location are considered based on their existence as determined by land use census. The values used for (χ/Q) and (D/Q) are shown in Table 4-1 through Table 4-6 and correspond to the applicable pathway location.

7. For a release attributable to a processing or effluent system shared by more than one reactor, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

8. The dose evaluated is also included as part of the 10CFR20 and 40CFR190 assessment (See Part II Section 5).

4.2.3.1 Ground Plane

1. The site-specific dose factor for ground deposition of radioactivity is considered to be a total body dose component and is calculated by the following expression:

$$R_{ai(GP)j}[D/Q] = K'K''(0.7)DFG_i\left[\frac{1-e^{-\lambda_i t_b}}{\lambda_i}\right] \qquad \textbf{(4-9)}$$

$R_{ai(GP)j}[D/Q]$ Ground Plane Deposition Dose Factor [(m^2 mrem/yr)/(μCi/sec)]

Site-specific ground plane dose factor for age group **a**, nuclide **i** and organ **j**. The ground plane dose is calculated using (D/Q).

K' Conversion Constant (1E6 pCi per μCi) [pCi/μCi]

K'' Conversion Constant (8760 hr/yr) [hr/yr]

0.7 Shielding Factor; a factor that accounts for dimensionless shielding due to occupancy of structures.

$\mathbf{DFG_i}$ Ground Plane Dose Conversion Factor [(mrem/hr)/(pCi/m^2)]

Dose rate to the total body per unit of surface radioactivity concentration due to standing on ground uniformly contaminated with radionuclide **i**. Ground Plane Dose Conversion Factors are shown in Table 4-8.

Note that ground plane dose conversion factors are only given for the total body and no age group. Doses to other organs are assumed to be equal to the total body dose. All age groups are assumed to receive the same dose.

λ_i Radiological Decay Constant [hr^{-1}]

Radiological decay constant for radionuclide **i**.

$\mathbf{t_b}$ Time Period of Ground Deposition [hr]

Time period during which the radioactivity on the ground is assumed to have been deposited (see Part II Table 1-3).

2. The ground plane exposure pathway is considered to exist at all locations.

4.2.3.2 Inhalation

1. The site-specific dose factor for inhalation is calculated by the following expression:

$$R_{ai(Inhal)j}[\chi/Q] = K'BR_aDFA_{aij} \qquad \textbf{(4-10)}$$

$R_{ai(Inhal)j}[\chi/Q]$ Inhalation Pathway Dose Factor [(mrem/yr)/(μCi/m^3)]

Site-specific inhalation dose factor for age group **a**, nuclide **i** and organ **j**. The inhalation dose is calculated using (χ/Q).

K' Conversion Constant (1E6 pCi per μCi) [pCi/μCi]

BR_a Individual Air Inhalation Rate [m^3/yr]

The air intake rate for individuals in age group **a**. See Table E-5 of Regulatory Guide 1.109.

DFA_{aij} Inhalation Dose Conversion Factor [mrem/pCi]

Dose commitment to an individual in age group **a** to organ **j** per unit of activity of radionuclide **i** inhaled. Taken from Tables E-7 through E-10 of Regulatory Guide 1.109. The value for H-3 is taken from NUREG 4013 (Reference 107).

2. The inhalation exposure pathway is considered to exist at all locations.

4.2.3.3 Ingestion: Vegetation

1. Food ingestion pathway doses are calculated at locations indicated by the land use census survey. If no real pathway exists within 5 miles of the station, the cow-milk pathway is assumed to be located at 5 miles. Food pathway calculations are not made for sectors in which the offsite regions near the station are over bodies of water.

2. The dose factor for consumption of vegetables is calculated by the following expression:

$$R_{ai(Veg)j}[D/Q] = K'\left[\frac{(r)}{Y_v(\lambda_i + \lambda_w)}\right]\left(DFL_{aij}\right)\left[U_a^L f_L e^{-\lambda_i t_L} + U_a^S f_g e^{-\lambda_i t_h}\right] \quad \textbf{(4-11)}$$

$R_{ai(Veg)j}[D/Q]$ Vegetation Ingestion Pathway Dose Factor
[(m^2 mrem/yr)/(μCi/sec)]

Site-specific vegetation ingestion dose factor for age group **a**, nuclide **i** and organ **j**. With the exception of H-3 and C-14 the vegetation dose is calculated using (D/Q).

K' Conversion Constant (1E6 pCi per μCi) [pCi/μCi]

r Vegetation Retention Factor [dimensionless]

Y_v Agricultural Productivity Yield [kg/ m^2]

λ_i Radiological Decay Constant [1/sec]

Radiological decay constant for radionuclide **i**

λ_w Weathering Decay Constant [1/sec]

Removal constant for physical loss of activity by weathering. See ODCM Part II Table 1-3.

DFL_{aij} Ingestion Dose Conversion Factor [mrem/pCi]

Ingestion dose conversion factor for age group **a**, nuclide **i** and organ **j**. Converts pCi ingested to mrem. Taken from Tables E-11 though E-14 of Regulatory Guide 1.109. The value for H-3 is taken from NUREG 4013 (Reference 107).

U_a^L Consumption Rate for Fresh Leafy Vegetation [kg/yr]

Consumption rate for fresh leafy vegetation for age group **a**.

U_a^S Consumption Rate for Stored Vegetation [kg/yr]

Consumption rate for stored vegetation for age group **a**.

f_L Local Leafy Vegetation Fraction [dimensionless]

Fraction of the annual intake of fresh leafy vegetation that is grown locally.

f_g Local Stored Vegetation Fraction [dimensionless]

Fraction of the annual intake of stored vegetation that is grown locally.

tL Environmental Transport Time - Fresh Vegetation [sec]

Average time between harvest of leafy vegetation and its consumption.

th Environmental Transport Time - Stored Vegetation [sec]

Average time between harvest of stored vegetation and its consumption.

3. The tritium dose from the vegetation pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the tritium vegetation pathway is:

$$R_{a(H-3)(veg)j}[\chi/Q] = K'K'''(U_a^L f_{L+} U_a^S f_g)DFL_{a(H-3)j}[0.75(0.5/H)] \quad \textbf{(4-12)}$$

$R_{a(H-3)(veg)j}[\chi/Q]$ Tritium Vegetation Ingestion Pathway Dose

Factor[(mrem/yr)/(μCi/m3)]

Site-specific tritium vegetation ingestion dose factor for age group **a** and organ **j**. The tritium vegetation dose is calculated using $[\chi/Q]$

K''' Conversion Constant (1E3 gm per Kg) [gm/Kg]

H Absolute Atmospheric Humidity [gm/m3]

0.75 Water Fraction [dimensionless]

The fraction of total vegetation that is water.

0.5 Specific Activity Ratio [dimensionless]

4. The Carbon-14 dose from the vegetation pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the Carbon-14 vegetation pathway is:

$$R_i^V \left[\chi / Q\right] = K'K'''\left(U_a^L f_L + U_a^S f_g\right)\left(DFL_i\right)_a \, p \left[0.11 / 0.16\right] \quad \textbf{(4-12a)}$$

K`	a constant of unit conversion, 1 E 6 pCi/uCi
U_a^L	gm/kg Leafy veg consumption rate adult (kg/yr)
U_a^S	Fraction of annual intake of fresh, leafy vegetation grown locally Stored veg consumption rate adult (kg/yr)
f_g	Fraction of annual intake of stored vegetation grown locally
$(DFL_i)_a$	Ingestion Dose Factors
p	The fractional equilibrium ratio (4400 hrs/8760 hrs). The ratio of the total annual release time (for C-14) atmospheric releases to the total annual time during which photosynthesis occurs (taken to be 4400 hrs), under the condition that the value of p should never exceed unity. For continuous C-14 releases, p is taken to be unity.
0.11	The fraction of total plant mass that is natural carbon (dimensionless)
0.16	The concentration of natural carbon in the atmosphere (gm/m^3)

4.2.3.4 Ingestion Milk

1. The dose factor for consumption of milk is calculated by the following expressions:

$$R_{ai(Milk)j}[D/Q] = K' \frac{Q_F(U_{am})}{\lambda_i + \lambda_w} F_m(r)(DFL_{aij}) \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f} \quad \textbf{(4-13)}$$

$R_{ai(Milk)j}[D/Q]$ Milk Ingestion Pathway Dose Factor
[(m^2 mrem/yr)/(μCi/sec)]

Site-specific milk ingestion dose factor for age group **a**, nuclide **i** and organ **j**. With the exception of H-3 and C-14 the milk dose factor is calculated using (D/Q).

K' Conversion Constant (1E6 pCi per μCi) [pCi/μCi]

Q_F Feed Consumption [Kg/da]

Amount of feed consumed by milk animal each day. See ODCM Part II Table 1-3.

U_{am} Milk Consumption Rate [l/yr]

Milk consumption rate for age group **a**.

F_m Stable Element Transfer Coefficient for Milk [da/l]

Fraction of animal's daily intake of a particular chemical element that appears in each liter of milk (pCi/l in milk per pCi/da ingested by animal). See ODCM Part II Table 1-4.

f_p Pasture Time Fraction [dimensionless]

Fraction of year that animal is on pasture.

f_s Pasture Grass Fraction [dimensionless]

Fraction of animal feed that is pasture grass while animal is on pasture.

Y_P Agricultural Productivity Yield - Pasture Grass [kg/m^2]

The agricultural productivity by unit area of pasture feed grass.

Y_S Agricultural Productivity Yield - Stored Feed [kg/m^2]

The agricultural productivity by unit area of stored feed.

t_h Environmental Transport Time - Stored Feed [sec]

Average time between harvest to consumption of stored feed by milk animal.

t_f Environmental Transport Time - Pasture to Consumption [sec]

Average time from pasture, to milk animal, to milk, to consumption.

All other terms have been previously defined.

The tritium dose from the milk pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the tritium milk pathway is:

$$R_{a(H-3)(Milk)j}[\chi/Q] = K'K'''F_m\,Q_F U_{am} DFL_{a(H-3)j}[0.75(0.5/H)] \qquad \textbf{(4-14)}$$

$R_{a(H-3)(milk)j}[\chi/Q]$ Tritium Milk Ingestion Pathway Dose Factor

[(mrem/yr)/(μCi/m3)]

Site-specific tritium milk ingestion dose factor for age group **a** and organ **j**.

The tritium milk dose is calculated using $[\chi/Q]$

K''' Conversion Constant (1E3 gm per Kg) [gm/Kg]

H Absolute Atmospheric Humidity [gm/m3]

0.75 Water Fraction [dimensionless]

The fraction of total feed that is water.

0.5 Specific Activity Ratio [dimensionless]

2. The Carbon-14 dose from the milk pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the Carbon-14 milk pathway is:

$$R_i^C\left[\chi / Q\right] = K'K'''\ p\ F_m\ Q_F\ U_{ap}\left(DFL_{\ i}\right)_a\left[0.11 / 0.16\right] \quad \textbf{(4-14a)}$$

K` a unit of conversion, 1.0E6 pCi/uCi

K'" gm/kg

p The fractional equilibrium ratio (4400 hrs/8760 hrs). The ratio of the total annual release time (for C-14) atmospheric releases to the total annual time during which photosynthesis occurs (taken to be 4400 hrs), under the condition that the value of p should never exceed unity. For continuous C-14 releases, p is taken to be unity.

F_m Stable Element Transfer Data

Q_F Milk cow feed consumption rate (kg/day wet)

U_{ap} Cow milk consumption rate adult (l/yr)

$(DFL_i)_a$ Ingestion Dose Factors

0.11 The fraction of total plant mass that is natural carbon (dimensionless)

0.16 The concentration of natural carbon in the atmosphere (gm/m^3)

4.2.3.5 Ingestion: Meat

1. The dose factor for consumption of meat is calculated by the following expression:

$$\mathbf{R_{ai(Meat)j}[D/Q] = K'\frac{Q_F(U_{af})}{\lambda_i+\lambda_w}F_f(r)(DFL_{aij})\left[\frac{f_p f_s}{Y_p}+\frac{(1-f_p f_s)e^{-\lambda_i t_h}}{Y_s}\right]e^{-\lambda_i t_f}} \quad \textbf{(4-15)}$$

$\mathbf{R_{ai(Meat)j}[D/Q]}$ Meat Ingestion Pathway Dose Factor [(m^2 mrem/yr)/(μCi/sec)]

Site-specific meat ingestion dose factor for age group **a**, nuclide **i** and organ **j**. With the exception of H-3 and C-14 the meat dose factor is calculated using (D/Q).

U_{af} Meat Consumption Rate [kg/yr]

Meat consumption rate for age group **a**.

F_f Stable Element Transfer Coefficient for Meat [da/Kg]

Fraction of animal's daily intake of a particular chemical element that appears in each Kg of meat (pCi/Kg in meat per pCi/da ingested by animal). See ODCM Part II Table 1-4.

t_h Environmental Transport Time - Stored Feed [sec]

Average time between harvest to consumption of stored feed by meat animal.

tf Environmental Transport Time - Pasture to Consumption [sec]

Average time from pasture, to meat animal, to meat, to consumption.

All other terms have been previously defined.

The tritium dose from the meat pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the tritium meat pathway is:

$$R_{a(H-3)(Meat)j}\left[\chi/Q\right] = K'K''' F_f Q_F U_{af} \left(DFL\right)_{a(H-3)j} \left[0.75\left(0.5/H\right)\right] \quad \textbf{(4-16)}$$

$R_{a(H-3)(Meat)j}\left[\chi/Q\right]$ Tritium Meat Ingestion Pathway Dose Factor (mrem/yr)/(µci/m3)]

Site-specific tritium meat ingestion dose factor for age group a and organ j. The tritium meat dose is calculated using χ/Q.

K''' Conversion Constant (1E3 gm per Kg) [gm/Kg]
H Absolute Atmospheric Humidity [gm/m3]
0.75 Water Fraction [dimensionless]

The fraction of total feed that is water.

0.5 Specific Activity Ratio [dimensionless]

All other terms have been previously defined.

2. The Carbon-14 dose from the meat pathway must be considered separately as the transport mechanism is based on airborne concentration rather than ground deposition. The dose factor for the Carbon-14 meat pathway is:

$$R_i^M \left[\chi / Q\right] = K'K''' \; p \; F_f \; Q_F \; U_{ap} \left(DFL_i\right)_a \; \left[0.11/0.16\right] \quad \textbf{(4-16a)}$$

K` a unit of conversion, 1.0E6 pCi/uCi

K''' gm/kg

p The fractional equilibrium ratio (4400 hrs/8760 hrs). The ratio of the total annual release time (for C-14) atmospheric releases to the total annual time during which photosynthesis occurs (taken to be 4400 hrs), under the condition that the value of p should never exceed unity. For continuous C-14 releases, p is taken to be unity.

F_f Days/kg for each stable element

Q_F Milk cow feed consumption rate (kg/day wet)

U_{ap} Meat consumption rate adult (kg/yr)

$(DFL_i)_a$ Ingestion Dose Factors

0.11 the fraction of total plant mass that is natural carbon (dimensionless)

0.16 the concentration of natural carbon in the atmosphere (gm/m^3)

Table 4-1
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	1875.	1.988E-07	1875.	1.983E-09	1875.	8.676E-07	4.671E-09	
NNE	1829.	1.677E-07	1829.	1.927E-09	1829.	7.531E-07	4.271E-09	
NE	1585.	1.530E-07	1585.	1.821E-09	1585.	7.876E-07	4.388E-09	
ENE	1234.	1.353E-07	1234.	1.764E-09	1234.	8.808E-07	5.036E-09	
E	1227.	1.688E-07	1227.	2.335E-09	1227.	1.143E-06	6.226E-09	
ESE	991.	2.519E-07	991.	3.540E-09	991.	1.692E-06	9.896E-09	
SE	1006.	3.020E-07	1006.	3.578E-09	1006.	2.480E-06	1.118E-08	
SSE	800.	4.497E-07	800.	3.761E-09	800.	4.152E-06	1.420E-08	
S	945.	2.249E-07	945.	2.792E-09	945.	1.946E-06	9.364E-09	
SSW	975.	1.476E-07	975.	1.970E-09	975.	1.305E-06	6.672E-09	
SW	1067.	1.148E-07	1067.	1.786E-09	1067.	9.279E-07	5.316E-09	
WSW	1212.	1.199E-07	1212.	1.903E-09	1212.	7.646E-07	5.002E-09	
W	1189.	1.758E-07	1189.	1.870E-09	1189.	9.348E-07	5.330E-09	
WNW	1227.	1.205E-07	1227.	1.292E-09	1227.	6.543E-07	3.745E-09	
NW	1128.	1.686E-07	1128.	1.719E-09	1128.	8.807E-07	4.984E-09	
NNW	1044.	3.047E-07	1044.	3.223E-09	1044.	1.432E-06	8.871E-09	

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Note: Based on “Irrigation from the Rock River” letter from G.P. Lahti (Sargent and Lundy) to J.C. Golden (NSEP), June 4, 1990 and the formulas in Reg. Guide 1.109.

χ/Q is used for beta skin, and inhalation dose pathways. See Sections 4.2.1, 4.2.2 and 0.

D/Q is used for produce and leafy vegetable pathways. See Section 4.2.3.

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 the highest χ/Q or D/Q at or beyond the unrestricted area boundary (UAB).

Table 4-2
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	777.	6.357E-07	777.	7.004E-09	777.	3.290E-06	2.036E-08
NNE	538.	8.778E-07	538.	1.046E-08	538.	5.086E-06	3.193E-08
NE	528.	6.803E-07	528.	7.792E-09	528.	4.371E-06	2.646E-08
ENE	474.	5.341E-07	474.	5.947E-09	474.	4.014E-06	2.346E-08
E	468.	6.698E-07	468.	7.930E-09	468.	5.359E-06	2.930E-08
ESE	480.	7.377E-07	480.	8.963E-09	480.	5.434E-06	3.144E-08
SE	427.	1.126E-06	427.	1.063E-08	427.	1.024E-05	4.352E-08
SSE	410.	1.349E-06	410.	8.744E-09	410.	1.305E-05	4.044E-08
S	295.	1.441E-06	295.	1.171E-08	295.	1.391E-05	5.707E-08
SSW	299.	9.382E-07	299.	8.293E-09	299.	9.376E-06	4.197E-08
SW	451.	3.949E-07	451.	5.065E-09	451.	3.666E-06	2.095E-08
WSW	386.	6.098E-07	386.	7.425E-09	386.	4.699E-06	3.088E-08
W	379.	1.041E-06	379.	8.116E-09	379.	6.009E-06	3.275E-08
WNW	385.	7.454E-07	385.	6.081E-09	385.	4.382E-06	2.370E-08
NW	445.	7.394E-07	445.	6.117E-09	445.	4.068E-06	2.198E-08
NNW	658.	6.123E-07	658.	6.177E-09	658.	2.980E-06	1.874E-08

Byron Site Meteorological Data 1/78 - 12/87

Note: Based on “Irrigation from the Rock River” letter from G.P. Lahti (Sargent and Lundy) to J.C. Golden (NSEP), June 4, 1990 and the formulas in Reg. Guide 1.109.

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 the highest χ/Q or D/Q at or beyond the restricted area boundary (RAB).

Table 4-3
Maximum Offsite Gamma-χ/Q

Downwind Direction	Radius (meters)	Ground Gamma-χ/Q (sec/m**3)	Vent Gamma-χ/Q (sec/m**3)
N	1875	4.80E-07	1.46E-07
NNE	1829	4.16E-07	1.36E-07
NE	1585	4.34E-07	1.31E-07
ENE	1234	4.83E-07	1.27E-07
E	1227	6.10E-07	1.50E-07
ESE	991	8.73E-07	2.13E-07
SE	1006	1.24E-06	2.45E-07
SSE	800	1.83E-06	3.02E-07
S	945	9.68E-07	1.85E-07
SSW	975	6.69E-07	1.34E-07
SW	1067	4.84E-07	1.08E-07
WSW	1212	4.19E-07	1.11E-07
W	1189	5.07E-07	1.39E-07
WNW	1227	3.54E-07	9.70E-08
NW	1128	4.61E-07	1.29E-07
NNW	1044	7.43E-07	2.15E-07

Table 4-4
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	2.67	4300	3.70E-07	9.80E-10	6.30E-08	3.80E-10
NEAREST RESIDENCE	NNE	0.99	1600	1.50E-06	5.30E-09	8.30E-08	1.70E-09
NEAREST RESIDENCE	NE	1.18	1900	1.00E-06	3.40E-09	6.60E-08	1.10E-09
NEAREST RESIDENCE	ENE	1.30	2100	8.20E-07	2.20E-09	4.60E-08	7.30E-10
NEAREST RESIDENCE	E	1.30	2100	1.20E-06	2.80E-09	5.90E-08	9.40E-10
NEAREST RESIDENCE	ESE	1.43	2300	9.10E-07	2.10E-09	5.10E-08	7.10E-10
NEAREST RESIDENCE	SE	0.75	1200	3.60E-06	7.40E-09	6.90E-08	2.00E-09
NEAREST RESIDENCE	SSE	0.62	1000	3.80E-06	8.10E-09	5.40E-08	1.60E-09
NEAREST RESIDENCE	S	0.50	800	3.40E-06	1.20E-08	8.40E-08	2.40E-09
NEAREST RESIDENCE	SSW	0.62	1000	1.70E-06	6.80E-09	6.40E-08	1.90E-09
NEAREST RESIDENCE	SW	0.75	1200	7.80E-07	3.10E-09	3.50E-08	8.80E-10
NEAREST RESIDENCE	WSW	1.68	2700	3.30E-07	1.40E-09	5.40E-08	6.50E-10
NEAREST RESIDENCE	W	1.68	2700	5.50E-07	1.40E-09	5.20E-08	4.10E-10
NEAREST RESIDENCE	WNW	0.75	1200	1.70E-06	5.20E-09	4.60E-08	1.00E-09
NEAREST RESIDENCE	NW	0.99	1600	1.10E-06	3.30E-09	4.30E-08	7.30E-10
NEAREST RESIDENCE	NNW	1.30	2100	8.50E-07	2.90E-09	6.20E-08	7.90E-10

Table 4-5
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	1.50E-07	3.20E-10	4.20E-08	1.40E-10
COW MILK	NNE	4.97	8000	1.30E-07	3.10E-10	3.90E-08	1.60E-10
COW MILK	NE	1.86	3000	5.00E-07	1.50E-09	6.70E-08	6.20E-10
COW MILK	ENE	4.97	8000	1.10E-07	2.00E-10	2.90E-08	1.10E-10
COW MILK	E	4.97	8000	1.60E-07	2.70E-10	3.90E-08	1.40E-10
COW MILK	ESE	4.97	8000	1.40E-07	2.30E-10	3.50E-08	1.20E-10
COW MILK	SE	4.97	8000	2.00E-07	2.70E-10	3.80E-08	1.40E-10
COW MILK	SSE	4.97	8000	1.50E-07	2.20E-10	3.10E-08	1.20E-10
COW MILK	S	4.78	7700	9.10E-08	2.40E-10	2.90E-08	1.50E-10
COW MILK	SSW	4.97	8000	6.10E-08	1.80E-10	2.20E-08	1.20E-10
COW MILK	SW	4.97	8000	3.90E-08	1.10E-10	1.50E-08	7.10E-11
COW MILK	WSW	4.97	8000	6.30E-08	2.10E-10	2.50E-08	1.30E-10
COW MILK	W	2.49	4000	3.00E-07	7.20E-10	4.90E-08	2.60E-10
COW MILK	WNW	3.29	5300	1.70E-07	4.00E-10	3.40E-08	1.50E-10
COW MILK	NW	2.98	4800	2.10E-07	4.90E-10	3.70E-08	1.80E-10
COW MILK	NNW	4.97	8000	1.10E-07	2.70E-10	3.50E-08	1.20E-10

Table 4-6
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	2.98	4800	3.10E-07	8.10E-10	6.00E-08	3.20E-10
COW MEAT	NNE	1.49	2400	7.70E-07	2.60E-09	7.60E-08	9.90E-10
COW MEAT	NE	3.42	5500	2.00E-07	5.30E-10	5.20E-08	2.70E-10
COW MEAT	ENE	2.30	3700	3.40E-07	8.10E-10	4.30E-08	3.50E-10
COW MEAT	E	2.24	3600	5.00E-07	1.10E-09	5.80E-08	4.70E-10
COW MEAT	ESE	1.49	2400	8.50E-07	2.00E-09	5.10E-08	6.80E-10
COW MEAT	SE	1.68	2700	9.80E-07	1.80E-09	5.90E-08	6.90E-10
COW MEAT	SSE	3.17	5100	2.90E-07	4.90E-10	4.10E-08	2.40E-10
COW MEAT	S	0.56	900	2.80E-06	9.90E-09	7.70E-08	2.10E-09
COW MEAT	SSW	2.17	3500	2.10E-07	8.00E-10	4.00E-08	4.30E-10
COW MEAT	SW	3.17	5100	7.60E-08	2.50E-10	2.10E-08	1.50E-10
COW MEAT	WSW	1.68	2700	3.30E-07	1.40E-09	5.40E-08	6.50E-10
COW MEAT	W	1.68	2700	5.50E-07	1.40E-09	5.20E-08	4.10E-10
COW MEAT	WNW	3.29	5300	1.70E-07	4.00E-10	3.40E-08	1.50E-10
COW MEAT	NW	3.79	6100	1.50E-07	3.20E-10	3.30E-08	1.30E-10
COW MEAT	NNW	1.37	2200	7.90E-07	2.70E-09	6.20E-08	7.50E-10

Table 4-7
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
C-14	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+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 4-7 (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 4-8
External Dose Factors for Standing on Contaminated Ground
DFG_{ij} (mrem/hr per pCi/ m^2)

Element	Whole Body Dose Factor	Reference	Element	Whole Body 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

Table 4-8 (cont.)
External Dose Factors for Standing on Contaminated Ground
DFG_{ij} (mrem/hr per pCi/ m^2)

Element	Whole Body Dose Factor	Reference	Element	Whole Body Dose Factor	Reference
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
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

1 Value 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.

Table 4-8 (cont.)
External Dose Factors for Standing on Contaminated Ground
DFG_{ij} (mrem/hr per pCi/ m^2)

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 4-9
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
C-14	1.82E+04	3.41E+03	3.41E+03	3.41E+03	3.41E+03	3.41E+03	3.41E+03
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 4-9 (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 4-10
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
C-14	2.60E+04	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03
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 4-10 (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 4-11
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
C-14	3.59E+04	6.73E+03	6.73E+03	6.73E+03	6.73E+03	6.73E+03	6.73E+03
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 4-11 (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 4-12
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
C-14	2.65E+04	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03
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 4-12 (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 4-13
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
C-14	8.97E+05	1.79E+05	1.79E+05	1.79E+05	1.79E+05	1.79E+05	1.79E+05
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 4-13 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-14
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
C-14	1.45E+06	2.91E+05	2.91E+05	2.91E+05	2.91E+05	2.91E+05	2.91E+05
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 4-14 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-15
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
C-14	3.50E+06	7.01E+05	7.01E+05	7.01E+05	7.01E+05	7.01E+05	7.01E+05
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 4-15 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.
3) The infant age group is assumed to receive no dose through the vegetation ingestion pathway therefore no dose factors are supplied.

Table 4-16
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
C-14	3.63E+05	7.26E+04	7.26E+04	7.26E+04	7.26E+04	7.26E+04	7.26E+04
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 4-16 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-17
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
C-14	6.70E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05
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 4-17 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-18
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
C-14	1.65E+06	3.29E+05	3.29E+05	3.29E+05	3.29E+05	3.29E+05	3.29E+05
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 4-18 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-19
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
C-14	3.23E+06	6.89E+05	6.89E+05	6.89E+05	6.89E+05	6.89E+05	6.89E+05
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 4-19 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-20
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
C-14	3.63E+05	7.26E+04	7.26E+04	7.26E+04	7.26E+04	7.26E+04	7.26E+04
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 4-20 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-21
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
C-14	6.70E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05
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 4-21 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-22
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
C-14	1.65E+06	3.29E+05	3.29E+05	3.29E+05	3.29E+05	3.29E+05	3.29E+05
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 4-22 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-23
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
C-14	3.23E+06	6.89E+05	6.89E+05	6.89E+05	6.89E+05	6.89E+05	6.89E+05
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 4-23 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-24
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
C-14	3.33E+05	6.66E+04	6.66E+04	6.66E+04	6.66E+04	6.66E+04	6.66E+04
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 4-24 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-25
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
C-14	2.81E+05	5.62E+04	5.62E+04	5.62E+04	5.62E+04	5.62E+04	5.62E+04
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 4-25 (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.
2) For H-3 and C-14, the units are mrem/yr per $\mu Ci/m^3$.

Table 4-26
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
C-14	5.29E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05
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 4-26 (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.
2) For H-3 and C-14, 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.

Table 4-27
Byron Station Characteristics

LOCATION: 3.7 miles SSW of Byron, 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 = 13.00 ms^{-1}[a]

Characteristics of Ground Level Point

1) Release Height = 0 m
2) Building Factor (D) = 60.6 m[a]

Meteorological Data

A 250 ft Tower is Located 1036 m SW of vent stack release point

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Tower Data Used in Calculations

Release Point	Wind Speed and Direction	Differential Temperature
Elevated	(NA)	(NA)
Vent	250 ft	250-30 ft
Ground	30 ft	250-30 ft

[a] Used in calculating the meteorological and dose factors in Table 4-1 and Table 4-4.

Table 4-28

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 US NRC Regulatory Guide 1.109

5. TOTAL DOSE

5.1. Total Dose Calculation Requirements

5.1.1. Total Effective Dose Equivalent Limits; 10CFR20 and 40CFR190

1. The Byron Station is required to determine the total dose to a member of the public due to all uranium fuel cycle sources in order to assess compliance with 40CFR190 as part of demonstrating compliance with 10CFR20.

2. The total dose for the uranium fuel cycle is the sum of doses due to radioactivity in airborne and liquid effluents and the doses due to direct radiation from contained sources at the nuclear power station. When evaluation of total dose is required for a station, the following contributions are summed:

    A. Doses due to airborne and liquid effluents from the station.

    B. Doses due to liquid effluents from nuclear power stations upstream.

    C. Doses due to any onsite radioactive waste storage facilities, if applicable.

    D. Doses due to ISFSI

3. 10CFR20 requires compliance to dose limits expressed as "Total Effective Dose Equivalent" (TEDE). Although annual dose limits in 10CFR20 are now expressed in terms of TEDEs, 40CFR190 limits remain stated as organ dose. The NRC continues to require 10CFR50 Appendix I and 40CFR190 doses to be reported in terms of organ dose and not TEDE. Due to the fact that organ dose limits set forth in 40CFR190 are substantially lower than those of 10CFR20 (25 mrem/yr vs. 100 mrem/yr), the NRC has stated that demonstration of compliance with the dose limits in 40CFR190 will be deemed as demonstration of compliance with the dose limits of 10CFR20 for most facilities (Reference 104). In addition to compliance with 40CFR190, it may be necessary for a nuclear power plant to address dose from on-site activity by members of the public.

5.1.2. ISFSI

1. 10CFR72.104 dose limits are the same as those specified by 40CFR190.

2. ISFSI dose contribution is in the form of direct radiation as no liquid or gas releases are expected to occur. The 10CFR72.212 report prepared in accordance with ISFSI requirements assumes a certain array of casks exists on the pad. The dose contribution from this array of casks in combination with historical uranium fuel cycle operations prior to ISFSI operations was analyzed to be within the 40CFR190 and 10CFR72.104 limits, and is documented in Holtec Report No. HI-2146048, Dose Versus Distance from a HI-STORM 100S version B containing the MPC-32 for Byron/Braidwood.

3. If the dose limits of 40CFR190 or 10CFR72.104 are exceeded, a special report to the NRC as well as an appropriate request for exemption/variance is required to be submitted to the NRC.

4. The requirement that the dose limits of 10CFR72.104 apply to “any real individual” is controlled for ISFSI activities in the ISFSI 72.212 report. Therefore, for the purposes of analyzing dose from the ISFSI, the member of the public as defined in 40CFR190 is the same as the “real individual” identified in the 72.212 report.

5.1.3. Total Dose Calculation Methodology

1. In addition to the total body, skin and single organ dose assessments previously described, an additional assessment is required. The additional assessment addresses radiation dose due to radioactivity contained within the nuclear power station and its structures.

2. Pressurized water reactors have the potential to affect off-site doses from contained sources of radioactivity, primarily due to gamma rays associated with radioactive material contained in onsite radwaste and radioactive material storage facilities.

5.2. Onsite Radwaste and Rad Material Storage Facilities

1. A 10CFR50.59 analysis is required for radwaste storage facilities.

5.2.1. Process Waste Storage Facilities

A. Interim Radwaste Storage Facility (IRSF) structure

B. Concrete vaults containing radwaste liners

5.2.2. DAW Storage Facilities

1. Dry Active Waste (DAW) facilities (may include Butler buildings/warehouses)

2. Seavans or other temporary warehouses

5.2.3. Replaced Steam Generator Storage Facilities

5.2.4. ISFSI Facilities

1. Independent spent fuel storage installation facilities.

5.3. Methodology

1. The external total body dose is comprised of the following parts:

   A. Total body dose due to noble gas radionuclides in gaseous effluents (Section 4.2.2.3),

   B. Dose due to other contained sources and

   C. Total body dose due to radioactivity deposited on the ground (Section 4.2.3.1).

2. The external total body dose due to radioactivity deposited on the ground is accounted for in the determination of the non-noble gas dose and is considered in section 5.4.

3. The total external total body dose, D^{Ex}, is given by:

$$\mathbf{D^{Ex} = D^{TB} + D^{OSF}} \qquad \textbf{(5-1)}$$

$\mathbf{D^{Ex}}$	Total External Total Body Dose	[mrem]
	Total external total body dose due to irradiation by external sources at the location of interest.	
$\mathbf{D^{TB}}$	Noble Gas Total Body Dose	[mrem]
	External total body dose due to gamma radiation from noble gas radionuclides released in gaseous effluents at the location of interest. See Section 4.2.2.3.	
$\mathbf{D^{OSF}}$	Dose From On-Site Storage Facilities	[mrem]
	External total body dose due to gamma radiation from on-site storage facilities at the location of interest. See Section 5.2.	

5.4. Total Dose

1. The total dose, D^{Tot}, in the unrestricted area to a member of the public due to plant operations is given by:

$$\mathbf{D^{Tot} = D^{Ex} + D_{aj}^{Liq} + D_{aj}^{NNG}} \qquad \textbf{(5-2)}$$

where:

$\mathbf{D^{Tot}}$	Total Dose To Member of Public	[mrem]
	Total off-site dose to a member of public due to plant operations.	
$\mathbf{D^{Ex}}$	Total External Total Body Dose	[mrem]
	Total body dose due to external exposure to noble gases, N-16 skyshine and on-site storage facilities.	
$\mathbf{D_{aj}^{Liq}}$	Liquid Effluent Dose	[mrem]
	Dose due to liquid effluents to age group **a** and organ **j**. The age group and organ with the highest dose from liquid effluents is used.	
$\mathbf{D_{aj}^{NNG}}$	Non-Noble Gaseous Effluent Dose	[mrem]
	Dose due to non-noble gaseous effluents to age group **a** and organ **j**. The age group and organ with the highest dose from non-noble gas effluents is used.	

5.5. COMPLIANCE TO TOTAL DOSE LIMITS

5.5.1. Total Effective Dose Equivalent Limit - 10CFR20 Compliance

1. Each station's RE limits the Total Effective Dose Equivalent (TEDE) to an annual limit of 100 mrem, as required by 10CFR20.1301 (a)(1). Demonstration of compliance with the limits of 40CFR190 (per Section 4.2.2) will be considered to demonstrate compliance with the 100 mrem/year limit.

5.5.2. Dose to a Member of the Public in the Unrestricted Area

1. The NRC has stated that demonstration of compliance with the limits of 40CFR190 or with the design objectives of Appendix I to 10CFR50 will be deemed to demonstrate compliance with the limits of 10CFR20.1301(a)(1). Power reactors that comply with Appendix I may also have to demonstrate that they are within the 25 mrem limit of 40CFR190 (See Reference 104).

5.5.3. Dose to a Member of the Public in the Restricted Area

1. In August of 1995, a revision to 10CFR20 was implemented that changed the definition of a member of the public. As a result, for each nuclear station, estimated doses were calculated for a member of the public who enters the site boundary, but is not authorized for unescorted access to the protected area of the site and does not enter any radiologically posted areas on the site. Realistic assumptions were made for occupancy times and locations visited while within the site boundary.

2. These evaluations indicate that the doses estimated for these members of the public are well within the 10CFR20 limits. These dose evaluations will be performed annually and if necessary, a model will be developed and included in the ODCM.

3. Evaluation of the 40CFR190 dose is used to demonstrate compliance to 10CFR20 and satisfy station TRM and Technical Specifications (see ODCM Part I)

5.5.4. Total Dose due to the Uranium Fuel Cycle (40CFR190)

1. RE and 40CFR190 limit 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 to the following:

    A. Less than or equal to 25 mrem to the total body.

    B. Less than or equal to 25 mrem to any organ except the thyroid.

    C. Less than or equal to 75 mrem to the thyroid.

2. Total Dose Components

    A. This requirement includes the total dose from operations at the nuclear power station. This includes doses due to radioactive effluents (airborne and liquid) and dose due to direct radiation from non-effluent sources (e.g., sources contained in systems on site). It also includes dose due to plants under consideration, neighboring plants and dose due to other facilities in the uranium fuel cycle.

3. The operations comprising the uranium fuel cycle are specified in 40CFR190.02(b). The following are included to the extent that they directly support the production of electrical power for public use utilizing nuclear energy:

    A. Milling of uranium ore.

    B. Chemical conversion of uranium.

    C. Isotopic enrichment of uranium.

    D. Fabrication of uranium fuel.

    E. Generation of electricity by a light-watered-cooled nuclear power plant using uranium fuel.

    F. Reprocessing of spent uranium fuel.

4. Excluded are:

    A. Mining operations.

    B. Operations at waste disposal sites.

    C. Transportation of any radioactive material in support of these operations.

    D. The re-use of recovered non-uranium special nuclear and by-product materials from the cycle.

5.6. When Compliance Assessment is Required

1. Compliance with the 40CFR190 regulations is now required as part of demonstration of compliance to 10CFR20 regulations per 10CFR20.1301(d).

2. The dose due to the uranium fuel cycle is determined by equation 5-2

6. RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1. The radiological environmental monitoring program for the environs around Byron Station is given in Table 6-1.

2. Figures 6-1 through 6-4 show sampling and monitoring locations.

Table 6-1
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations	Sampling or Collection Frequency	Type or Frequency of Analysis
1. Airborne			
Radioiodine and Particulates	a. Indicators-Near Field BY-21 BY-22 BY-23 BY-24	Continuous sampler operation with particulate sample collection weekly, or more frequently if required by dust loading, and radioiodine canister collection weekly.	Radioiodine Canister: I-131 analysis weekly 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.
	b. Indicators-Far Field BY-01, Byron BY-04, Paynes Pt. BY-06, Oregon		
	c. Controls BY-08, Leaf River		

Table 6-1 (Cont.)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations	Sampling or Collection Frequency	Type or Frequency of Analysis
2. Direct Radiation	a. Indicators-Inner Ring BY-101-1 BY-101-2 BY-102-1 BY-102-2 BY-103-1 BY-103-2 BY-103-3 BY-104-1 BY-104-2 BY-104-3 BY-105-1 BY-105-2 BY-106-1 BY-106-2 BY-107-1 BY-107-2 BY-107-3 BY-108-1 BY-108-2 BY-109-1 BY-109-2 BY-110-1 BY-110-2 BY-111-3 BY-111-4 BY-112-3 BY-112-4	Quarterly	Gamma Dose Quarterly

Table 6-1 (Cont.)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations	Sampling or Collection Frequency	Type or Frequency of Analysis
2. Direct Radiation	Indicators-Inner Ring (cont'd)		
(cont'd)	BY-113-1 BY-113-2 BY-114-1 BY-114-2 BY-115-1 BY-115-2 BY-116-1 BY-116-2 BY-116-3		
	c. Indicators- Outer Ring	Quarterly	Gamma Dose Quarterly
	BY-201-3 BY-201-4 BY-202-1 BY-202-2 BY-203-1 BY-203-2 BY-204-1 BY-204-2 BY-205-1 BY-205-2 BY-206-1 BY-206-2 BY-207-1 BY-207-2		

Table 6-1 (Cont.)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations	Sampling or Collection Frequency	Type of Frequency of Analysis
2. Direct Radiation (cont'd)	Indicators-Outer Ring (cont'd) BY-208-1 BY-208-2 BY-209-1 BY-209-4 BY-210-3 BY-210-4 BY-211-1 BY-211-4 BY-212-1 BY-212-4 BY-213-1 BY-213-4 BY-214-1 BY-214-4 BY-215-1 BY-215-4 BY-216-1 BY-216-2		
	c. Indicators-Other Two at each airborne location Listed in Section 1: BY-01-1 BY-01-2 BY-04-1 BY-04-2 BY-24-1 BY-24-2 BY-06-1 BY-06-2 BY-21-1	Quarterly	Gamma Dose Quarterly

Table 6-1 (Cont.)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations	Sampling or Collection Frequency	Type of Frequency of Analysis
2. Direct Radiation (cont'd)	Indicators-Other (cont'd) BY-21-2 BY-22-1 BY-22-2 BY-23-1 BY-23-2		
	d. Control Two at each airborne location Listed in Section 1: BY-08-1 BY-08-2		
	e. Special Interest BY-301-1 BY-301-2 BY-309-1 BY-309-2 BY-309-3 BY-309-4 BY-314-2		

Table 6-1 (Cont.)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations	Sampling or Collection Frequency	Type or Frequency of Analysis
3. Waterborne Ground/Well	a. Indicators BY-14-1, 3200 German Church Rd BY-18-1, Calhoun Well BY-32, Wolford Well BY-35, Vancko Well BY-36, Blanchard Well BY-37, Alexander Well	Quarterly	Gamma isotopic[3] and tritium analysis quarterly.
Drinking	There is no drinking water pathway within 6.2 mi downstream of the station.		
Surface	a. Indicators BY-12, Oregon Pool of Rock River, Downstream of Discharge b. Control BY-29, Byron, Upstream of Intake	Weekly grab samples.	Gross beta and gamma isotopic analysis[3] on monthly composite; tritium analysis on quarterly composite.
Sediment	a. Indicators BY-12, Oregon Pool of Rock River, Downstream of Discharge b. Control BY-34, Rock River Upstream of discharge	Semiannually	Gamma isotopic[3] analysis semiannually.

Table 6-1 (Cont.)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations	Sampling or Collection Frequency	Type or Frequency of Analysis
4. Ingestion			
Milk	a. Indicators BY-20-1 R. Snodgrass,Dairy Farm	Biweekly: May through October; monthly: November through April.	Gamma isotopic[3] and I-131 analysis[4] on each sample.
	b. Controls BY-26-2, Akins Dairy		
Fish	a. Indicator BY-31, Rock River in vicinity of Discharge	Two times annually	Gamma isotopic[3] analysis on edible portions.
	b. Control BY-29, Byron, Upstream of Intake		
Food Products	a. Indicators Two samples from each of the four major quadrants within 6.2 miles of the station.	Annually	Gamma isotopic[3] analysis on each sample.

Table 6-1 (Cont.)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations	Sampling or Collection Frequency	Type of Frequency of Analysis
Food Products (cont'd)	b. Control Two samples within 9.3 to 18.6 miles of the station. Sample locations for food products may vary based on availability and therefore are not required to be identified here but shall be taken.	Annually	Gamma Isotopic[3] analysis on each sample.

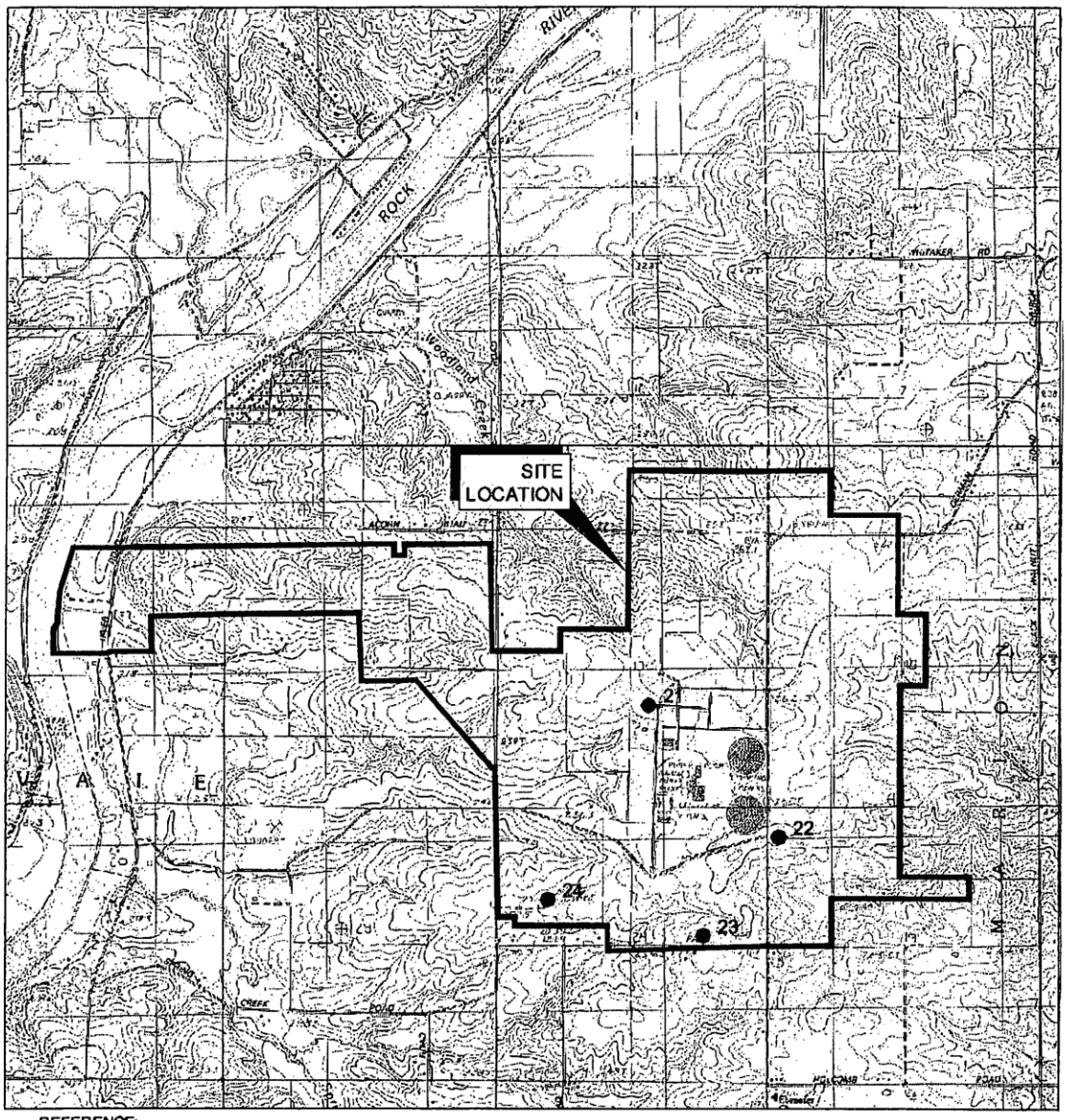
Table 6-1 (Cont'd)
Radiological Environmental Monitoring Program

[1]Far field samples are not required to be analyzed, unless 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 Chemistry Manager.

[2]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 ten 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.



REFERENCE:
UNITED STATES GEOLOGIC SURVEY
STILLMAN VALLEY QUADRANGLE, OR
TOPOGRAPHIC, 7.5 MINUTES SERIES 1976

0 1/2 1 KM

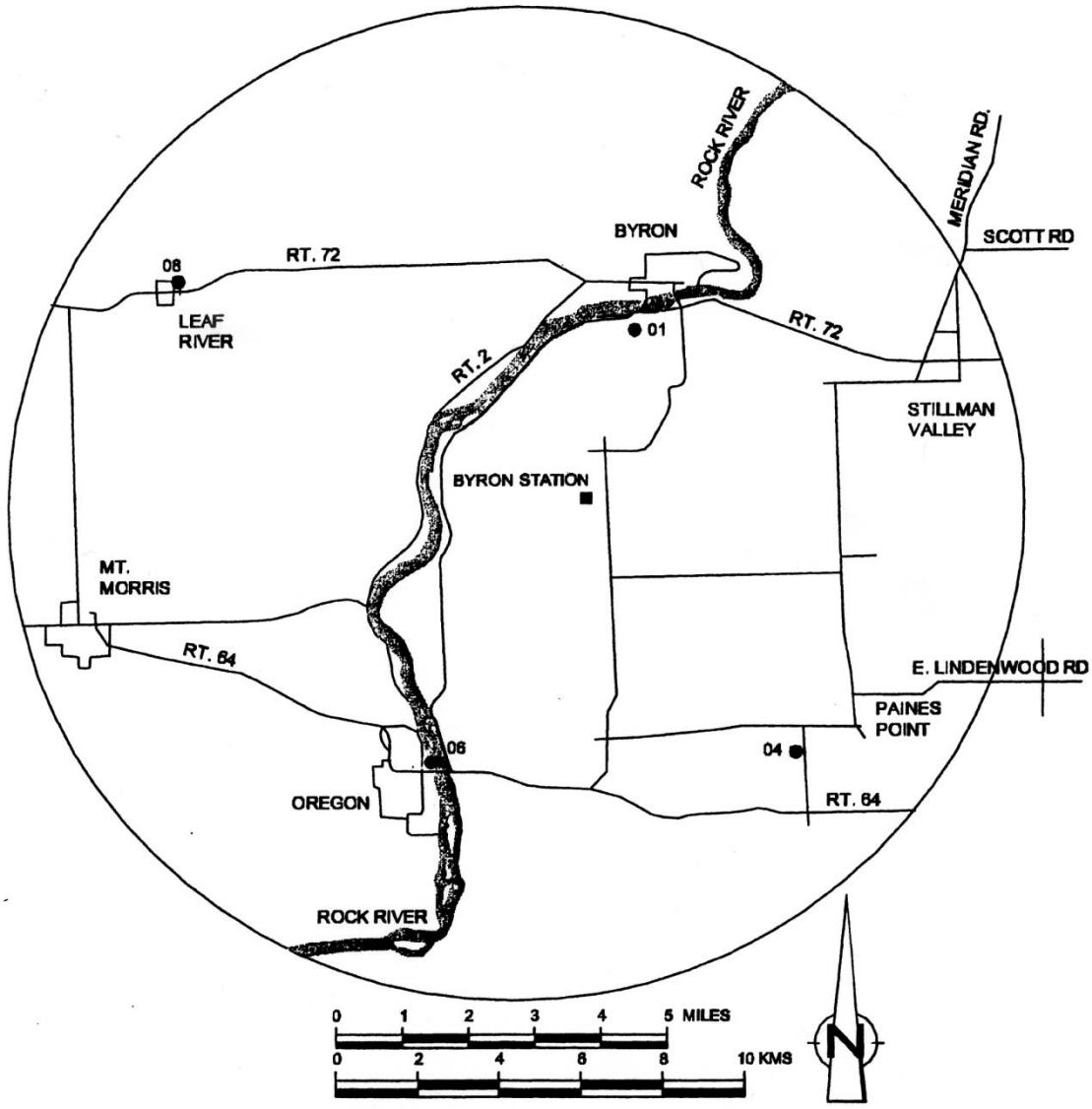
0 1/2 1 MILE

● AIR SAMPLING LOCATION

OFFSITE DOSE CALCULATION MANUAL
BYRON STATION

FIGURE 6-1

ONSITE AIR SAMPLING LOCATIONS
and Unrestricted Area Boundary



● AIR SAMPLING LOCATION

■ BYRON STATION

OFFSITE DOSE CALCULATION MANUAL BYRON STATION
FIGURE 6-2 OFFSITE AIR SAMPLING LOCATIONS

Figure 6.3a
Inner Ring and Special Interest Dosimeter Locations

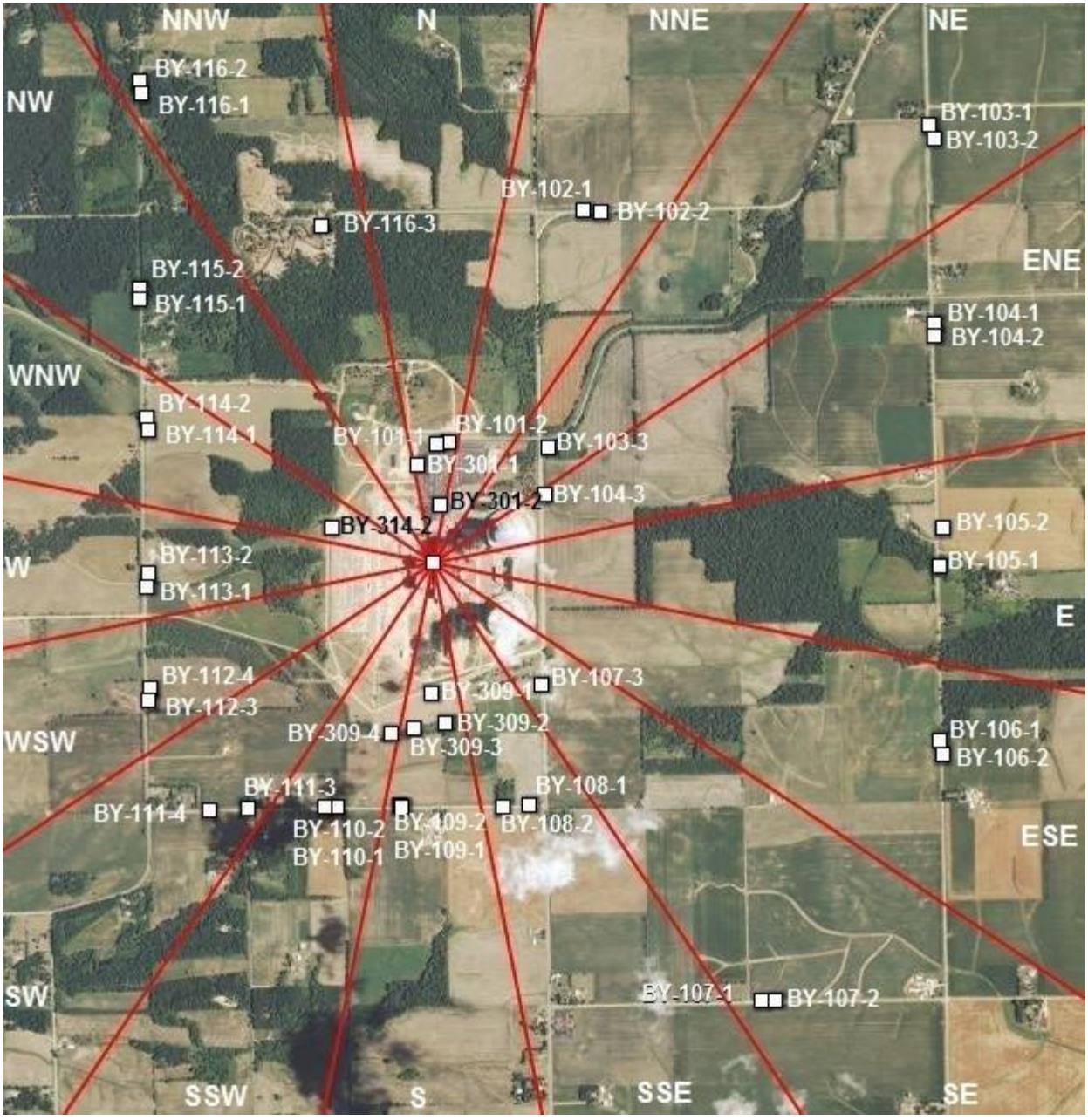
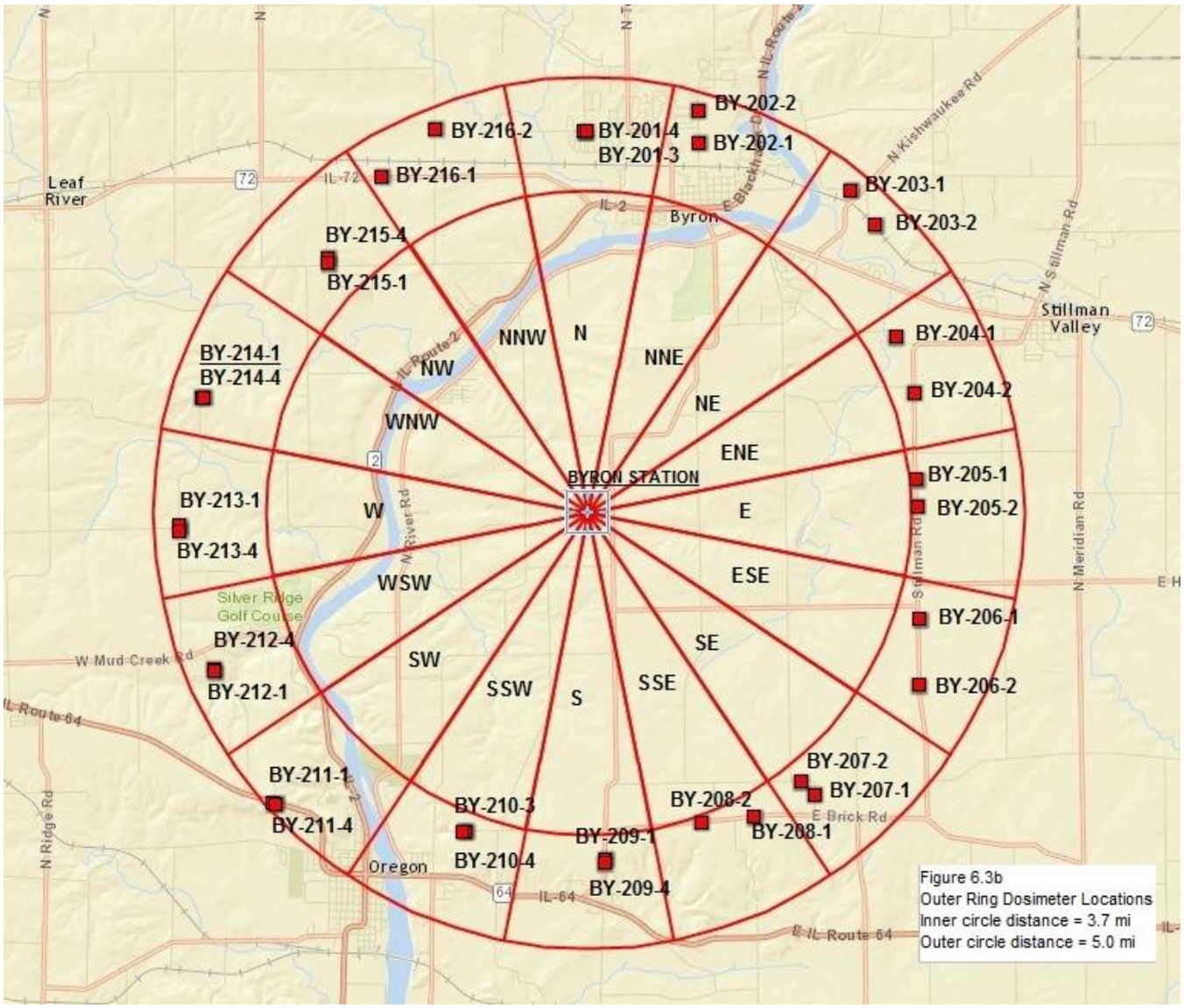
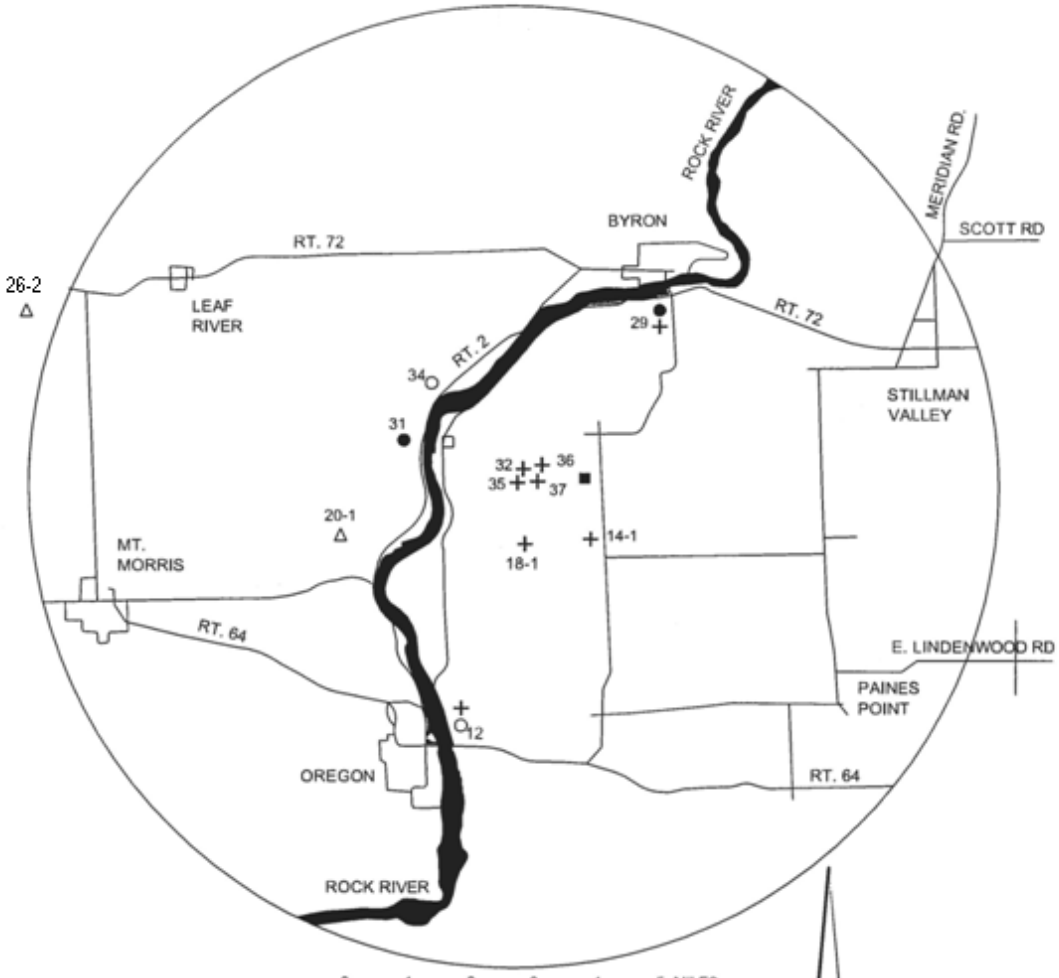


Figure 6.3b
Outer Ring Dosimeter Locations





OFFSITE DOSE CALCULATION MANUAL
BYRON STATION

FIGURE 6-4

INGESTION AND WATERBORNE EXPOSURE
PATHWAY SAMPLE LOCATIONS

Latitude/Longitude Positions of REMP Samples

Table 6-2

Sampling Location	Latitude (deg)	Longitude (deg)	Distance (km)	Distance (mi)	Direction (deg)	Sector Desig	Compass Dir
Release (Reference) Point							
Vent Stack	42.07472	-89.28264	N/A	N/A	N/A	N/A	N/A
Air Sampling Stations							
BY-01	42.11762	-89.27993	4.77	2.96	3	A	N
BY-04	42.01867	-89.22213	7.98	4.96	142	G	SE
BY-06	42.01577	-89.33010	7.63	4.74	211	K	SSW
BY-08	42.12668	-89.39918	11.20	6.96	301	P	WNW
BY-21	42.07908	-89.28213	0.49	0.30	5	A	N
BY-22	42.07168	-89.27693	0.58	0.36	125	G	SE
BY-23	42.06585	-89.28230	0.98	0.61	178	J	S
BY-24	42.06790	-89.29278	1.13	0.70	228	L	SW
Surface Water							
BY-12	42.01717	-89.32603	7.33	4.55	209	K	SSW
BY-29	42.11773	-89.27990	4.78	2.97	3	A	N
Sediment							
BY-12	42.01717	-89.32603	7.33	4.55	209	K	SSW
BY-34	42.09355	-89.32638	4.18	2.60	300	P	WNW
Fish							
BY-29	42.11773	-89.27990	4.78	2.97	3	A	N
BY-31	42.09353	-89.32623	4.16	2.58	300	P	WNW
Milk							
BY-20-1	42.05898	-89.37455	7.80	4.85	257	M	WSW
BY-26-2	42.12221	-89.51107	19.60	12.20	286	P	WNW
Well Water							
BY-14-1	42.06102	-89.27753	1.58	0.98	164	H	SSE
BY-18-1	42.06578	-89.29051	1.19	0.74	213	K	SSW
BY-32	42.07527	-89.31863	3.00	1.86	271	N	W
BY-35	42.08097	-89.31802	3.01	1.87	283	P	WNW
BY-36	42.01867	-89.29600	1.35	0.84	305	Q	NW
BY-37	42.08225	-89.31928	3.14	1.95	285	P	WNW
Vegetation							
BY-Control	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year
BY-Quad 1	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year
BY-Quad 2	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year
BY-Quad 3	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year
BY-Quad 4	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year	Varies by year

LATITUDE/LONGITUDE POSITIONS OF REMP SAMPLES

Table 6-2
Dosimeter Locations

Sampling Location	Latitude (deg)	Longitude (deg)	Distance (km)	Distance (mi)	Direction (deg) From Stack	Sector	Sector
Inner Ring							
BY-101-1	42.07908	-89.28243	0.48	0.30	2	A	N
BY-101-2	42.07912	-89.28188	0.49	0.30	8	A	N
BY-102-1	42.08757	-89.27522	1.56	0.97	23	B	NNE
BY-102-2	42.08752	-89.27438	1.58	0.98	26	B	NNE
BY-103-1	42.09068	-89.25822	2.69	1.67	49	C	NE
BY-103-2	42.09020	-89.25802	2.67	1.66	50	C	NE
BY-103-3	42.07893	-89.27692	0.67	0.42	45	C	NE
BY-104-1	42.08345	-89.25798	2.26	1.40	65	D	ENE
BY-104-2	42.08303	-89.25797	2.24	1.39	66	D	ENE
BY-104-3	42.07720	-89.27717	0.53	0.33	59	D	ENE
BY-105-1	42.07462	-89.25777	2.06	1.28	59	E	E
BY-105-2	42.07598	-89.25760	2.08	1.29	90	E	E
BY-106-1	42.06822	-89.25770	2.19	1.36	109	F	ESE
BY-106-2	42.06770	-89.25758	2.22	1.38	111	F	ESE
BY-107-1	42.05870	-89.26647	2.23	1.39	143	G	SE
BY-107-2	42.05873	-89.26580	2.26	1.40	142	G	SE
BY-107-3	42.07027	-89.27730	0.66	0.41	138	G	SE
BY-108-1	42.06588	-89.27790	1.06	0.66	158	H	SSE
BY-108-2	42.06578	-89.27920	1.03	0.64	164	H	SSE
BY-109-1	42.06580	-89.28417	1.00	0.62	187	J	S
BY-109-2	42.06583	-89.28427	1.00	0.62	188	J	S
BY-110-1	42.06578	-89.28738	1.07	0.66	201	K	SSW
BY-110-2	42.06577	-89.28793	1.08	0.67	204	K	SSW
BY-111-3	42.06573	-89.29173	1.25	0.78	217	L	SW

LATITUDE/LONGITUDE POSITIONS OF REMP SAMPLES

Table 6-2
Dosimeter Locations

Sampling Location	Latitude (deg)	Longitude (deg)	Distance (km)	Distance (mi)	Direction (deg) From Stack	Sector	Sector
Inner Ring							
BY-111-4	42.06565	-89.29363	1.36	0.85	222	L	SW
BY-112-3	42.06967	-89.29660	1.28	0.80	244	M	WSW
BY-112-4	42.07010	-89.29653	1.26	0.78	246	M	WSW
BY-113-1	42.07385	-89.29670	1.16	0.72	265	N	W
BY-113-2	42.07432	-89.29662	1.15	0.71	268	N	W
BY-114-1	42.07955	-89.29665	1.27	0.79	295	P	WNW
BY-114-2	42.08000	-89.29673	1.30	0.81	297	P	WNW
BY-115-1	42.08433	-89.29705	1.60	0.99	312	Q	NW
BY-115-2	42.08473	-89.29702	1.63	1.01	313	Q	NW
BY-116-1	42.09185	-89.29697	2.24	1.39	328	R	NNW
BY-116-2	42.09227	-89.29705	2.28	1.42	329	R	NNW
BY-116-3	42.08702	-89.28810	1.44	0.89	342	R	NNW

LATITUDE/LONGITUDE POSITIONS OF REMP SAMPLES
Table 6-2
Dosimeter Locations Continued

Sampling Location	Latitude (deg)	Longitude (deg)	Distance (km)	Distance (mi)	Direction (deg) From Stack	Sector	Sector
Outer Ring							
BY-201-3	42.13811	-89.28378	7.04	4.37	359	A	N
BY-201-4	42.13810	-89.28316	7.04	4.37	360	A	N
BY-202-1	42.13623	-89.25798	7.13	4.43	17	B	NNE
BY-202-2	42.14157	-89.25817	7.70	4.78	15	B	NNE
BY-203-1	42.12840	-89.22405	7.69	4.78	39	C	NE
BY-203-2	42.12258	-89.21855	7.51	4.67	45	C	NE
BY-204-1	42.10407	-89.21380	6.57	4.08	60	D	ENE
BY-204-2	42.09472	-89.20980	6.43	4.00	70	D	ENE
BY-205-1	42.08028	-89.20923	6.11	3.80	84	E	E
BY-205-2	42.07587	-89.20907	6.09	3.78	89	E	E
BY-206-1	42.05707	-89.20862	6.44	4.00	108	F	ESE
BY-206-2	42.04622	-89.20870	6.89	4.28	117	F	ESE
BY-207-1	42.02793	-89.23200	6.68	4.15	141	G	SE
BY-207-2	42.03008	-89.23523	6.32	3.93	142	G	SE
BY-208-1	42.02425	-89.24565	6.39	3.97	151	H	SSE
BY-208-2	42.02340	-89.25740	6.07	3.77	160	H	SSE
BY-209-1	42.01717	-89.27887	6.40	3.98	177	J	S
BY-209-4	42.01657	-89.27917	6.47	4.02	177	J	S
BY-210-3	42.02180	-89.31012	6.30	3.91	201	K	SSW
BY-210-4	42.02180	-89.31083	6.32	3.93	202	K	SSW
BY-211-1	42.02658	-89.35338	7.93	4.93	228	L	SW
BY-211-4	42.02645	-89.35278	7.90	4.91	227	L	SW

LATITUDE/LONGITUDE POSITIONS OF REMP SAMPLES
Table 6-2
Dosimeter Locations Continued

Sampling Location	Latitude (deg)	Longitude (deg)	Distance (km)	Distance (mi)	Direction (deg) From Stack	Sector	Sector
Outer Ring							
BY-212-1	42.04847	-89.36643	7.52	4.67	247	M	WSW
BY-212-4	42.04888	-89.36672	7.52	4.67	248	M	WSW
BY-213-1	42.07263	-89.37440	7.59	4.72	268	N	W
BY-213-4	42.07183	-89.37440	7.60	4.72	268	N	W
BY-214-1	42.09397	-89.36945	7.49	4.65	287	P	WNW
BY-214-4	42.09397	-89.36890	7.45	4.63	287	P	WNW
BY-215-1	42.11618	-89.34107	6.68	4.15	314	Q	NW
BY-215-4	42.11710	-89.34100	6.74	4.19	314	Q	NW
BY-216-1	42.13058	-89.32910	7.30	4.54	328	R	NNW
BY-216-2	42.13847	-89.31702	7.63	4.74	338	R	NNW
Special Interest							
BY-301-1	42.07830	-89.28338	0.40	0.25	352	A	N
BY-301-2	42.07685	-89.28230	0.24	0.15	7	A	N
BY-309-1	42.06995	-89.28268	0.53	0.33	183	J	S
BY-309-2	42.06887	-89.28200	0.65	0.40	175	J	S
BY-309-3	42.06865	-89.28358	0.68	0.42	186	J	S
BY-309-4	42.06850	-89.28472	0.71	0.44	194	K	SSW
BY-314-2	42.07601	-89.28764	0.43	0.27	289	P	WNW

Byron Station
ODCM Revision 11 Change Determination
CY-AA-170-3100

Station: Byron

ODCM Revision No: 11 Determination Identifier: A – Administrative Changes

1. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1301? Explain: This ODCM change will maintain the radioactive effluent control required by 10CFR20.1301, Dose Limits for Individual Members of the Public, which is to ensure total effective dose equivalent to individual members of the public from licensed operation does not exceed 0.1 rem. Determination A changes are administrative in nature. All of the changes include document formatting and correction of typos. None of these administrative changes affect the radioactive effluent control required by 10CFR20.1301.	_x_Yes	___No
2. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1302? Explain: This ODCM change will maintain the level of control required in 10CFR20. The requirement of 10CFR20.1302 is to provide "surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in 10CFR20.1301." Determination A changes are administrative in nature. All of the changes include document formatting and correction of typos. None of these administrative changes affect the radioactive effluent control required by 10CFR20.1302.	_x_Yes	___No
3. Does the ODCM change maintain the level of radioactive effluent control required by 40CFR190 and 10CFR72.104? Explain: This ODCM change will not reduce the control required by 40CFR190. The controls required by 40CFR190 and 10CFR72.104 include limiting the annual dose equivalent of any member of the public to less than 25 mrem whole body, 75 mrem thyroid, and 25 mrem to any organ as the result of activities from the uranium fuel cycle. Determination A changes are administrative in nature. All of the changes include document formatting and correction of typos. These changes do not affect radioactive effluent controls.	_x_Yes	___No
4. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50.36a? Explain: This ODCM change does not affect the level of control previously established in the ODCM required by 10CFR50.36a. The basic requirement of 10CFR50.36a is to keep releases and the resultant dose to the public as low as reasonably achievable (ALARA). This ODCM change will not reduce the station's ability to keep releases of radioactive materials to unrestricted areas as low as reasonably achievable, as required by 10CFR50.36a. Determination A changes are administrative in nature. All of the changes include document formatting and correction of typos. None of these administrative changes affect the radioactive effluent control required by 10CFR50.36a.	_x_Yes	___No
5. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50 Appendix I? Explain: 10CFR50 Appendix I states that liquid effluents from each reactor each year shall not expose any individual to more than 3 mrem to the total body or 10 mrem to any critical	_x_Yes	___No

Station: Byron

ODCM Revision No: 11 Determination Identifier: A – Administrative Changes

	organ. Gaseous releases of particulates and iodines with half-lives >8 days shall not expose any individual organ to more than 15 mrem/year. Noble gases shall not expose any individual today body to more than 500 mrem/year, skin to more than 3000 mrem/year, gamma dose to 10 mrad/year, and beta dose to 20 mrad/year. Determination A changes are administrative in nature. All of the changes include document formatting and correction of typos. None of these administrative changes affect the radioactive effluent control required by 10CFR50 Appendix I.		
6.	Does the ODCM change maintain the accuracy or reliability of effluent, dose, or setpoint calculations? Explain: The accuracy and reliability of effluent, dose, and setpoint calculations will not be affected by this ODCM change. Effluent and setpoint calculations will continue to be performed using the established ODCM methodology. Determination A changes are administrative in nature. All of the changes include document formatting and correction of typos. None of these administrative changes affect the accuracy or reliability of effluent, dose, or setpoint calculations.	_x_Yes	___No
7.	Does the ODCM change maintain the accuracy of radioactive effluent control required by the SAR ? Explain: This ODCM change will maintain the accuracy of the radioactive effluent control required by the Byron/Braidwood UFSAR. The B/B UFSAR Table 11.5-6, Radiological Analysis Summary of Gaseous Effluent Samples, includes typical sampling frequency, type of analysis, sensitivity, and purpose for effluent radiation monitors. No UFSAR described effluent samples or monitors are affected by this change. Determination A changes are administrative in nature. All of the changes include document formatting and correction of typos. None of these administrative changes affect the accuracy of radioactive effluent control required by the SAR.	_x_Yes	___No

Byron Station
ODCM Revision 11 Change Determination
CY-AA-170-3100

Station: Byron

ODCM Revision No: 11 Determination Identifier: B – Holtec Report Reference

1. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1301? Explain: This ODCM change will maintain the radioactive effluent control required by 10CFR20.1301, Dose Limits for Individual Members of the Public, which is to ensure total effective dose equivalent to individual members of the public from licensed operation does not exceed 0.1 rem. This ODCM revision only changes the references to an updated Holtec report and does not affect the radioactive effluent control required by 10CFR20.1301.	_x_Yes	___No
2. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1302? Explain: This ODCM change will maintain the level of control required in 10CFR20. The requirement of 10CFR20.1302 is to provide "surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in 10CFR20.1301." This ODCM revision only changes the references to an updated Holtec report and does not affect the radioactive effluent control required by 10CFR20.1302.	_x_Yes	___No
3. Does the ODCM change maintain the level of radioactive effluent control required by 40CFR190 and 10CFR72.104? Explain: The 10CFR 72.212 report, prepared in accordance with ISFSI requirements, demonstrates that dose from the ISFSI pad in combination with uranium fuel cycle operations is within 40CFR 190 and 10CFR 72.104 limits. Holtec Report HI-2084113 provided the basis for the dose versus distance calculations prior to the onset of the ISFSI campaign. Based on conservative assumptions relative to fuel source term and pad loading, the 10CFR 72.212 report issued in conjunction with the onset of the ISFSI campaign limited the number of casks that could be placed on the pad to demonstrate 40CFR 190 dose compliance. A new Holtec Report HI-2146048, issued in 2014, provided the basis for 10CFR 72.212, Revision 4, part of EC 398479, which implements the new source term calculations to allow for a fully loaded ISFSI pad while still maintaining 40 CFR 190 dose requirements. Section 5.1.2 of the ODCM describes the dose requirements related to ISFSI and states that compliance will be demonstrated via the 10CFR 72.212 reports. This section references the Holtec report. Since the ODCM revision only updates the reference to the updated Holtec report, this ODCM revision maintains the level of radioactive effluent control required by 40CFR190 and 10CFR 72.104.	_x_Yes	___No
4. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50.36a? Explain: This ODCM change does not affect the level of control previously established in the ODCM required by 10CFR50.36a. The basic requirement of 10CFR50.36a is to keep releases and the resultant dose to the public as low as reasonably achievable (ALARA). This ODCM revision only changes the references to an updated Holtec report does not reduce the station's ability to keep releases of radioactive materials to unrestricted areas as low as reasonably achievable, as required by 10CFR50.36a.	_x_Yes	___No

Station: Byron

ODCM Revision No: 11 Determination Identifier: B – Holtec Report Reference

5. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50 Appendix I? Explain: 10CFR50 Appendix I states that liquid effluents from each reactor each year shall not expose any individual to more than 3 mrem to the total body or 10 mrem to any critical organ. Gaseous releases of particulates and iodines with half-lives >8 days shall not expose any individual organ to more than 15 mrem/year. Noble gases shall not expose any individual today body to more than 500 mrem/year, skin to more than 3000 mrem/year, gamma dose to 10 mrad/year, and beta dose to 20 mrad/year. This ODCM revision only changes the references to an updated Holtec report does not affect the amount of liquid and gaseous effluent releases required to maintain the level of radioactive effluent control required by 10CFR50 Appendix I.	_x_Yes	___No
6. Does the ODCM change maintain the accuracy or reliability of effluent, dose, or setpoint calculations? Explain: The accuracy and reliability of effluent, dose, and setpoint calculations will not be affected by this ODCM change. Effluent and setpoint calculations will continue to be performed using the established ODCM methodology. This ODCM revision only changes the references to an updated Holtec report does not affect the amount of liquid and gaseous effluent releases required to maintain the accuracy or reliability of effluent, dose, or setpoint calculations.	_x_Yes	___No
7. Does the ODCM change maintain the accuracy of radioactive effluent control required by the SAR ? Explain: This ODCM change will maintain the accuracy of the radioactive effluent control required by the Byron/Braidwood UFSAR. The B/B UFSAR Table 11.5-6, Radiological Analysis Summary of Gaseous Effluent Samples, includes typical sampling frequency, type of analysis, sensitivity, and purpose for effluent radiation monitors. No UFSAR described effluent samples or monitors are affected by this change. This ODCM revision only changes the references to an updated Holtec report does not affect the accuracy of radioactive effluent control required by the SAR.	_x_Yes	___No

Station: Byron

ODCM Revision No: 11 Determination Identifier: C – Air Sampler Dosimeter Location Listings

1. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1301? Explain: This ODCM change will maintain the radioactive effluent control required by 10CFR20.1301, Dose Limits for Individual Members of the Public, which is to ensure total effective dose equivalent to individual members of the public from licensed operation does not exceed 0.1 rem. Dosimeters are present at each air sampler location, notated as "other" and "control" in Table 6-1, Radiological Environmental Monitoring Program, Section 2 (Direct Radiation). This change adds notations to clarify that dosimeters are present at each airborne sample location listed in Section 1. This change does not affect the radioactive effluent control required by 10CFR20.1301.	_x_Yes	___No
2. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1302? Explain: This ODCM change will maintain the level of control required in 10CFR20. The requirement of 10CFR20.1302 is to provide "surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in 10CFR20.1301." Dosimeters are present at each air sampler location, notated as "other" and "control" in Table 6-1, Radiological Environmental Monitoring Program, Section 2 (Direct Radiation). This change adds notations to clarify that dosimeters are present at each airborne sample location listed in Section 1. This change does not affect the radioactive effluent control required by 10CFR20.1302.	_x_Yes	___No
3. Does the ODCM change maintain the level of radioactive effluent control required by 40CFR190 and 10CFR72.104? Explain: This ODCM change will not reduce the control required by 40CFR190. The controls required by 40CFR190 and 10CFR72.104 include limiting the annual dose equivalent of any member of the public to less than 25 mrem whole body, 75 mrem thyroid, and 25 mrem to any organ as the result of activities from the uranium fuel cycle. Dosimeters are present at each air sampler location, notated as "other" and "control" in Table 6-1, Radiological Environmental Monitoring Program, Section 2 (Direct Radiation). This change adds notations to clarify that dosimeters are present at each airborne sample location listed in Section 1. This change does not affect radioactive effluent controls in any way.	_x_Yes	___No
4. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50.36a? Explain: This ODCM change does not affect the level of control previously established in the ODCM required by 10CFR50.36a. The basic requirement of 10CFR50.36a is to keep releases and the resultant dose to the public as low as reasonably achievable (ALARA). This ODCM change will not reduce the station's ability to keep releases of radioactive materials to unrestricted areas as low as reasonably achievable, as required by 10CFR50.36a. Dosimeters are present at each air sampler location, notated as "other" and "control" in Table 6-1, Radiological Environmental Monitoring Program, Section 2 (Direct Radiation). This change adds notations to clarify that dosimeters are present at each airborne sample	_x_Yes	___No

Station: Byron

ODCM Revision No: 11 Determination Identifier: C – Air Sampler Dosimeter Location Listings

location listed in Section 1. This change does not affect the radioactive effluent control required by 10CFR50.36a.		
5. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50 Appendix I? Explain: 10CFR50 Appendix I states that liquid effluents from each reactor each year shall not expose any individual to more than 3 mrem to the total body or 10 mrem to any critical organ. Gaseous releases of particulates and iodines with half-lives >8 days shall not expose any individual organ to more than 15 mrem/year. Noble gases shall not expose any individual today body to more than 500 mrem/year, skin to more than 3000 mrem/year, gamma dose to 10 mrad/year, and beta dose to 20 mrad/year. Dosimeters are present at each air sampler location, notated as “other” and “control” in Table 6-1, Radiological Environmental Monitoring Program, Section 2 (Direct Radiation). This change adds notations to clarify that dosimeters are present at each airborne sample location listed in Section 1. This change does affect the radioactive effluent control required by 10CFR50 Appendix I.	_x_Yes	___No
6. Does the ODCM change maintain the accuracy or reliability of effluent, dose, or setpoint calculations? Explain: The accuracy and reliability of effluent, dose, and setpoint calculations will not be affected by this ODCM change. Effluent and setpoint calculations will continue to be performed using the established ODCM methodology. Dosimeters are present at each air sampler location, notated as “other” and “control” in Table 6-1, Radiological Environmental Monitoring Program, Section 2 (Direct Radiation). This change adds notations to clarify that dosimeters are present at each airborne sample location listed in Section 1. This change does not affect the accuracy or reliability of effluent, dose, or setpoint calculations.	_x_Yes	___No
7. Does the ODCM change maintain the accuracy of radioactive effluent control required by the SAR ? Explain: This ODCM change will maintain the accuracy of the radioactive effluent control required by the Byron/Braidwood UFSAR. The B/B UFSAR Table 11.5-6, Radiological Analysis Summary of Gaseous Effluent Samples, includes typical sampling frequency, type of analysis, sensitivity, and purpose for effluent radiation monitors. No UFSAR described effluent samples or monitors are affected by this change. Dosimeters are present at each air sampler location, notated as “other” and “control” in Table 6-1, Radiological Environmental Monitoring Program, Section 2 (Direct Radiation). This change adds notations to clarify that dosimeters are present at each airborne sample location listed in Section 1. This change does affect the accuracy of radioactive effluent control required by the SAR.	_x_Yes	___No

Byron Station
ODCM Revision 11 Change Determination
CY-AA-170-3100

Station: Byron

ODCM Revision No: 11 Determination Identifier: D – Dosimeter Maps

1. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1301? Explain: This ODCM change will maintain the radioactive effluent control required by 10CFR20.1301, Dose Limits for Individual Members of the Public, which is to ensure total effective dose equivalent to individual members of the public from licensed operation does not exceed 0.1 rem. Inner Ring and Outer Ring dosimeters were plotted on the same map (Figure 6-3) and did not include the Special Interest dosimeters. This change deletes Figure 6-3 and creates two separate maps for improved readability. Figure 6-3a includes the inner ring and special interest dosimeter locations. Figure 6-3b includes the outer ring dosimeter locations. The existing Figure 6-3 used sector designator labels A through Z and circle distance rings at 2 and 5 miles that were derived from Emergency Planning (EP) maps. This change includes the more conventional compass direction labels (N, NNE, NE, etc.) and changes the circle distance rings for the outer ring map to 3.7 and 5.0 miles, which is the required range per TRM Table T3.12.a-1, Section 2. These changes do not affect the radioactive effluent control required by 10CFR20.1301.	_x_ Yes	___ No
2. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1302? Explain: This ODCM change will maintain the level of control required in 10CFR20. The requirement of 10CFR20.1302 is to provide "surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in 10CFR20.1301." Inner Ring and Outer Ring dosimeters were plotted on the same map (Figure 6-3) and did not include the Special Interest dosimeters. This change deletes Figure 6-3 and creates two separate maps for improved readability. Figure 6-3a includes the inner ring and special interest dosimeter locations. Figure 6-3b includes the outer ring dosimeter locations. The existing Figure 6-3 used sector designator labels A through Z and circle distance rings at 2 and 5 miles that were derived from Emergency Planning (EP) maps. This change includes the more conventional compass direction labels (N, NNE, NE, etc.) and changes the circle distance rings for the outer ring map to 3.7 and 5.0 miles, which is the required range per TRM Table T3.12.a-1, Section 2. These changes do not affect the radioactive effluent control required by 10CFR20.1302.	_x_ Yes	___ No
3. Does the ODCM change maintain the level of radioactive effluent control required by 40CFR190 and 10CFR72.104? Explain: This ODCM change will not reduce the control required by 40CFR190. The controls required by 40CFR190 and 10CFR72.104 include limiting the annual dose equivalent of any member of the public to less than 25 mrem whole body, 75 mrem thyroid, and 25 mrem to any organ as the result of activities from the uranium fuel cycle. Inner Ring and Outer Ring dosimeters were plotted on the same map (Figure 6-3) and did not include the Special Interest dosimeters. This change deletes Figure 6-3 and creates two separate maps for improved readability. Figure 6-3a includes the inner ring and special interest dosimeter locations. Figure 6-3b includes the outer ring dosimeter locations. The existing Figure 6-3 used sector designator labels A through Z and circle distance rings at 2 and 5 miles that were derived from Emergency Planning (EP) maps. This change includes the more conventional compass direction labels (N, NNE, NE, etc.) and changes the circle distance rings for the outer ring map to 3.7 and 5.0 miles, which is the required range per TRM Table T3.12.a-1, Section 2. These changes do not affect radioactive effluent controls.	_x_ Yes	___ No

Station: Byron

ODCM Revision No: 11 Determination Identifier: D – Dosimeter Maps

4. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50.36a? Explain: This ODCM change does not affect the level of control previously established in the ODCM required by 10CFR50.36a. The basic requirement of 10CFR50.36a is to keep releases and the resultant dose to the public as low as reasonably achievable (ALARA). This ODCM change will not reduce the station's ability to keep releases of radioactive materials to unrestricted areas as low as reasonably achievable, as required by 10CFR50.36a. Inner Ring and Outer Ring dosimeters were plotted on the same map (Figure 6-3) and did not include the Special Interest dosimeters. This change deletes Figure 6-3 and creates two separate maps for improved readability. Figure 6-3a includes the inner ring and special interest dosimeter locations. Figure 6-3b includes the outer ring dosimeter locations. The existing Figure 6-3 used sector designator labels A through Z and circle distance rings at 2 and 5 miles that were derived from Emergency Planning (EP) maps. This change includes the more conventional compass direction labels (N, NNE, NE, etc.) and changes the circle distance rings for the outer ring map to 3.7 and 5.0 miles, which is the required range per TRM Table T3.12.a-1, Section 2. These changes do not affect the radioactive effluent control required by 10CFR50.36a.	_x_Yes	___No
5. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50 Appendix I? Explain: 10CFR50 Appendix I states that liquid effluents from each reactor each year shall not expose any individual to more than 3 mrem to the total body or 10 mrem to any critical organ. Gaseous releases of particulates and iodines with half-lives >8 days shall not expose any individual organ to more than 15 mrem/year. Noble gases shall not expose any individual today body to more than 500 mrem/year, skin to more than 3000 mrem/year, gamma dose to 10 mrad/year, and beta dose to 20 mrad/year. Inner Ring and Outer Ring dosimeters were plotted on the same map (Figure 6-3) and did not include the Special Interest dosimeters. This change deletes Figure 6-3 and creates two separate maps for improved readability. Figure 6-3a includes the inner ring and special interest dosimeter locations. Figure 6-3b includes the outer ring dosimeter locations. The existing Figure 6-3 used sector designator labels A through Z and circle distance rings at 2 and 5 miles that were derived from Emergency Planning (EP) maps. This change includes the more conventional compass direction labels (N, NNE, NE, etc.) and changes the circle distance rings for the outer ring map to 3.7 and 5.0 miles, which is the required range per TRM Table T3.12.a-1, Section 2. These changes do not affect the radioactive effluent control required by 10CFR50 Appendix I.	_x_Yes	___No
6. Does the ODCM change maintain the accuracy or reliability of effluent, dose, or setpoint calculations? Explain: The accuracy and reliability of effluent, dose, and setpoint calculations will not be affected by this ODCM change. Effluent and setpoint calculations will continue to be performed using the established ODCM methodology. Inner Ring and Outer Ring dosimeters were plotted on the same map (Figure 6-3) and did not include the Special Interest dosimeters. This change deletes Figure 6-3 and creates two separate maps for improved readability. Figure 6-3a includes the inner ring and special interest dosimeter locations. Figure 6-3b includes the outer ring dosimeter locations. The existing Figure 6-3 used sector designator labels A through Z and circle distance rings at 2 and 5 miles that were derived from Emergency Planning (EP) maps. This change includes the more conventional compass direction labels (N, NNE, NE, etc.) and changes the circle distance rings for the outer ring map to 3.7 and 5.0 miles, which is the required range per	_x_Yes	___No

Station: Byron

ODCM Revision No: 11 Determination Identifier: D – Dosimeter Maps

	TRM Table T3.12.a-1, Section 2. These changes do not affect the accuracy or reliability of effluent, dose, or setpoint calculations.		
7.	Does the ODCM change maintain the accuracy of radioactive effluent control required by the SAR ? Explain: This ODCM change will maintain the accuracy of the radioactive effluent control required by the Byron/Braidwood UFSAR. The B/B UFSAR Table 11.5-6, Radiological Analysis Summary of Gaseous Effluent Samples, includes typical sampling frequency, type of analysis, sensitivity, and purpose for effluent radiation monitors. No UFSAR described effluent samples or monitors are affected by this change. Inner Ring and Outer Ring dosimeters were plotted on the same map (Figure 6-3) and did not include the Special Interest dosimeters. This change deletes Figure 6-3 and creates two separate maps for improved readability. Figure 6-3a includes the inner ring and special interest dosimeter locations. Figure 6-3b includes the outer ring dosimeter locations. The existing Figure 6-3 used sector designator labels A through Z and circle distance rings at 2 and 5 miles that were derived from Emergency Planning (EP) maps. This change includes the more conventional compass direction labels (N, NNE, NE, etc.) and changes the circle distance rings for the outer ring map to 3.7 and 5.0 miles, which is the required range per TRM Table T3.12.a-1, Section 2. These changes do not affect the accuracy of radioactive effluent control required by the SAR.	_x_ Yes	___ No

Byron Station
ODCM Revision 11 Change Determination
CY-AA-170-3100

Station: Byron

ODCM Revision No: 11 Determination Identifier: E – Special Interest Dosimeter Location Changes

1. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1301? Explain: This ODCM change will maintain the radioactive effluent control required by 10CFR20.1301, Dose Limits for Individual Members of the Public, which is to ensure total effective dose equivalent to individual members of the public from licensed operation does not exceed 0.1 rem. Special Interest dosimeters BY-302-1 and BY-314-1 were removed and BY-301-2 and BY-314-1 were added. The dosimeters remained in the same general locations but were moved from inside the security exclusion zone to outside the exclusion zone to allow easier access for the REMP sample collector and to more accurately reflect non-occupational dose to a member of the public. The new locations were measured via GPS as required per CY-AA-170-1000. These changes do not affect the radioactive effluent control required by 10CFR20.1301.	_x_Yes	___No
2. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR20.1302? Explain: This ODCM change will maintain the level of control required in 10CFR20. The requirement of 10CFR20.1302 is to provide "surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in 10CFR20.1301." Special Interest dosimeters BY-302-1 and BY-314-1 were removed and BY-301-2 and BY-314-1 were added. The dosimeters remained in the same general locations but were moved from inside the security exclusion zone to outside the exclusion zone to allow easier access for the REMP sample collector and to more accurately reflect non-occupational dose to a member of the public. The new locations were measured via GPS as required per CY-AA-170-1000. These changes do not affect the radioactive effluent control required by 10CFR20.1302.	_x_Yes	___No
3. Does the ODCM change maintain the level of radioactive effluent control required by 40CFR190 and 10CFR72.104? Explain: This ODCM change will not reduce the control required by 40CFR190. The controls required by 40CFR190 and 10CFR72.104 include limiting the annual dose equivalent of any member of the public to less than 25 mrem whole body, 75 mrem thyroid, and 25 mrem to any organ as the result of activities from the uranium fuel cycle. Special Interest dosimeters BY-302-1 and BY-314-1 were removed and BY-301-2 and BY-314-1 were added. The dosimeters remained in the same general locations but were moved from inside the security exclusion zone to outside the exclusion zone to allow easier access for the REMP sample collector and to more accurately reflect non-occupational dose to a member of the public. The new locations were measured via GPS as required per CY-AA-170-1000. These changes do not affect radioactive effluent controls.	_x_Yes	___No
4. Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50.36a? Explain: This ODCM change does not affect the level of control previously established in the ODCM required by 10CFR50.36a. The basic requirement of 10CFR50.36a is to keep releases and the resultant dose to the public as low as reasonably achievable (ALARA). This ODCM change will not reduce the station's ability to keep releases of radioactive materials to unrestricted areas as low as reasonably achievable, as required by 10CFR50.36a.	_x_Yes	___No

Station: Byron

ODCM Revision No: 11 Determination Identifier: E – Special Interest Dosimeter Location Changes

	Special Interest dosimeters BY-302-1 and BY-314-1 were removed and BY-301-2 and BY-314-1 were added. The dosimeters remained in the same general locations but were moved from inside the security exclusion zone to outside the exclusion zone to allow easier access for the REMP sample collector and to more accurately reflect non-occupational dose to a member of the public. The new locations were measured via GPS as required per CY-AA-170-1000. These changes do not affect the radioactive effluent control required by 10CFR50.36a.		
5.	Does the ODCM change maintain the level of radioactive effluent control required by 10CFR50 Appendix I? Explain: 10CFR50 Appendix I states that liquid effluents from each reactor each year shall not expose any individual to more than 3 mrem to the total body or 10 mrem to any critical organ. Gaseous releases of particulates and iodines with half-lives >8 days shall not expose any individual organ to more than 15 mrem/year. Noble gases shall not expose any individual today body to more than 500 mrem/year, skin to more than 3000 mrem/year, gamma dose to 10 mrad/year, and beta dose to 20 mrad/year. Special Interest dosimeters BY-302-1 and BY-314-1 were removed and BY-301-2 and BY-314-1 were added. The dosimeters remained in the same general locations but were moved from inside the security exclusion zone to outside the exclusion zone to allow easier access for the REMP sample collector and to more accurately reflect non-occupational dose to a member of the public. The new locations were measured via GPS as required per CY-AA-170-1000. These changes do not affect the radioactive effluent control required by 10CFR50 Appendix I.	_x_Yes	___No
6.	Does the ODCM change maintain the accuracy or reliability of effluent, dose, or setpoint calculations? Explain: The accuracy and reliability of effluent, dose, and setpoint calculations will not be affected by this ODCM change. Effluent and setpoint calculations will continue to be performed using the established ODCM methodology. Special Interest dosimeters BY-302-1 and BY-314-1 were removed and BY-301-2 and BY-314-1 were added. The dosimeters remained in the same general locations but were moved from inside the exclusion zone to outside the exclusion zone to allow easier access for the REMP sample collector and to more accurately reflect non-occupational dose to a member of the public. These changes do not affect the accuracy or reliability of effluent, dose, or setpoint calculations.	_x_Yes	___No
7.	Does the ODCM change maintain the accuracy of radioactive effluent control required by the SAR ? Explain: This ODCM change will maintain the accuracy of the radioactive effluent control required by the Byron/Braidwood UFSAR. The B/B UFSAR Table 11.5-6, Radiological Analysis Summary of Gaseous Effluent Samples, includes typical sampling frequency, type of analysis, sensitivity, and purpose for effluent radiation monitors. No UFSAR described effluent samples or monitors are affected by this change. Special Interest dosimeters BY-302-1 and BY-314-1 were removed and BY-301-2 and BY-314-1 were added. The dosimeters remained in the same general locations but were moved from inside the security exclusion zone to outside the exclusion zone to allow easier access for the REMP sample collector and to more accurately reflect non-occupational dose to a member of the public. The new locations were measured via GPS as required per CY-AA-170-1000. These changes do not affect the accuracy of radioactive effluent control required by the SAR.	_x_Yes	___No

Byron Station
ODCM Revision 11 Change Determination
CY-AA-170-3100

Station: Byron

ODCM Revision No: 11 Determination Identifier: E – Special Interest Dosimeter Location Changes

Prepared by: _____ Date:_____

Reviewed by: _____ Date: _____

Byron Station
ODCM Revision 11 Change Summary Matrix

Administrative Changes - Determination A

Technical Changes (Holtec Report Reference) – Determination B

Technical Changes (Air Sampler Dosimeter Location Listings) – Determination C

Technical Changes (Dosimeter Maps) – Determination D

Technical Changes (Special Interest Dosimeter Location Changes) – Determination E

Item No.	(old) Rev. page No.	(new) Rev. page No.	Determination Identifier	Description of Change
1.	All	All	A	Revised page numbering format of entire document to align with current Exelon procedure writer's guide. Changed page number format from *X.X-X to Page X of X.*
2.	Multiple	Multiple	A	Added sub-step numbering as applicable over entire document to align with current Exelon procedure writer's guide. Section titles and subsection titles were retained.
3.	Table of Contents Page 6 of 7	Page 5 of 188	D	Changed Figure 6-3, "Inner Ring & Outer Ring Dosimeter Locations" to Figure 6-3a, "Inner Ring & Special Interest Dosimeter Locations," page 181. Added Figure 6-3b, "Outer Ring Dosimeter Locations," page 182.
4.	Table of Contents Page 7 of 7	N/A	A	Removed "Page Intentionally Left Blank" page.
5.	Radiological Effluents for Byron Station Units 1&2 Title Page	Page 6 of 188	A	Removed title page and added "Part 1 – Radiological Effluents" to start of section.
6.	Page I.5-5	Page 26 of 188	A	Removed "Page Intentionally Left Blank" page and added "Part 2 – ODCM" to start of section.
7.	Page II.1-7 Table 1-1	Page 33 of 188 Table 1-1	A	Changed Total Doses reference in table from" ODCM Section II" to "ODCM Part 2" to maintain consistent nomenclature.
8.	Page II.1-16	Page 42 of 188	B	Changed Reference 108 from Holtec Report No. HI-2084113, Dose Versus Distance from a HI-STORM 100S Version B Containing the MPC-32 for Byron/Braidwood, Holtec International, 8/14/08," to Holtec Report No. HI-2146048, Dose

Administrative Changes - Determination A

Technical Changes (Holtec Report Reference) – Determination B

Technical Changes (Air Sampler Dosimeter Location Listings) – Determination C

Technical Changes (Dosimeter Maps) – Determination D

Technical Changes (Special Interest Dosimeter Location Changes) – Determination E

				Versus Distance from a HI-STORM 100S Version B Containing the MPC-32 for Byron/Braidwood, Holtec International, 6/12/14"
9.	Page II.4-2 & II.4-3	Page 93 of 188	A	Moved $(\chi/Q)_s$ term to align with definition on page
10.	Page II.4-21 Table 4-2	Page 115 to 188 Table 4-2	A	Retyped Ground Level Release D/Q values to enhance legibility.
11.	Page II.5-2	Page 164 of 188 Section 5.1.2.2	B	Changed Holtec Report HI-2084113 to HI-2146048
12.	Page II.6-5	Page 173 of 188	C	Under Table 6-1, Section 2.c, Direct Radiation Indicators (Other), added the following: Two at each airborne location listed in Section 1.
13.	Page II.6-6	Page 174 of 188	C	Under Table 6-1, Section 2.d, Direct Radiation Indicators (Control), added the following: Two at each airborne location listed in Section 1.
14.	Page II.6-6	Page 174 of 188	E	Removed Table 6-1, Section 2, Direct Radiation Special Interest dosimeters BY-302-1, BY-314-1 and added BY-301-2, BY-314-2.
15.	Page II.6-13	Page 181-182 of 188	D	Made the following modifications to Figure 6-3, Inner Ring and Outer Ring Dosimeter Locations: • Removed Figure 6-3 and created 2 new maps consisting of Figure 6-3a, Inner Ring and Special Interest Dosimeter Locations, and Figure 6-3b, Outer Ring Dosimeter Locations • Added the Special Interest Dosimeters to Figure 6-3a, which were not previously mapped on Figure 6-3 • Changed the meteorological sector designator labels from A through R to compass direction labels (N, NNE, NE, etc.) • Changed the circle distance rings from 2 and 5 miles (generated from EP zone maps) in Figure 6-3, to 3.7

Administrative Changes - Determination A

Technical Changes (Holtec Report Reference) – Determination B

Technical Changes (Air Sampler Dosimeter Location Listings) – Determination C

Technical Changes (Dosimeter Maps) – Determination D

Technical Changes (Special Interest Dosimeter Location Changes) – Determination E

				and 5.0 miles (TRM Table T3.12.a-1 Section 2 requirements) in Figure 6-3b.
16.	Page II.6-17	Page 181-186 of 188	A	Corrected typo for BY-115-1 dosimeter longitude location from -89.27905 to -89.29705
17.	Page II.6-18	Page 181-187 of 188	A	Corrected typo for BY-201-4 dosimeter latitude location from 42.01381 to 42.13810
18.	Page II.6-19	Page 181-188 of 188	E	Removed dosimeter location BY-302-1 and BY-314-1 and added dosimeters BY-301-2 and BY-314-2 with the following characteristics: BY-301-2: Lat 42.07685, Long -89.28230, Distance (km) 0.24, Distance (mi) 0.15, Direction (deg) 7, Sector A, Sector N BY-314-2: Lat 42.07601, Long -89.28764, Distance (km) 0.43, Distance (mi) 0.27, Direction (deg) 289, Sector P, Sector WNW