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OPPD

Omaha Public Power District

April 27, 2016
LIC-16-0030

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Fort Calhoun Station, Unit No. 1
Renewed Facility Operating License No. DPR-40
NRC Docket No. 50-285

Subject: Fort Calhoun Station (FCS) Radiological Effluent Release Report and Radiological Environmental Operating Report

References: FCS Technical Specifications (TS) 5.9.4a and 5.9.4b

Pursuant to Fort Calhoun Station (FCS), Unit No. 1, Technical Specifications (TS) 5.9.4a, and 5.9.4b, the Omaha Public Power District (OPPD) provides the Annual Radiological Effluent Release Report and the Annual Radiological Environmental Operating Report.

The Annual Radiological Effluent Release Report is submitted in accordance with TS 5.9.4a and encompasses the period of January 1, 2015 through December 31, 2015. The report is presented in the format outlined in Regulatory Guide 1.21, Revision 1. In addition, the report provides the results of quarterly dose calculations performed in accordance with the Offsite Dose Calculation Manual (ODCM). In accordance with TS 5.17d and 5.18d, Section VII of the Annual Radiological Effluent Release Report includes the revisions to the ODCM and Process Control Program made during this period.

The Annual Radiological Environmental Operating Report is submitted in accordance with TS 5.9.4b and encompasses the period of January 1, 2015 through December 31, 2015.

No commitments to the NRC are contained in this letter.

IE48
NRR

Please contact Mr. Joel Glantz, Supervisor, RadWaste/Environmental, at (402) 533-7382 if you should have any questions.

Respectfully,

Bradley H. Blome
Manager, Site Regulatory Assurance

BHB/JMG/epm

Enclosures:

1. Annual Radiological Effluent Release Report
2. Annual Radiological Environmental Operating Report

c: M. L. Dapas, NRC Regional Administrator, Region IV
C. F. Lyon, NRC Project Manager
S. M. Schneider, NRC Senior Resident Inspector

Omaha Public Power District
Fort Calhoun Station Unit No. 1

Annual Report
For
Technical Specification
Section 5.9.4.a

January 1, 2015 to December 31, 2015

DOCKET NO. 50-285

OPERATING LICENSE DPR-40

Memorandum

Date: May 1, 2016

From: Plant Manager, Fort Calhoun Station

To: Distribution

Re: Annual Radiological Effluent Release Report for Technical Specification Section 5.9.4.a.
January 1, 2015 through December 31, 2015

Attached is a copy of the 2015 Annual Radiological Effluent Release Report for January 1, 2015 through December 31, 2015. This report is submitted in accordance with Section 5.9.4.a of the Technical Specifications of Fort Calhoun Station Unit No. 1, Facility Operating License DPR-40. The Effluent Report is presented in the format outlined in Regulatory Guide 1.21, Revision 2.

In addition, this report provides the results of quarterly dose calculations performed in accordance with the Offsite Dose Calculation Manual. Results are presented by quarter for the period January 1, 2015 through December 31, 2015. Descriptions of any changes made during the preceding twelve months to the Offsite Dose Calculation Manual and/or the Process Control Program for the Fort Calhoun Station are presented.

Plant Manager
Fort Calhoun Station

Todd Livingston

Distribution:

Site Vice President
Plant Manager
Director-Operations
Manager-Radiation Protection
Manager-Site Chemistry, Environmental and Radwaste
Supervisor-Radwaste and Environmental
Supervisor-RP Technical Support

Omaha Public Power District
Fort Calhoun Station Unit No. 1

Annual Report
For
Technical Specifications,
Section 5.9.4.a

January 1, 2015 to December 31, 2015

DOCKET NO. 50-285 OPERATING LICENSE DPR-40

Annual Radiological Effluent Release Report

This report is submitted in accordance with Section 5.9.4.a of the Technical Specifications of Fort Calhoun Station Unit No. 1, Facility Operating License DPR-40 for the period January 1, 2015 through December 31, 2015. The Effluent Report is presented in the format outlined in Regulatory Guide 1.21, Revision 2.

In addition, this report provides the results of quarterly dose calculations performed in accordance with the Offsite Dose Calculation Manual. Results are presented by quarter for the period January 1, 2015 through December 31, 2015.

Descriptions of any changes made during the preceding twelve months to the Offsite Dose Calculation Manual and/or the Process Control Program for the Fort Calhoun Station are presented.

Division Manager Nuclear Operations/Plant Manager

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1.0 INTRODUCTION

This Annual Radiological Effluent Release Report, for Fort Calhoun Station Unit No. 1, is submitted as required by Technical Specification 5.9.4.a for the period January 1, 2015 through December 31, 2015.

1.1 Executive Summary

The Radioactive Effluent Monitoring program for the year 2015 was conducted as described in the following report. Major efforts were made to maintain the release of radioactive effluents to the environment as low as reasonably achievable.

The total airborne activity released from noble gas was 1.31 curies. This was a decrease from the 2014 activity of 1.49 curies.

The total airborne activity from I-131, I-133, and particulates with half-lives > 8 days in 2015 was 3.70E-06 curies. This an increase from the 2014 activity of 0.00 curies.

The total airborne activity from Tritium was 2.88 curies. This was an increase from the 2014 activity of 0.904 curies. RFO activities represent 79% of this release.

The total airborne activity from C-14 was 1.97 curies. This was a decrease from the 2014 activity of 2.35 curies. This decrease is attributed to the station operating 10 months vice for a full year. Airborne activity from C-14 is included in the 2015 annual report, per Regulatory Guide 1.21, Revision 2. This is a calculated value based on power generation and days of operation. Critical organ doses from C-14 were calculated using a ratio of 15% as CO_2. This ratio was determined during an NRC in-plant source term study conducted at the Fort Calhoun Station between 1976 and 1977, NUREG/CR-0140.

Dose contributions from airborne effluents at the unrestricted area boundary were; 1.35 E-03 mRad gamma air dose, 6.66E-04 mRad beta air dose, 9.97E-02 mRem total body dose, and 4.83E-01 mRem critical organ dose. Gamma and beta dose showed an decrease from 2014 levels of 1.50 E-03 mRad gamma air dose and 7.40E-04 mRad beta air dose, which is attributed to the station being operated 10 months vice 12 and reduction in gas source term for Cycle 27. Whole body and critical organ doses decreased from 2014 levels of 1.19E-01 mRem total body dose and 5.90E-02 mRem critical organ dose. This decrease is attributed to the station being operated 10 months vice 12 and the gas source term reduction previously mentioned.

Total water activity (excluding tritium, dissolved gases, and alpha) released in 2015 in liquid effluents was 1.21E-02 curies. This was an increase from the 2014 activity of 2.17E-03 curies.
The total activity released increased despite a significant decrease in total volume released. Processed liquid rad waste volume increased due to increased RCS Pressurizer Quench Tank and Safety Injection Tank leakage. A higher fraction of tanks with increased activity offset total liquid volume reductions made by the station. Forty per cent of the activity released was from HTD beta emitters Ni-63 and Fe-55 being identified in liquid effluent composites. The total water tritium activity released in 2015 in liquid effluents was 158 curies. This was a decrease from the 2014 activity of 186 curies. This decrease was due to the station outages.

The calculated whole body dose due to liquid effluents at the site discharge from all sources in 2015 was 3.11E-02 mRem. This was an increase from the 2014 dose of 5.70-04 mRem. Dose increased due to an increase in released activity and a reduction in dilution flow due to refueling activities.

The calculated critical organ dose due to liquid effluents at the site discharge from all sources in 2015 was 4.40E-02 mRem. This was an increase from the 2014 dose of 6.77E-04 mRem. Dose increased due to an increase in released activity and a reduction in dilution flow due to refueling activities.

The Fort Calhoun Station meteorological system had a cumulative recovery rate of 99.90% from the station meteorological tower with the remaining 0.1% provided by the National Weather Service, for the joint frequency parameters required by Regulatory Guide 1.23 for wind speed, wind direction, and delta temperature.

There were no abnormal releases during 2015.

During 2015 there was one change to the Off-site Dose Calculations Manual (ODCM), CH-ODCM-0001 and one change to the Process Control Program, RW-AA-100.

For 2015, the total volume of solid radwaste released from the unit was 580 cubic meters. This was an increase from the 0.0 cubic meters of solid waste released from the unit in 2014. The increase was attributed to eight shipments made in 2015.

The total activity released from the unit for 2015 was 0.711 curies, 0.00 curies from spent resin and 0.711 curies from dry

compressables. This was an increase from the 2014 value of 0.0 curies. Overall, the effluent monitoring program was conducted in a manner to ensure the activity released and dose to the public were maintained as low as reasonably achievable.

2.0 SUPPLEMENTAL INFORMATION

2.1 Regulatory Limits

The ODCM Radiological Effluent Control Specifications applicable to the release of radioactive material in liquid and gaseous effluents are described in the following sections.

2.1.1 Fission and Activation Gases (Noble Gases)

The release rate of radioactive material in airborne effluents shall be controlled such that the instantaneous concentrations of radionuclides do not exceed the values specified in 10 CFR 20 for airborne effluents at the unrestricted area boundary. To support plant operations, Supervisor - System Chemistry may increase this limit up to the limits specified in Technical Specification 5.16.1.g.

Technical Specification 5.16.1.g establishes the administrative control limit on the concentration resulting from radioactive material, other than noble gases, released in gaseous effluents to unrestricted areas conforming to ten times 10 CFR 20.1001-20.2401, Appendix B, Table 2, Column 1. For noble gases, the concentration shall be limited to five times 10 CFR 20.1001-20.2401, Appendix B, Table 2, Column 1.

The air dose due to noble gases released in gaseous effluents to areas at or beyond the unrestricted area boundary shall be limited to the following:

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

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

2.1.2 Doses from I-131, I-133, C-14, Tritium, and Radioactive Material in Particulate Form with Half Lives Greater than 8 Days (Other than Noble Gases).

a. The dose to an individual or dose commitment to any organ of an individual in unrestricted areas due to the release of I-131, I-133, C-14, H-3, and radioactive material in particulate form with half-lives greater than eight days (other than noble gases) in airborne effluents shall not exceed 7.5 millirem from all exposure pathways during any calendar quarter.

b. The dose to an individual or dose commitment to any organ of an individual in unrestricted areas due to the release of I-131, I-133, C-14, H-3, and radioactive materials in particulate form with half-lives greater than eight days (other than noble gases) in airborne effluents shall not exceed 15 millirem from all exposure pathways during any calendar year.

2.1.3 Liquid Effluents

The release rate of radioactive material in liquid effluents shall be controlled such that the instantaneous concentrations for radionuclides, other than dissolved or entrained noble gases, do not exceed the values specified in 10 CFR 20 for liquid effluents at site discharge. To support plant operations, the Supervisor - System Chemistry may increase this limit up to the limit specified in Technical Specifications 5.16.1.b.

Technical Specification 5.16.1.b establishes the administrative control limit on concentration of radioactive material, other than dissolved or entrained noble gases, released in liquid effluents to unrestricted areas conforming to ten times 10 CFR 20.1001-20.2401, Appendix B, Table 2, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-04 µCi/mL total activity.

The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released to unrestricted areas shall be limited to:

a. During any calendar quarter: Less than or equal to 1.5 mRem to the whole body and less than or equal to 5 mRem to any organ, and

b. During any calendar year: Less than or equal to 3

mRem to the whole body and less than or equal to 10 mRem to any organ.

2.1.4 Total Dose-Uranium Fuel Cycle

The dose to any individual from uranium fuel cycle sources shall be limited to ≤ 25 mRem to the total body or any organ (except the thyroid, which shall be limited to ≤ 75 mRem) during each calendar year.

2.2 Effluent Concentration Limits (ECL)

2.2.1 Liquid Effluents

The values specified in 10 CFR Part 20, Appendix B, Column 2 are used as the ECL for liquid radioactive effluents released to unrestricted areas. A value of 2.0E-04 µCi/mL is used as the ECL for dissolved and entrained noble gases in liquid effluents.

2.2.2 Gaseous Effluents

The values specified in 10 CFR Part 20, Appendix B, Column 1 are used as the ECL for gaseous radioactive effluents released to unrestricted areas.

2.3 Measurements and Approximations of Total Radioactivity

Measurements of total radioactivity in liquid and gaseous radioactive effluents were accomplished in accordance with the sampling and analysis requirements of Tables 3.1 and 3.2 of Part I of the ODCM.

2.3.1 Liquid Radioactive Effluents

Each batch was sampled and analyzed for gamma emitting radionuclides using gamma spectroscopy, prior to release. Composite samples were analyzed monthly and quarterly for the Monitor Tanks and Steam Generators. Composite samples were analyzed monthly in the onsite laboratory for tritium and gross alpha radioactivity, using liquid scintillation and proportional counting techniques respectively. Composite samples were analyzed quarterly for Sr-89, Sr-90, Fe-55, Ni-63, and Gross Alpha by a contract laboratory (Teledyne Brown Engineering, Inc.). A software program

was used to project the total body and critical organ dose contribution at the unrestricted area boundary for each release and the percent contribution to the annual objective dose.

There were no continuous releases from the Steam Generator blowdown during the reporting period.

2.3.2 Gaseous Radioactive Effluents

Each gaseous batch release was sampled and analyzed for radioactivity prior to release. For release of Waste Gas Decay Tanks, noble gas grab samples were analyzed for gamma emitting radionuclides using gamma spectroscopy. For releases from the Containment Building, samples were taken using charcoal and particulate filters, in addition to noble gas and Tritium grab samples, and analyzed for gamma emitting radionuclides prior to each release. The results of the analysis and the total volume of effluent released were used to determine the total amount of radioactivity released in the batch mode. A software program was developed and installed that can project the total body and critical organ dose contribution at the unrestricted area boundary for each release and the percent contribution to the annual objective dose. This program also adds the projected dose to the current actual dose totals in a temporary file, until it is updated with actual release data at the completion of a purge.

Continuous release effluent pathways were continuously sampled using charcoal and particulate filters and analyzed weekly for gamma emitting radionuclides using gamma spectroscopy. Weekly particulate filters were analyzed for gross alpha radioactivity in the onsite laboratory using proportional counting techniques. Quarterly composites of particulate filters were analyzed for Sr-89, Sr-90, and Gross Alpha by a contract laboratory (Teledyne Brown Engineering, Inc.).

2.4 Estimation of Total Percent Error

The estimated total percent error is calculated as follows:

Total Percent Error = $(E_1^2 + E_2^2 + E_3^2 + \ldots + E_n^2)^{0.5}$
Where E_n = percent error associated with each contributing parameter.

Sample counting error is estimated by the Canberra Genie System Software for samples analyzed by gamma spectroscopy. This calculation can include the error associated with peak area determination, gamma ray abundance, efficiency and half-life. Systematic error is estimated for gaseous and liquid effluent analyses and dilution and wastewater volume.

2.5 Batch Releases

A summary of information for liquid and gaseous batch releases is included in Table III.1.

2.6 Abnormal Releases

Abnormal Releases are defined as unplanned and unmonitored releases of radioactive material from the site.

A summary of information for liquid and gaseous abnormal releases is included in Table III.2.

3.0 GASEOUS EFFLUENTS

The quantities of radioactive material released in gaseous effluents are summarized in Tables III.3, III.4 and III.5. All radioactive materials released in gaseous form are considered to be ground level releases.

4.0 LIQUID EFFLUENTS

The quantities of radioactive material released in liquid effluents are summarized in Tables III.6, III.7 and III.8.

5.0 SOLID WASTES

The quantities of radioactive material released as solid effluents are summarized in Section VI.

6.0 RELATED INFORMATION

6.1 Operability of Liquid and Gaseous Monitoring Instrumentation

During the reporting period there were no instruments used to monitor radioactive effluent releases that failed to meet the minimum reportable instrument operability requirements listed in the ODCM during the reporting period.

6.2 Revision to the Offsite Dose Calculation Manual (ODCM) and/or Process Control Program

During 2015, one revision was made to the ODCM:

- Incorporate NFPA 805 requirements, examples include:

  -add survey guidance for liquids and gases generated during Firefighting activities

- Table 5.2 footnote correction.

- Clarify ODCM grace period requirements.

During 2015, one revision was made to the Process Control Program, RW-AA-100:

- Change procedure to fleet format.

6.3 New Locations or Modifications for Dose Calculations or Environmental Monitoring

- No new locations for the REMP in 2015.

6.4 Noncompliance with Radiological Effluent Control Requirements

This section provides a list of any event that did not comply with the applicable requirements of the Radiological Effluent Controls given in the Offsite Dose Calculation Manual (ODCM). Detailed documentation concerning the evaluations and corrective actions is maintained onsite.

6.4.1 Abnormal Gaseous and Liquid Releases

No abnormal releases were made during the calendar year of 2015.

6.4.2 Failure to Meet Specified Sampling Requirements

During 2015, there were no instances in which specified sampling requirements were not met.

6.5 Modifications to Liquid and Gaseous Waste Treatment and Ventilation Exhaust Systems

During the reporting period no design modifications were approved nor implemented involving major changes to the Liquid and Gaseous Waste Treatment Systems.

6.6 Meteorological Monitoring Program

A summary of hourly meteorological data, collected during 2015, is retained onsite and is maintained as documentation as required by Regulatory Guide 1.21 Rev 2. This data is available for review by the Nuclear Regulatory Commission upon request. Joint Frequency tables are included in Section VII, Attachment 2

Real time hourly meteorological data is used to calculate the annual air effluent dose to individuals. For quarterly estimates during the year an annual average X/Q is used, which is an average of the highest X/Q's calculated for each of the previous two years.

6.7 Assessment of Doses

6.7.1 Doses Due to Liquid Effluents

Total body, skin, and organ dose for liquid releases were calculated in mRem for all significant liquid pathways using the annual configuration of the LADTAP II program. The site discharge location was chosen to present a most conservative estimate of dose for an average adult, teenager, child, and infant. A conservative approach is also presented by the assumption that Omaha and Council Bluffs receive all drinking water from the Missouri River.

The LADTAP II program in its annual configuration was also used to calculate the total body and organ doses for the population of 950,006 within a 50-mile radius of the plant (based on the 2010 census). The results of the calculations are listed in Section V.

The doses due to liquid effluents for total body and critical organ are also calculated quarterly using the methods in the ODCM. The results are listed in Section II.

6.7.2 Doses Due to Gaseous Effluents

Total body, skin and organ doses from ground releases were

calculated in mRem to an average adult, teenager, child, and infant in each receptor using the annual configuration of the GASPAR II program. Also, the doses to the same groups, in units of mRad due to gamma and beta radiation carried by air, were computed using GASPAR II.
The GASPAR II program in its annual configuration was also used to calculate the ALARA integrated population dose summary for the total body, skin and organ doses in person-rem for all individuals within a 50-mile radius. The results of the calculations are shown in Section IV.

The doses due to gaseous effluents for total body gamma and beta noble gas air dose are calculated quarterly using the methods in the ODCM with an annual average X/Q. The results are listed in Section II.

6.7.3 Doses Due to I-131, I-133, C-14, H-3, and Particulates with Half Lives Greater than 8 days.

The doses due to I-131, I-133, C-14, H-3, and Particulates with half-lives greater than 8 days for total body and critical organ dose are calculated quarterly using the highest of infant or child dose factors and an annual average X/Q. The results are listed in Section II for inhalation, ground and food.

6.7.4 Direct Radiation Dose to Individuals and Populations

Direct radiation doses attributed to the gamma radiation emitted from the containment structure were not observed above local background at any TLD sample locations for this annual period.

6.7.5 40 CFR 190 Dose Evaluation

ODCM Radiological Effluent Controls require dose evaluations to demonstrate compliance with 40 CFR Part 190 only if calculated yearly doses exceed two times the annual design objectives for liquid and/or gaseous effluents. At no time during 2015 were any of these limits exceeded; therefore, no evaluations were required.

6.8 Groundwater Monitoring Program and Observations

- OPPD conducted groundwater sampling from 19 wells, 2 surface water sites, and 4 storm water headers within the

site property per NEI 07-07. Additionally Nebraska requirements regarding avoidance of snow runoff were deleted, so storm water sampling is now performed quarterly, if available.

- No new monitoring wells were added to the sampling program during 2015. Ten sample locations in sectors experiencing significant (>10%) wind direction were established to assess potential atmospheric deposition. After an initial sampling regime in all ten sectors displayed no detectable tritium, the sampling program was switched to 2 affected sectors per rain event and an upwind background test. Four sampling events were conducted. No tritium activity in excess of the vendor's Minimum Detectable Activity (MDA) was reported.

- One tritium activity in excess of the vendor's Minimum Detectable Activity (MDA) was reported in Table III.9. This result was obtained at MW-6. MW-6 is hydro-geologically connected to the river and is in close proximity to the licensed effluent release point. MW-6 has historically had activity identified in excess of the MDA when river levels are high. The results are all below NRC, EPA, NEI and FCS groundwater protection program administrative reporting limits. Some hard to detect nuclides, were reduced to an annual sample frequency (Ni-63, Fe-55, Sr-90 in deep wells) based on 2 years of quarterly sampling with no detections above MDA.

- The Fort Calhoun REMP sampling identified one detected tritium sample within the Missouri River downstream at the nearest municipal drinking water facility at a level of 389 pCi/l. No groundwater drinking pathway exists on site. No state or federal drinking water limits, and no site groundwater protection program administrative limits were exceeded.

SECTION II

QUARTERLY DOSES FROM EFFLUENTS

Offsite Dose Calculation Manual

January 1, 2015 - December 31, 2015

Quarterly Dose Calculation Results

January 1, 2015 through December 31, 2015

With the implementation of the Fort Calhoun Station Radiological Effluent Technical Specifications (RETS) on October 1, 1985, radiation doses in the unrestricted area from liquid and gaseous effluents must be calculated on a quarterly basis in accordance with the Offsite Dose Calculation Manual (ODCM). These calculations are performed to ensure the annual dose limits delineated in Appendix I of 10 CFR 50 and implemented by RETS are not exceeded. If the results of the quarterly calculations exceed fifty percent (50%) of the annual limits of Appendix I, actions are taken to reduce effluents so that the resultant doses do not exceed the annual limits during the remainder of the year and a special report is submitted to the Nuclear Regulatory Commission. No special reports were required for 2015 calculated doses.

This section presents the results of the quarterly dose calculations performed during the period January 1, 2015 through December 31, 2015. Details are shown as to the types, sources and resultant doses from the effluents, the annual limits and a comparison to the annual limits.

QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN FIRST QUARTER 2015 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	8.11E-03	8.77E-03
Continuous:	0.00E+00	0.00E+00
Totals:	8.11E-03	8.77E-03
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.54 %	0.18 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.27 %	0.09 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	8.12E-04	3.64E-04
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.02 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.01 %	0.00 %

B. I-131, I-133, Tritium, C-14, and Particulates with Half-Lives > 8 Days:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Inhalation:	5.39E-05	5.39E-05
Ground and Food:	4.83E-02	2.40E-01
Totals:	4.83E-02	2.40E-01
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.64 %	3.20 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.32 %	1.60 %

Reviewed by: 7/22/15

QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN SECOND QUARTER 2015 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	4.26E-03	5.61E-03
Continuous:	0.00E+00	0.00E+00
Totals:	4.26E-03	5.61E-03
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.28 %	0.11 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.41 %	0.14 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	2.52E-04	1.53E-04
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.01 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.01 %	0.00 %

B. I-131, I-133, Tritium, C-14, and Particulates with Half-Lives > 8 Days:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Inhalation:	3.60E-04	3.72E-04
Ground and Food:	1.65E-02	7.42E-02
Totals:	1.69E-02	7.46E-02
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.22 %	0.99 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.43 %	2.10 %

Reviewed by: _____
10/1/15

QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN THIRD QUARTER 2015 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	8.05E-03	1.15E-02
Continuous:	0.00E+00	0.00E+00
Totals:	8.05E-03	1.15E-02
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.54 %	0.23 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.62 %	0.26 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	6.16E-04	3.68E-04
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.01 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.02 %	0.00 %

B. I-131, I-133, Tritium, C-14, and Particulates with Half-Lives > 8 Days:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Inhalation:	4.44E-04	4.57E-04
Ground and Food:	4.45E-02	2.12E-01
Totals:	4.50E-02	2.13E-01
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.60 %	2.84 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.73 %	3.52 %

Reviewed by: 4/15/16

QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN FOURTH QUARTER 2015 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	1.18E-02	1.77E-02
Continuous:	0.00E+00	0.00E+00
Totals:	1.18E-02	1.77E-02
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.79 %	0.35 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	1.02 %	0.43 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	6.95E-04	2.90E-04
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.01 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.02 %	0.01 %

B. I-131, I-133, Tritium, C-14, and Particulates with Half-Lives > 8 Days:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Inhalation:	1.48E-04	1.48E-04
Ground and Food:	4.87E-02	2.40E-01
Totals:	4.88E-02	2.40E-01
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.65 %	3.20 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	1.06 %	5.12 %

Reviewed by: _____ 4/15/16

SECTION III

RADIOLOGICAL EFFLUENT RELEASES

Technical Specification (5.9.4.a)

January 1, 2015 - December 31, 2015

TABLE III.1

BATCH LIQUID AND GASEOUS RELEASE SUMMARY

JANUARY THROUGH DECEMBER 2015

A. Liquid Releases All Sources	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. Number of Batch Releases:	23	88	51	29	191
2. Total Time Period for Batch Releases(min):	3,121	18,009	6,940	4,140	32,210
3. Maximum Time Period for Batch Releases(min):	210	1,240	223	250	1,240
4. Average Time Period for Batch Releases(min):	136	205	136	143	169
5. Minimum Time Period for Batch Releases(min):	110	5	5	110	5
6. Average Dilution Stream Flow During Periods of Release into the Missouri River(mls/min):	1.225E+09	4.526E+08	1.283E+09	1.332E+09	9.007E+08

B. Gaseous Releases All Sources	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. Number of Batch Releases:	17	52	24	17	110
2. Total Time Period for Batch Releases(min):	98,402	79,496	100,722	118,207	396,827
3. Maximum Time Period for Batch Releases(min):	8,528	8,388	8,669	9,725	9,725
4. Average Time Period for Batch Releases(min):	5,788	1,529	4,197	6,953	3,608
5. Minimum Time Period for Batch Releases(min):	65	1	1	55	1

TABLE III.2

ABNORMAL BATCH LIQUID AND GASEOUS RELEASE SUMMARY

JANUARY THROUGH DECEMBER 2015

A. Liquid Releases All Sources	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
Number of Releases:	0	0	0	0	0
Total Activity Releases(Ci):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

B. Gaseous Releases All Sources	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
Number of Releases:	0	0	0	0	0
Total Activity Releases (Ci):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE III.3

GASEOUS EFFLUENTS--SUMMATION OF ALL RELEASES

JANUARY THROUGH DECEMBER 2015

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
A.	Fission & Activation Gases					
	Total Release (Ci):	3.66E-01	2.06E-01	4.79E-01	2.63E-01	1.31E+00
	Average Release Rate (uCi/sec):	1.22E-03	1.32E-03	1.17E-03	7.97E-04	1.09E-03
	Total Error (%): 26.25					
B.	Iodines					
	Total Release (Ci):	0.00E+00	1.75E-06	1.96E-06	0.00E+00	3.70E-06
	Average Release Rate (uCi/sec):	0.00E+00	2.25E-07	2.49E-07	0.00E+00	2.36E-07
	Total Error (%): 21.88					
C.	Particulates					
	Total Release (Ci):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Average Release Rate (uCi/sec):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total Error (%): 20.62					
	Gross Alpha:					
	Total Error (%): 20.62	3.26E-06	3.85E-06	2.31E-06	2.05E-06	1.15E-05
D.	Tritium					
	Total Release (Ci):	1.64E-01	9.16E-01	1.35E+00	4.52E-01	2.88E+00
	Average Release Rate (uCi/sec):	8.20E-04	1.90E-03	5.21E-03	2.13E-03	2.48E-03
	Total Error (%): 25.08					
E.	Carbon-14					
	Total Release (Ci):	6.15E-01	1.90E-01	5.45E-01	6.15E-01	1.97E+00
	Average Release Rate (uCi/sec):	6.15E-03	4.90E-03	5.77E-03	6.02E-03	5.81E-03
	Total Error (%): 25.08					

NOTE: Values reported as zero are determined to be below the Lower Limit of Detection (LLD).

TABLE III.4

GASEOUS EFFLUENTS--GROUND LEVEL RELEASES

JANUARY THROUGH DECEMBER 2015

Batch Mode

Nuclides(Ci)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	YEAR
Fission & Activation Gases					
XE-133	1.77E-01	1.51E-01	3.36E-01	9.89E-02	7.63E-01
XE-135	3.87E-03	1.37E-03	1.19E-02	3.98E-03	2.11E-02
XE-133M	0.00E+00	0.00E+00	8.21E-05	0.00E+00	8.21E-05
AR-41	1.85E-01	5.36E-02	1.31E-01	1.60E-01	5.30E-01
XE-131M	0.00E+00	0.00E+00	7.10E-05	0.00E+00	7.10E-05
Totals for Period:	3.66E-01	2.06E-01	4.79E-01	2.63E-01	1.31E+00
Iodines					
Totals for Period:	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulates					
Totals for Period:	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium and Gross Alpha					
H-3	4.62E-02	5.83E-01	1.04E+00	1.04E-01	1.77E+00

NOTE: Values reported as zero are determined to be below the Lower Limit of Detection (LLD).

TABLE III.5

GASEOUS EFFLUENTS--GROUND LEVEL RELEASES

JANUARY THROUGH DECEMBER 2015

Continuous Mode

Nuclides(Ci)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
Fission & Activation Gases					
Totals for Period:	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iodines					
I-131	0.00E+00	1.75E-06	1.96E-06	0.00E+00	3.70E-06
Totals for Period:	0.00E+00	1.75E-06	1.96E-06	0.00E+00	3.70E-06
Particulates					
C-14	6.15E-01	1.90E-01	5.45E-01	6.15E-01	1.97E+00
Totals for Period:	6.15E-01	1.90E-01	5.45E-01	6.15E-01	1.97E+00
Tritium and Gross Alpha					
ALPHA	3.26E-06	3.85E-06	2.31E-06	2.05E-06	1.15E-05
H-3	1.18E-01	3.33E-01	3.10E-01	3.47E-01	1.11E+00

NOTE: Values reported as zero are determined to be below the Lower Limit of Detection (LLD).

TABLE III.6

LIQUID EFFLUENTS--SUMMATION OF ALL RELEASES

JANUARY THROUGH DECEMBER 2015

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
A. Fission & Activiation Products					
Total Release (No H-3,Gas,Alpha) (Ci):	2.76E-04	4.79E-03	4.25E-03	2.81E-03	1.21E-02
Average Diluted Concentration (uCi/mL):	3.82E-11	3.32E-09	9.49E-10	4.12E-10	2.80E-09
10 CFR 20, App. B Limit 1.00E-06 (uCi/mL) Percent of Limit (%):	3.82E-03	3.32E-01	9.49E-02	4.12E-02	2.80E-01
Total Error (%): 24.76					
B. Tritium					
Total Release (Ci):	7.45E+01	3.72E+01	3.02E+01	1.64E+01	1.58E+02
Average Diluted Concentration (uCi/mL):	1.03E-05	2.58E-05	6.74E-06	2.41E-06	3.66E-05
10 CFR 20, App. B Limit 1.00E-03(uCi/mL) Percent of Limit (%):	1.03E+00	2.58E+00	6.74E-01	2.41E-01	3.66E+00
Total Error (%): 25.08					
C. Dissolved & Entrained Gases					
Total Release (Ci):	1.04E-05	6.18E-04	9.22E-05	1.04E-06	7.22E-04
Average Diluted Concentration (uCi/mL):	1.44E-12	4.28E-10	2.06E-11	1.53E-13	1.67E-10
ODCM Limit 2.00E-04 (uCi/mL): Percent of Limit (%):	7.18E-07	2.14E-04	1.03E-05	7.63E-08	8.33E-05
Total Error (%): 37.06					
D. Gross Alpha Radioactivity					
Total Release (Ci):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Error (%): 27.22					
E. Volume of Waste Released Prior to Dilution (Liters):	2.81E+07	1.76E+07	2.93E+07	3.19E+07	1.07E+08
F. Volume of Dilution Water During Releases (Liters):	3.50E+11	1.43E+11	3.37E+11	3.83E+11	1.21E+12

NOTE: Values reported as zero are determined to be below the Lower Limit of Detection (LLD).

TABLE III.7

LIQUID EFFLUENTS

JANUARY THROUGH DECEMBER 2015

Batch Mode

Nuclides(Ci)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
Fission & Activation Gases					
TC-99M	0.00E+00	0.00E+00	2.08E-05	0.00E+00	2.08E-05
RU-103	0.00E+00	3.68E-08	0.00E+00	0.00E+00	3.68E-08
MN-54	0.00E+00	0.00E+00	0.00E+00	6.18E-07	6.18E-07
FE-55	0.00E+00	1.17E-03	0.00E+00	0.00E+00	1.17E-03
SE-75	0.00E+00	8.45E-08	4.56E-07	0.00E+00	5.40E-07
I-133	0.00E+00	6.37E-06	2.96E-05	1.54E-08	3.60E-05
SN-117M	0.00E+00	8.21E-09	0.00E+00	0.00E+00	8.21E-09
CS-137	9.56E-05	1.94E-04	1.02E-03	1.90E-03	3.21E-03
I-132	0.00E+00	2.40E-06	3.12E-05	0.00E+00	3.36E-05
CS-134	0.00E+00	0.00E+00	0.00E+00	1.49E-05	1.49E-05
CO-58	0.00E+00	1.09E-03	1.09E-03	2.03E-04	2.38E-03
MO-99	0.00E+00	0.00E+00	2.09E-05	0.00E+00	2.09E-05
I-131	5.99E-06	1.11E-04	3.18E-04	1.74E-05	4.52E-04
AM-241	0.00E+00	0.00E+00	0.00E+00	2.77E-06	2.77E-06
SB-124	0.00E+00	2.92E-04	1.69E-04	6.37E-06	4.68E-04
SB-125	2.50E-06	3.77E-05	5.09E-06	0.00E+00	4.53E-05
NI-63	8.97E-05	1.70E-03	1.31E-03	5.55E-04	3.66E-03
CO-60	8.25E-05	1.90E-04	2.39E-04	1.11E-04	6.22E-04
Totals for Period:	2.76E-04	4.79E-03	4.25E-03	2.81E-03	1.21E-02
Dissolved & Entrained Gases					
XE-133	1.04E-05	6.18E-04	9.22E-05	1.04E-06	7.22E-04
Totals for Period:	1.04E-05	6.18E-04	9.22E-05	1.04E-06	7.22E-04
Tritium and Gross Alpha					
H-3	7.45E+01	3.72E+01	3.02E+01	1.64E+01	1.58E+02

NOTE: Values reported as zero are determined to be below the Lower Limit of Detection (LLD) values.
Reported Alpha activity was attributed to natural short-lived radionuclides. This was confirmed by quarterly offside vendor analysis.

TABLE III.8
LIQUID EFFLUENTS
JANUARY THROUGH DECEMBER 2015
Continuous Mode

Nuclides(Ci)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
Fission & Activation Products					
Totals for Period:	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved & Entrained Gases					
Totals for Period:	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium and Gross Alpha					
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

NOTE: Values reported as zero are determined to be below the Lower Limit of Detection (LLD).

TABLE III.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2015

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
MW-1A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55				
	NI-63		0.00E+00		
	Sr-90	0.00E+00	0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-1B					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-2					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55			0.00E+00	
	NI-63			0.00E+00	
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-2A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90	0.00E+00	0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-2B					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-3					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55			0.00E+00	
	NI-63			0.00E+00	
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-3A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90		0.00E+00	0.00E+00	
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-3B					
	Tritium	0.00E+00	0.00E+00	2.37E+02	0.00E+00
	FE-55		0.00E+00	0.00E+00	0.00E+00
	NI-63		0.00E+00	0.00E+00	0.00E+00
	Sr-90			0.00E+00	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-4A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90	0.00E+00	0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	

TABLE III.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2015

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
MW-4B					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00	0.00E+00	
	NI-63		0.00E+00	0.00E+00	
	Sr-90			0.00E+00	
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-5A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55				
	NI-63				
	Sr-90	0.00E+00	0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-6					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55	0.00E+00	0.00E+00		0.00E+00
	NI-63	0.00E+00	0.00E+00		0.00E+00
	Sr-90	0.00E+00	0.00E+00		0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-5B					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55			0.00E+00	
	NI-63			0.00E+00	
	Sr-90			0.00E+00	
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-7					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55	0.00E+00		0.00E+00	
	NI-63			0.00E+00	
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-9					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55	0.00E+00	0.00E+00		
	NI-63	0.00E+00	0.00E+00		
	Sr-90	0.00E+00	0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-10					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55	0.00E+00	0.00E+00		
	NI-63	0.00E+00	0.00E+00		
	Sr-90	0.00E+00	0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-11					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55	0.00E+00	0.00E+00		
	NI-63	0.00E+00	0.00E+00		
	Sr-90	0.00E+00	0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	
MW-12A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55	0.00E+00	0.00E+00		
	NI-63	0.00E+00	0.00E+00		
	Sr-90	0.00E+00	0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	

TABLE III.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2015

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
MW-12B				
Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55	0.00E+00	0.00E+00		
NI-63	0.00E+00	0.00E+00		
Sr-90	0.00E+00	0.00E+00		
Total Gamma	0.00E+00	0.00E+00	0.00E+00	
EAST LAGOON				
Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55				
NI-63				
Sr-90				
Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
WEST LAGOON				
Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55				
NI-63				
Sr-90				
Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NORTH STORMWATER HDR				
Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55				
NI-63				
Sr-90				
Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SOUTH STORMWATER HDR				
Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55				
NI-63				
Sr-90				
Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW-8 NORTH PA				
Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55				
NI-63				
Sr-90				
Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW-6 ISFSI				
Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55				
NI-63				
Sr-90				
Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00

NOTE: Values reported as zero are determined to be below the Lower Limit of Detection (LLD).
Only Tritium and Gamma are required for each sampling event.
Hard to detect (HTD) nuclide sampling frequency is per station procedures.
Missed sampling events are covered in the executive summary.

SECTION IV
DOSE FROM GASEOUS EFFLUENTS

Technical Specification 5.9.4.a

GASPAR II OUTPUT

January 1, 2015 - December 31, 2015

Radioactive Effluent Releases - First, Second, Third and Fourth Quarters 2015

GASEOUS EFFLUENTS

Radioactive gaseous releases for the reporting period totaled 1.31 curies of inert gas. The gross gaseous activity release rates were 1.22E-03 µCi/sec for the first quarter, 1.32E-03 µCi/sec for the second quarter, 1.17E-03 µCi/sec for the third quarter, and 7.97E-04 µCi/sec for the fourth quarter.

Radioactive halogens releases for the reporting period totaled 3.70E-06 curies. The halogen activity release rates were 0.00E+00 µCi/sec for the first quarter, 2.25E-07 µCi/sec for the second quarter, 2.49E-07 µCi/sec for the third quarter, and 0.00E+00 µCi/sec for the fourth quarter from gaseous effluent discharges.
No radioactive particulates with half-lives greater that eight days were released during the reporting period from gaseous effluent discharges.

Radioactive tritium released during the reporting period totaled 2.88E+00 curies.

Carbon-14 released for the reporting period totaled 1.97 curies, this is a calculated value based on reactor power and days of operation. The Fort Calhoun estimate of 1.97 Ci carbon-14 and 0.296 Ci $_{14}CO_2$ is based upon a normalized C-14 production rate and 15% carbon dioxide fraction.

Off-site vendor analysis of weekly composite samples indicated that no gross alpha radioactivity was released during the reporting period.

POTENTIAL DOSES TO INDIVIDUALS AND POPULATIONS

A. Potential Annual Doses to Individuals from Gaseous Releases

Total body, skin, and organ doses from ground releases were calculated in mRem to an average adult, teenager, child, and infant using the annual configuration of the GASPAR II program. Results to each receptor are shown in Tables IV-A-1 through IV-A-39. Also, the doses to the same groups, Table IV-B-1, in units of mRad, due to gamma and beta radiation carried by air, was computed using GASPAR II. In its annual configuration, GASPAR II assumes that all release rates are entered in curies per year (Ci/yr).

The inputs to GASPAR II for the annual period from January 1, 2015 through December 31, 2015 were as follows:

(1) All gaseous effluents

(2) Entrained gases (Ar-41, Xe-131M, Xe-133M, Xe-133, Xe-135M, Xe-135, Kr-85M, Kr-87, and Kr-88) from liquid effluents.

(3) Annual X/Q at the actual receptor locations, which are corrected for open terrain and plume depletion, are calculated according to Regulatory Guide 1.111. Also included are annual deposition rates corrected for the open terrain factor.

(4) The production, intake and grazing fractions were as follows: 1.0 for leafy vegetables grown in garden of interest, 0.76 for produce grown in garden of interest, 0.5 for the pasture grazing season of the milk animal, 1.0 for pasture grazing season of the meat animal, and 8 g/m^3 for the air water (humidity) concentrations.

(5) All dose factors, transport times from receptor to individual, and usage factors are defined by Regulatory Guide 1.109 and NUREG-0172.

(6) Site specific information, within a five-mile radius of the plant, on types of receptors located in each sector was used. That is, if a cow was not present in a sector, then the milk pathway for that sector was not considered. If it was present, then the actual sector distance was used.

(7) Using approved methodologies the C-14 doses to the site specific pathways (e.g. inhalation, milk, meat, and vegetation pathways) age group and organs are based upon airborne composition rather than ground deposition. For this reason, X/Q is utilized to calculate doses from Carbon-14 effluent releases

.

These inputs introduce a most conservative approach for the following reasons:

(1) The open terrain and deposition corrections increase annual X/Q by a factor ranging between 1.0 and 4.0

(2) The production, intake, and grazing fractions, as defined in the input definition statement, represent the environment in an extremely conservative manner.

B. Potential Semiannual Doses to Population from Gaseous Releases

The GASPAR II program in its annual configuration was also used to calculate the ALARA integrated population dose summary for the total body, skin, and organ doses in man-rem for all individuals within a 50-mile radius. The population-integrated dose is the summation of the dose received by all individuals and has units of man-thyroid-rem when applied to the summation of thyroid doses. The same inputs were used as in the individual case with the addition of the following:

(1) A total population of 950,006 (based on the 2010 census) was used to define the sector segments within a 50-mile radius of the plant.

(2) Production of milk, meat, and vegetation is based on 1973 annual data for Nebraska as recommended by the Nuclear Regulatory Commission for use in GASPAR II.

TABLE IV-A- 1

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 1 RES
AT 4.36 MILES N

ANNUAL_BETA_AIR_DOSE = 9.04E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.83E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05	2.01E-05
GROUND	2.28E-08	2.28E-08	2.28E-08	2.28E-08	2.28E-08	2.28E-08	2.28E-08	2.66E-08
INHAL								
ADULT	7.22E-06	7.22E-06	5.14E-10	7.22E-06	7.22E-06	7.36E-06	7.22E-06	7.22E-06
TEEN	7.29E-06	7.29E-06	7.09E-10	7.29E-06	7.29E-06	7.45E-06	7.29E-06	7.29E-06
CHILD	6.44E-06	6.43E-06	9.44E-10	6.44E-06	6.44E-06	6.62E-06	6.44E-06	6.43E-06
INFANT	3.70E-06	3.70E-06	6.73E-10	3.70E-06	3.70E-06	3.87E-06	3.70E-06	3.70E-06

TABLE IV-A- 2

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 2 RES
AT 1.93 MILES NNE

ANNUAL_BETA_AIR_DOSE = 3.31E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 5.67E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.74E-05	3.74E-05	3.74E-05	3.74E-05	3.74E-05	3.74E-05	3.75E-05	6.37E-05
GROUND	1.12E-07	1.12E-07	1.12E-07	1.12E-07	1.12E-07	1.12E-07	1.12E-07	1.30E-07
INHAL								
ADULT	3.68E-05	3.68E-05	2.75E-09	3.68E-05	3.68E-05	3.75E-05	3.68E-05	3.68E-05
TEEN	3.71E-05	3.71E-05	3.80E-09	3.71E-05	3.71E-05	3.80E-05	3.71E-05	3.71E-05
CHILD	3.28E-05	3.28E-05	5.05E-09	3.28E-05	3.28E-05	3.37E-05	3.28E-05	3.28E-05
INFANT	1.88E-05	1.88E-05	3.59E-09	1.88E-05	1.88E-05	1.97E-05	1.88E-05	1.88E-05

TABLE IV-A- 3

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 3 RES
AT 1.52 MILES NE

ANNUAL_BETA_AIR_DOSE = 8.22E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.66E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.83E-04
GROUND	1.47E-07	1.47E-07	1.47E-07	1.47E-07	1.47E-07	1.47E-07	1.47E-07	1.72E-07
INHAL								
ADULT	6.57E-05	6.57E-05	5.15E-09	6.57E-05	6.57E-05	6.70E-05	6.57E-05	6.57E-05
TEEN	6.62E-05	6.62E-05	7.11E-09	6.63E-05	6.63E-05	6.79E-05	6.62E-05	6.62E-05
CHILD	5.85E-05	5.85E-05	9.45E-09	5.85E-05	5.85E-05	6.03E-05	5.85E-05	5.85E-05
INFANT	3.37E-05	3.37E-05	6.71E-09	3.37E-05	3.37E-05	3.53E-05	3.37E-05	3.37E-05

TABLE IV-A- 4

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 4 RES
AT 4.79 MILES ENE

ANNUAL_BETA_AIR_DOSE = 3.09E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.16E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.04E-06	2.04E-06	2.04E-06	2.04E-06	2.04E-06	2.04E-06	2.07E-06	3.84E-06
GROUND	6.59E-09	6.59E-09	6.59E-09	6.59E-09	6.59E-09	6.59E-09	6.59E-09	7.69E-09
INHAL								
ADULT	5.71E-06	5.71E-06	3.97E-10	5.71E-06	5.71E-06	5.82E-06	5.71E-06	5.71E-06
TEEN	5.76E-06	5.76E-06	5.48E-10	5.76E-06	5.76E-06	5.89E-06	5.76E-06	5.76E-06
CHILD	5.09E-06	5.09E-06	7.29E-10	5.09E-06	5.09E-06	5.23E-06	5.09E-06	5.09E-06
INFANT	2.93E-06	2.93E-06	5.20E-10	2.93E-06	2.93E-06	3.06E-06	2.93E-06	2.93E-06

TABLE IV-A- 5

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 5 RES
AT 4.67 MILES E

ANNUAL_BETA_AIR_DOSE = 3.70E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.16E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.70E-06	2.70E-06	2.70E-06	2.70E-06	2.70E-06	2.70E-06	2.73E-06	4.97E-06
GROUND	9.12E-09	9.12E-09	9.12E-09	9.12E-09	9.12E-09	9.12E-09	9.12E-09	1.07E-08
INHAL								
ADULT	6.43E-06	6.43E-06	4.51E-10	6.44E-06	6.43E-06	6.55E-06	6.43E-06	6.43E-06
TEEN	6.49E-06	6.49E-06	6.22E-10	6.49E-06	6.49E-06	6.64E-06	6.49E-06	6.49E-06
CHILD	5.73E-06	5.73E-06	8.28E-10	5.73E-06	5.73E-06	5.89E-06	5.73E-06	5.73E-06
INFANT	3.30E-06	3.30E-06	5.90E-10	3.30E-06	3.30E-06	3.45E-06	3.30E-06	3.30E-06

TABLE IV-A- 6

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 6 RES
AT 4.22 MILES ESE

ANNUAL_BETA_AIR_DOSE = 4.00E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.08E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.99E-06	3.97E-06
GROUND	1.47E-08	1.47E-08	1.47E-08	1.47E-08	1.47E-08	1.47E-08	1.47E-08	1.72E-08
INHAL								
ADULT	8.54E-06	8.54E-06	5.99E-10	8.54E-06	8.54E-06	8.69E-06	8.54E-06	8.54E-06
TEEN	8.61E-06	8.61E-06	8.27E-10	8.61E-06	8.61E-06	8.80E-06	8.61E-06	8.61E-06
CHILD	7.61E-06	7.60E-06	1.10E-09	7.61E-06	7.61E-06	7.82E-06	7.61E-06	7.60E-06
INFANT	4.37E-06	4.37E-06	7.83E-10	4.38E-06	4.38E-06	4.57E-06	4.37E-06	4.37E-06

TABLE IV-A- 7

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 7 RES
AT 1.67 MILES SE

ANNUAL_BETA_AIR_DOSE = 3.77E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 6.59E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.34E-05	4.34E-05	4.34E-05	4.34E-05	4.34E-05	4.34E-05	4.35E-05	7.38E-05
GROUND	1.82E-07	1.82E-07	1.82E-07	1.82E-07	1.82E-07	1.82E-07	1.82E-07	2.13E-07
INHAL								
ADULT	4.07E-05	4.07E-05	3.09E-09	4.07E-05	4.07E-05	4.15E-05	4.07E-05	4.07E-05
TEEN	4.11E-05	4.11E-05	4.26E-09	4.11E-05	4.11E-05	4.20E-05	4.11E-05	4.11E-05
CHILD	3.63E-05	3.63E-05	5.67E-09	3.63E-05	3.63E-05	3.74E-05	3.63E-05	3.63E-05
INFANT	2.09E-05	2.09E-05	4.03E-09	2.09E-05	2.09E-05	2.19E-05	2.09E-05	2.09E-05

TABLE IV-A- 8

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 8 RES
AT 0.65 MILES SSE

ANNUAL_BETA_AIR_DOSE = 5.42E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.10E-03 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	7.25E-04	7.25E-04	7.25E-04	7.25E-04	7.25E-04	7.25E-04	7.26E-04	1.21E-03
GROUND	3.09E-06	3.09E-06	3.09E-06	3.09E-06	3.09E-06	3.09E-06	3.09E-06	3.61E-06
INHAL								
ADULT	4.33E-04	4.33E-04	3.48E-08	4.33E-04	4.33E-04	4.42E-04	4.33E-04	4.33E-04
TEEN	4.37E-04	4.37E-04	4.80E-08	4.37E-04	4.37E-04	4.48E-04	4.37E-04	4.37E-04
CHILD	3.86E-04	3.86E-04	6.38E-08	3.86E-04	3.86E-04	3.98E-04	3.86E-04	3.86E-04
INFANT	2.22E-04	2.22E-04	4.53E-08	2.22E-04	2.22E-04	2.33E-04	2.22E-04	2.22E-04

TABLE IV-A- 9

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 9 RES
AT 0.73 MILES S

ANNUAL_BETA_AIR_DOSE = 2.38E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.82E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.19E-04	5.30E-04
GROUND	9.63E-07	9.63E-07	9.63E-07	9.63E-07	9.63E-07	9.63E-07	9.63E-07	1.12E-06
INHAL								
ADULT	1.90E-04	1.90E-04	1.51E-08	1.90E-04	1.90E-04	1.94E-04	1.90E-04	1.90E-04
TEEN	1.92E-04	1.92E-04	2.09E-08	1.92E-04	1.92E-04	1.97E-04	1.92E-04	1.92E-04
CHILD	1.70E-04	1.70E-04	2.78E-08	1.70E-04	1.70E-04	1.75E-04	1.70E-04	1.70E-04
INFANT	9.76E-05	9.76E-05	1.97E-08	9.76E-05	9.76E-05	1.02E-04	9.76E-05	9.76E-05

TABLE IV-A-10

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 10 RES
AT 0.65 MILES SSW

ANNUAL_BETA_AIR_DOSE = 1.20E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.64E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.07E-04	1.07E-04	1.07E-04	1.07E-04	1.07E-04	1.07E-04	1.08E-04	1.89E-04
GROUND	5.58E-07	5.58E-07	5.58E-07	5.58E-07	5.58E-07	5.58E-07	5.58E-07	6.51E-07
INHAL								
ADULT	1.77E-04	1.77E-04	1.40E-08	1.77E-04	1.77E-04	1.81E-04	1.77E-04	1.77E-04
TEEN	1.79E-04	1.79E-04	1.94E-08	1.79E-04	1.79E-04	1.83E-04	1.79E-04	1.79E-04
CHILD	1.58E-04	1.58E-04	2.57E-08	1.58E-04	1.58E-04	1.63E-04	1.58E-04	1.58E-04
INFANT	9.09E-05	9.09E-05	1.82E-08	9.09E-05	9.09E-05	9.53E-05	9.09E-05	9.09E-05

TABLE IV-A-11

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 11 RES
AT 0.73 MILES SW

ANNUAL_BETA_AIR_DOSE = 2.14E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.32E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.85E-04	2.85E-04	2.85E-04	2.85E-04	2.85E-04	2.85E-04	2.86E-04	4.75E-04
GROUND	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.97E-07
INHAL								
ADULT	1.71E-04	1.71E-04	1.35E-08	1.71E-04	1.71E-04	1.74E-04	1.71E-04	1.71E-04
TEEN	1.72E-04	1.72E-04	1.86E-08	1.72E-04	1.72E-04	1.76E-04	1.72E-04	1.72E-04
CHILD	1.52E-04	1.52E-04	2.47E-08	1.52E-04	1.52E-04	1.57E-04	1.52E-04	1.52E-04
INFANT	8.75E-05	8.75E-05	1.75E-08	8.75E-05	8.75E-05	9.18E-05	8.75E-05	8.75E-05

TABLE IV-A-12

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 12 RES
AT 1.06 MILES WSW

ANNUAL_BETA_AIR_DOSE = 1.15E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.32E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.54E-04	1.54E-04	1.54E-04	1.54E-04	1.54E-04	1.54E-04	1.54E-04	2.56E-04
GROUND	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.49E-07
INHAL								
ADULT	9.19E-05	9.19E-05	7.08E-09	9.19E-05	9.19E-05	9.37E-05	9.19E-05	9.19E-05
TEEN	9.27E-05	9.27E-05	9.77E-09	9.28E-05	9.28E-05	9.50E-05	9.27E-05	9.27E-05
CHILD	8.19E-05	8.19E-05	1.30E-08	8.19E-05	8.19E-05	8.44E-05	8.19E-05	8.19E-05
INFANT	4.71E-05	4.71E-05	9.23E-09	4.71E-05	4.71E-05	4.94E-05	4.71E-05	4.71E-05

TABLE IV-A-13

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 13 RES
AT 1.20 MILES W

ANNUAL_BETA_AIR_DOSE = 4.00E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.08E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.96E-05	1.96E-05	1.96E-05	1.96E-05	1.96E-05	1.96E-05	1.99E-05	3.97E-05
GROUND	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.48E-07
INHAL								
ADULT	8.54E-05	8.54E-05	6.54E-09	8.54E-05	8.54E-05	8.70E-05	8.54E-05	8.54E-05
TEEN	8.61E-05	8.61E-05	9.02E-09	8.61E-05	8.61E-05	8.82E-05	8.61E-05	8.61E-05
CHILD	7.61E-05	7.60E-05	1.20E-08	7.61E-05	7.61E-05	7.83E-05	7.61E-05	7.60E-05
INFANT	4.37E-05	4.37E-05	8.51E-09	4.38E-05	4.38E-05	4.58E-05	4.37E-05	4.37E-05

TABLE IV-A-14

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 14 RES
AT 2.60 MILES WNW

ANNUAL_BETA_AIR_DOSE = 2.05E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.15E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.74E-05	2.74E-05	2.74E-05	2.74E-05	2.74E-05	2.74E-05	2.75E-05	4.57E-05
GROUND	4.31E-08	4.31E-08	4.31E-08	4.31E-08	4.31E-08	4.31E-08	4.31E-08	5.03E-08
INHAL								
ADULT	1.64E-05	1.64E-05	1.21E-09	1.64E-05	1.64E-05	1.67E-05	1.64E-05	1.64E-05
TEEN	1.66E-05	1.66E-05	1.66E-09	1.66E-05	1.66E-05	1.69E-05	1.66E-05	1.66E-05
CHILD	1.46E-05	1.46E-05	2.21E-09	1.46E-05	1.46E-05	1.51E-05	1.46E-05	1.46E-05
INFANT	8.41E-06	8.41E-06	1.58E-09	8.41E-06	8.41E-06	8.80E-06	8.41E-06	8.41E-06

TABLE IV-A-15

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 15 RES
AT 2.40 MILES NW

ANNUAL_BETA_AIR_DOSE = 2.85E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.78E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.14E-05	3.14E-05	3.14E-05	3.14E-05	3.14E-05	3.14E-05	3.16E-05	5.38E-05
GROUND	9.63E-08	9.63E-08	9.63E-08	9.63E-08	9.63E-08	9.63E-08	9.63E-08	1.12E-07
INHAL								
ADULT	3.28E-05	3.28E-05	2.41E-09	3.28E-05	3.28E-05	3.35E-05	3.28E-05	3.28E-05
TEEN	3.31E-05	3.31E-05	3.33E-09	3.31E-05	3.31E-05	3.39E-05	3.31E-05	3.31E-05
CHILD	2.93E-05	2.92E-05	4.43E-09	2.93E-05	2.93E-05	3.01E-05	2.93E-05	2.92E-05
INFANT	1.68E-05	1.68E-05	3.15E-09	1.68E-05	1.68E-05	1.76E-05	1.68E-05	1.68E-05

TABLE IV-A-16

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 16 RES
AT 2.08 MILES NNW

ANNUAL_BETA_AIR_DOSE = 3.92E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 6.89E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.54E-05	4.54E-05	4.54E-05	4.54E-05	4.54E-05	4.54E-05	4.56E-05	7.71E-05
GROUND	1.77E-07	1.77E-07	1.77E-07	1.77E-07	1.77E-07	1.77E-07	1.77E-07	2.07E-07
INHAL								
ADULT	4.20E-05	4.20E-05	3.16E-09	4.20E-05	4.20E-05	4.28E-05	4.20E-05	4.20E-05
TEEN	4.24E-05	4.24E-05	4.36E-09	4.24E-05	4.24E-05	4.34E-05	4.24E-05	4.24E-05
CHILD	3.74E-05	3.74E-05	5.80E-09	3.74E-05	3.74E-05	3.86E-05	3.74E-05	3.74E-05
INFANT	2.15E-05	2.15E-05	4.13E-09	2.15E-05	2.15E-05	2.26E-05	2.15E-05	2.15E-05

TABLE IV-A-17

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 17 VEG
AT 2.23 MILES NNE

ANNUAL_BETA_AIR_DOSE = 1.89E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.92E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.92E-05	1.92E-05	1.92E-05	1.92E-05	1.92E-05	1.92E-05	1.93E-05	3.32E-05
GROUND	7.10E-08	7.10E-08	7.10E-08	7.10E-08	7.10E-08	7.10E-08	7.10E-08	8.29E-08
VEGET								
ADULT	6.70E-04	6.70E-04	3.13E-03	6.70E-04	6.70E-04	6.79E-04	6.70E-04	6.70E-04
TEEN	1.07E-03	1.07E-03	5.08E-03	1.07E-03	1.07E-03	1.08E-03	1.07E-03	1.07E-03
CHILD	2.53E-03	2.53E-03	1.22E-02	2.53E-03	2.53E-03	2.55E-03	2.53E-03	2.53E-03

TABLE IV-A-18

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 18 VEG
AT 1.59 MILES NE

ANNUAL_BETA_AIR_DOSE = 5.47E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 9.11E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.02E-05	1.03E-04
GROUND	1.37E-07	1.37E-07	1.37E-07	1.37E-07	1.37E-07	1.37E-07	1.37E-07	1.60E-07
VEGET								
ADULT	1.76E-03	1.76E-03	8.21E-03	1.76E-03	1.76E-03	1.77E-03	1.76E-03	1.76E-03
TEEN	2.79E-03	2.79E-03	1.33E-02	2.79E-03	2.79E-03	2.82E-03	2.79E-03	2.79E-03
CHILD	6.62E-03	6.62E-03	3.21E-02	6.62E-03	6.62E-03	6.66E-03	6.62E-03	6.62E-03

TABLE IV-A-19

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 19 VEG
AT 4.79 MILES ENE

ANNUAL_BETA_AIR_DOSE = 3.09E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.16E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.04E-06	2.04E-06	2.04E-06	2.04E-06	2.04E-06	2.04E-06	2.07E-06	3.84E-06
GROUND	6.59E-09	6.59E-09	6.59E-09	6.59E-09	6.59E-09	6.59E-09	6.59E-09	7.69E-09
VEGET								
ADULT	1.58E-04	1.58E-04	7.36E-04	1.58E-04	1.58E-04	1.58E-04	1.58E-04	1.58E-04
TEEN	2.51E-04	2.51E-04	1.19E-03	2.51E-04	2.51E-04	2.52E-04	2.51E-04	2.51E-04
CHILD	5.94E-04	5.94E-04	2.88E-03	5.94E-04	5.94E-04	5.96E-04	5.94E-04	5.94E-04

TABLE IV-A-20

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 20 VEG
AT 4.22 MILES ESE

ANNUAL_BETA_AIR_DOSE = 4.00E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.08E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.96E-06	1.99E-06	3.97E-06
GROUND	1.47E-08	1.47E-08	1.47E-08	1.47E-08	1.47E-08	1.47E-08	1.47E-08	1.72E-08
VEGET								
ADULT	2.35E-04	2.35E-04	1.10E-03	2.35E-04	2.35E-04	2.37E-04	2.35E-04	2.35E-04
TEEN	3.74E-04	3.74E-04	1.78E-03	3.74E-04	3.74E-04	3.77E-04	3.74E-04	3.74E-04
CHILD	8.87E-04	8.87E-04	4.30E-03	8.87E-04	8.87E-04	8.91E-04	8.87E-04	8.87E-04

TABLE IV-A-21

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 21 VEG
AT 1.74 MILES SE

ANNUAL_BETA_AIR_DOSE = 4.77E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 9.63E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	6.37E-05	6.37E-05	6.37E-05	6.37E-05	6.37E-05	6.37E-05	6.38E-05	1.06E-04
GROUND	1.67E-07	1.67E-07	1.67E-07	1.67E-07	1.67E-07	1.67E-07	1.67E-07	1.95E-07
VEGET								
ADULT	1.05E-03	1.05E-03	4.91E-03	1.05E-03	1.05E-03	1.07E-03	1.05E-03	1.05E-03
TEEN	1.67E-03	1.67E-03	7.96E-03	1.67E-03	1.67E-03	1.70E-03	1.67E-03	1.67E-03
CHILD	3.96E-03	3.96E-03	1.92E-02	3.96E-03	3.96E-03	4.01E-03	3.96E-03	3.96E-03

TABLE IV-A-22

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 22 VEG
AT 0.94 MILES SSE

ANNUAL_BETA_AIR_DOSE = 2.38E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.82E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.19E-04	5.30E-04
GROUND	1.37E-06	1.37E-06	1.37E-06	1.37E-06	1.37E-06	1.37E-06	1.37E-06	1.60E-06
VEGET								
ADULT	5.25E-03	5.25E-03	2.45E-02	5.26E-03	5.25E-03	5.43E-03	5.25E-03	5.25E-03
TEEN	8.35E-03	8.35E-03	3.98E-02	8.36E-03	8.35E-03	8.57E-03	8.35E-03	8.35E-03
CHILD	1.98E-02	1.98E-02	9.59E-02	1.98E-02	1.98E-02	2.02E-02	1.98E-02	1.98E-02

TABLE IV-A-23

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 23 VEG
AT 0.73 MILES S

ANNUAL_BETA_AIR_DOSE = 2.38E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.82E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.19E-04	5.30E-04
GROUND	9.63E-07	9.63E-07	9.63E-07	9.63E-07	9.63E-07	9.63E-07	9.63E-07	1.12E-06
VEGET								
ADULT	5.25E-03	5.25E-03	2.45E-02	5.25E-03	5.25E-03	5.37E-03	5.25E-03	5.25E-03
TEEN	8.35E-03	8.35E-03	3.98E-02	8.35E-03	8.35E-03	8.51E-03	8.35E-03	8.35E-03
CHILD	1.98E-02	1.98E-02	9.59E-02	1.98E-02	1.98E-02	2.01E-02	1.98E-02	1.98E-02

TABLE IV-A-24

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 24 VEG
AT 2.00 MILES SSW

ANNUAL_BETA_AIR_DOSE = 1.56E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.15E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.09E-05	2.09E-05	2.09E-05	2.09E-05	2.09E-05	2.09E-05	2.09E-05	3.47E-05
GROUND	3.70E-08	3.70E-08	3.70E-08	3.70E-08	3.70E-08	3.70E-08	3.70E-08	4.32E-08
VEGET								
ADULT	3.44E-04	3.44E-04	1.61E-03	3.44E-04	3.44E-04	3.49E-04	3.44E-04	3.44E-04
TEEN	5.47E-04	5.47E-04	2.61E-03	5.47E-04	5.47E-04	5.53E-04	5.47E-04	5.47E-04
CHILD	1.30E-03	1.30E-03	6.28E-03	1.30E-03	1.30E-03	1.31E-03	1.30E-03	1.30E-03

TABLE IV-A-25

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 25 VEG
AT 1.36 MILES SW

ANNUAL_BETA_AIR_DOSE = 3.15E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 5.37E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.54E-05	3.54E-05	3.54E-05	3.54E-05	3.54E-05	3.54E-05	3.55E-05	6.04E-05
GROUND	8.62E-08	8.62E-08	8.62E-08	8.62E-08	8.62E-08	8.62E-08	8.62E-08	1.01E-07
VEGET								
ADULT	9.78E-04	9.78E-04	4.57E-03	9.78E-04	9.78E-04	9.89E-04	9.78E-04	9.78E-04
TEEN	1.56E-03	1.56E-03	7.41E-03	1.56E-03	1.56E-03	1.57E-03	1.56E-03	1.56E-03
CHILD	3.69E-03	3.69E-03	1.79E-02	3.69E-03	3.69E-03	3.71E-03	3.69E-03	3.69E-03

TABLE IV-A-26

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 26 VEG
AT 1.13 MILES WSW

ANNUAL_BETA_AIR_DOSE = 9.04E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.83E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.21E-04	1.21E-04	1.21E-04	1.21E-04	1.21E-04	1.21E-04	1.21E-04	2.01E-04
GROUND	1.72E-07	1.72E-07	1.72E-07	1.72E-07	1.72E-07	1.72E-07	1.72E-07	2.01E-07
VEGET								
ADULT	1.99E-03	1.99E-03	9.31E-03	1.99E-03	1.99E-03	2.01E-03	1.99E-03	1.99E-03
TEEN	3.17E-03	3.17E-03	1.51E-02	3.17E-03	3.17E-03	3.20E-03	3.17E-03	3.17E-03
CHILD	7.51E-03	7.51E-03	3.64E-02	7.51E-03	7.51E-03	7.56E-03	7.51E-03	7.51E-03

TABLE IV-A-27

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 27 VEG
AT 1.30 MILES W

ANNUAL_BETA_AIR_DOSE = 6.78E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.26E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	8.30E-05	8.30E-05	8.30E-05	8.30E-05	8.30E-05	8.30E-05	8.32E-05	1.40E-04
GROUND	1.67E-07	1.67E-07	1.67E-07	1.67E-07	1.67E-07	1.67E-07	1.67E-07	1.95E-07
VEGET								
ADULT	1.81E-03	1.81E-03	8.46E-03	1.81E-03	1.81E-03	1.83E-03	1.81E-03	1.81E-03
TEEN	2.88E-03	2.88E-03	1.37E-02	2.88E-03	2.88E-03	2.91E-03	2.88E-03	2.88E-03
CHILD	6.82E-03	6.82E-03	3.31E-02	6.83E-03	6.82E-03	6.87E-03	6.82E-03	6.82E-03

TABLE IV-A-28

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 28 VEG
AT 2.65 MILES WNW

ANNUAL_BETA_AIR_DOSE = 1.01E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.29E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	8.42E-06	8.42E-06	8.42E-06	8.42E-06	8.42E-06	8.42E-06	8.48E-06	1.51E-05
GROUND	4.05E-08	4.05E-08	4.05E-08	4.05E-08	4.05E-08	4.05E-08	4.05E-08	4.73E-08
VEGET								
ADULT	4.35E-04	4.35E-04	2.03E-03	4.35E-04	4.35E-04	4.40E-04	4.35E-04	4.35E-04
TEEN	6.91E-04	6.91E-04	3.29E-03	6.91E-04	6.91E-04	6.98E-04	6.91E-04	6.91E-04
CHILD	1.64E-03	1.64E-03	7.94E-03	1.64E-03	1.64E-03	1.65E-03	1.64E-03	1.64E-03

TABLE IV-A-29

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 29 VEG
AT 2.40 MILES NW

ANNUAL_BETA_AIR_DOSE = 2.85E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.78E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.14E-05	3.14E-05	3.14E-05	3.14E-05	3.14E-05	3.14E-05	3.16E-05	5.38E-05
GROUND	9.63E-08	9.63E-08	9.63E-08	9.63E-08	9.63E-08	9.63E-08	9.63E-08	1.12E-07
VEGET								
ADULT	9.06E-04	9.06E-04	4.23E-03	9.06E-04	9.06E-04	9.18E-04	9.06E-04	9.06E-04
TEEN	1.44E-03	1.44E-03	6.86E-03	1.44E-03	1.44E-03	1.46E-03	1.44E-03	1.44E-03
CHILD	3.41E-03	3.41E-03	1.65E-02	3.41E-03	3.41E-03	3.44E-03	3.41E-03	3.41E-03

TABLE IV-A-30

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 30 VEG
AT 3.73 MILES NNW

ANNUAL_BETA_AIR_DOSE = 1.40E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.82E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05	3.11E-05
GROUND	4.01E-08	4.01E-08	4.01E-08	4.01E-08	4.01E-08	4.01E-08	4.01E-08	4.68E-08
VEGET								
ADULT	3.08E-04	3.08E-04	1.44E-03	3.08E-04	3.08E-04	3.13E-04	3.08E-04	3.08E-04
TEEN	4.90E-04	4.90E-04	2.33E-03	4.90E-04	4.90E-04	4.96E-04	4.90E-04	4.90E-04
CHILD	1.16E-03	1.16E-03	5.62E-03	1.16E-03	1.16E-03	1.17E-03	1.16E-03	1.16E-03

TABLE IV-A-31

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 31 BEEF
AT 4.91 MILES E

ANNUAL_BETA_AIR_DOSE = 3.06E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.80E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.80E-06	1.80E-06	1.80E-06	1.80E-06	1.80E-06	1.80E-06	1.82E-06	3.48E-06
GROUND	8.11E-09	8.11E-09	8.11E-09	8.11E-09	8.11E-09	8.11E-09	8.11E-09	9.47E-09
MEAT								
ADULT	5.94E-05	5.94E-05	2.89E-04	5.94E-05	5.94E-05	5.94E-05	5.94E-05	5.94E-05
TEEN	4.98E-05	4.98E-05	2.44E-04	4.98E-05	4.98E-05	4.98E-05	4.98E-05	4.98E-05
CHILD	9.29E-05	9.29E-05	4.59E-04	9.29E-05	9.29E-05	9.30E-05	9.29E-05	9.29E-05

TABLE IV-A-32

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 32 BEEF
AT 1.82 MILES SSE

ANNUAL_BETA_AIR_DOSE = 3.77E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 6.59E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.34E-05	4.34E-05	4.34E-05	4.34E-05	4.34E-05	4.34E-05	4.35E-05	7.38E-05
GROUND	2.69E-07	2.69E-07	2.69E-07	2.69E-07	2.69E-07	2.69E-07	2.69E-07	3.14E-07
MEAT								
ADULT	4.00E-04	4.00E-04	1.95E-03	4.00E-04	4.00E-04	4.02E-04	4.00E-04	4.00E-04
TEEN	3.35E-04	3.35E-04	1.65E-03	3.35E-04	3.35E-04	3.36E-04	3.35E-04	3.35E-04
CHILD	6.26E-04	6.26E-04	3.09E-03	6.26E-04	6.26E-04	6.28E-04	6.26E-04	6.26E-04

TABLE IV-A-33

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 33 BEEF
AT 2.48 MILES S

ANNUAL_BETA_AIR_DOSE = 1.15E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.32E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.54E-05	1.54E-05	1.54E-05	1.54E-05	1.54E-05	1.54E-05	1.54E-05	2.56E-05
GROUND	4.26E-08	4.26E-08	4.26E-08	4.26E-08	4.26E-08	4.26E-08	4.26E-08	4.97E-08
MEAT								
ADULT	9.04E-05	9.04E-05	4.40E-04	9.04E-05	9.04E-05	9.06E-05	9.04E-05	9.04E-05
TEEN	7.57E-05	7.57E-05	3.72E-04	7.57E-05	7.57E-05	7.59E-05	7.57E-05	7.57E-05
CHILD	1.41E-04	1.41E-04	6.98E-04	1.41E-04	1.41E-04	1.42E-04	1.41E-04	1.41E-04

TABLE IV-A-34

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 34 BEEF
AT 0.65 MILES SSW

ANNUAL_BETA_AIR_DOSE = 1.20E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.64E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.07E-04	1.07E-04	1.07E-04	1.07E-04	1.07E-04	1.07E-04	1.08E-04	1.89E-04
GROUND	5.58E-07	5.58E-07	5.58E-07	5.58E-07	5.58E-07	5.58E-07	5.58E-07	6.51E-07
MEAT								
ADULT	1.74E-03	1.74E-03	8.48E-03	1.74E-03	1.74E-03	1.75E-03	1.74E-03	1.74E-03
TEEN	1.46E-03	1.46E-03	7.17E-03	1.46E-03	1.46E-03	1.46E-03	1.46E-03	1.46E-03
CHILD	2.73E-03	2.73E-03	1.35E-02	2.73E-03	2.73E-03	2.73E-03	2.73E-03	2.73E-03

TABLE IV-A-35

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 35 BEEF
AT 0.76 MILES SW

ANNUAL_BETA_AIR_DOSE = 1.97E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.99E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.63E-04	2.63E-04	2.63E-04	2.63E-04	2.63E-04	2.63E-04	2.64E-04	4.39E-04
GROUND	3.90E-07	3.90E-07	3.90E-07	3.90E-07	3.90E-07	3.90E-07	3.90E-07	4.56E-07
MEAT								
ADULT	1.55E-03	1.55E-03	7.54E-03	1.55E-03	1.55E-03	1.55E-03	1.55E-03	1.55E-03
TEEN	1.30E-03	1.30E-03	6.37E-03	1.30E-03	1.30E-03	1.30E-03	1.30E-03	1.30E-03
CHILD	2.42E-03	2.42E-03	1.20E-02	2.42E-03	2.42E-03	2.43E-03	2.42E-03	2.42E-03

TABLE IV-A-36

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 36 BEEF
AT 2.42 MILES WSW

ANNUAL_BETA_AIR_DOSE = 6.50E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 6.85E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.43E-06	4.43E-06	4.43E-06	4.43E-06	4.43E-06	4.43E-06	4.48E-06	8.28E-06
GROUND	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.72E-08
MEAT								
ADULT	1.16E-04	1.16E-04	5.65E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04
TEEN	9.74E-05	9.74E-05	4.78E-04	9.74E-05	9.74E-05	9.75E-05	9.74E-05	9.74E-05
CHILD	1.82E-04	1.82E-04	8.98E-04	1.82E-04	1.82E-04	1.82E-04	1.82E-04	1.82E-04

TABLE IV-A-37

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 37 BEEF
AT 3.25 MILES W

ANNUAL_BETA_AIR_DOSE = 9.86E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.99E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.32E-05	1.32E-05	1.32E-05	1.32E-05	1.32E-05	1.32E-05	1.32E-05	2.19E-05
GROUND	1.57E-08	1.57E-08	1.57E-08	1.57E-08	1.57E-08	1.57E-08	1.57E-08	1.84E-08
MEAT								
ADULT	7.75E-05	7.74E-05	3.77E-04	7.75E-05	7.74E-05	7.75E-05	7.74E-05	7.74E-05
TEEN	6.49E-05	6.49E-05	3.18E-04	6.49E-05	6.49E-05	6.50E-05	6.49E-05	6.49E-05
CHILD	1.21E-04	1.21E-04	5.99E-04	1.21E-04	1.21E-04	1.21E-04	1.21E-04	1.21E-04

TABLE IV-A-38

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
SPECIAL LOCATION NO. 38 COW
AT 3.44 MILES S

ANNUAL_BETA_AIR_DOSE = 3.56E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 5.44E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.57E-06	3.57E-06	3.57E-06	3.57E-06	3.57E-06	3.57E-06	3.59E-06	6.20E-06
GROUND	1.93E-08	1.93E-08	1.93E-08	1.93E-08	1.93E-08	1.93E-08	1.93E-08	2.25E-08
COW MILK								
ADULT	5.15E-05	5.15E-05	2.43E-04	5.15E-05	5.15E-05	5.30E-05	5.15E-05	5.15E-05
TEEN	9.35E-05	9.35E-05	4.49E-04	9.35E-05	9.35E-05	9.59E-05	9.35E-05	9.35E-05
CHILD	2.27E-04	2.27E-04	1.10E-03	2.27E-04	2.27E-04	2.31E-04	2.27E-04	2.27E-04
INFANT	4.70E-04	4.70E-04	2.16E-03	4.71E-04	4.70E-04	4.82E-04	4.70E-04	4.70E-04

TABLE IV-B-1

FORT CALHOUN 1 DOSE CONTRIBUTIONS FROM GASEOUS EFFLUENTS
UNRESTRICTED AREA BOUNDARY
REQUIRED BY TECHNICAL SPECIFICATION 5.9.4.a.
JANUARY 1, 2015 TO DECEMBER 31, 2015

MAXIMUM SITE BOUNDARY GAMMA AIR DOSE - 1.35E-03 MILLRADS

MAXIMUM SITE BOUNDARY BETA AIR DOSE - 6.66E-04 MILLRADS

TABLE IV-C-1

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.49E-04	1.49E-04	1.49E-04	1.49E-04	1.49E-04	1.49E-04	1.52E-04	3.30E-04
	0.51%	0.51%	0.11%	0.51%	0.51%	0.51%	0.52%	1.13%
GROUND	1.24E-06	1.24E-06	1.24E-06	1.24E-06	1.24E-06	1.24E-06	1.24E-06	1.45E-06
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
INHAL	6.91E-04	6.91E-04	5.20E-08	6.91E-04	6.91E-04	7.04E-04	6.91E-04	6.91E-04
	2.38%	2.37%	0.00%	2.38%	2.38%	2.41%	2.37%	2.36%
VEGET	1.63E-02	1.63E-02	7.74E-02	1.63E-02	1.63E-02	1.63E-02	1.63E-02	1.63E-02
	55.84%	55.84%	56.93%	55.84%	55.84%	55.73%	55.84%	55.50%
COW MILK	4.10E-03	4.10E-03	1.97E-02	4.10E-03	4.10E-03	4.14E-03	4.10E-03	4.10E-03
	14.09%	14.09%	14.52%	14.09%	14.09%	14.19%	14.09%	14.00%
MEAT	7.91E-03	7.91E-03	3.87E-02	7.91E-03	7.91E-03	7.92E-03	7.91E-03	7.91E-03
	27.18%	27.18%	28.45%	27.17%	27.18%	27.15%	27.17%	27.01%
TOTAL	2.91E-02	2.91E-02	1.36E-01	2.91E-02	2.91E-02	2.92E-02	2.91E-02	2.93E-02

SECTION V

DOSE FROM LIQUID EFFLUENTS
LADTAP II OUTPUT
Technical Specification 5.9.4.a

January 1, 2015 - December 31, 2015

Radioactive Effluent Releases - First, Second, Third, and Fourth Quarters 2015

LIQUID EFFLUENTS

During the reporting period, a total of 1.21E-02 curies of radioactive liquid materials less tritium, dissolved noble gases, and alpha were released to the Missouri River at an average concentration of 3.01E-10 µCi/mL. This represents 2.80E-01 percent of the limits specified in Appendix B to 10 CFR 20 (1.0E-06 µCi/mL for unrestricted areas), 158 curies of tritium were discharged at an average diluted concentration of 3.66E-05 µCi/mL or 3.66 percent of ECL (1.0E-03 µCi/mL).

No gross alpha radioactivity was identified by Off-site vendor analysis of quarterly liquid composites for the reporting period. Ni-63 was identified in all quarterly composites, and represented 30% of the total activity released.

Dilution water during the period amounted to 1.21E+12 liters, while liquid waste discharges consisted of 1.07E+08 liters of radioactive liquid waste.

A. Potential Annual Doses to Individuals from Liquid Releases

Total body, skin, and organ mRem for liquid releases were calculated for all significant liquid pathways using the annual configuration of the LADTAP II program.

The inputs to LADTAP II for the annual period from January 1, 2015 through December 31, 2015 were as follows:

(1) All liquid effluents were as described in Section IV except for entrained noble gases (Ar-41, Xe-131M, Xe-133M, Xe-133, Xe-135M, Xe-135, Kr-85M, Kr-87, and Kr-88).

(2) An average dilution stream flow during periods of release was 530.1 cubic feet per second (CFS) was utilized for 2015. The average discharge rate during releases was 612.2 cubic feet per second (CFS).

(3) Dilution factors (inverse of the mixing ratios) were computed based on Regulatory Guide 1.113 (equation 7 in Section 2.a.1 of Appendix A) for a one dimensional transport model.

(4) Drinking water transport times of 6.6 hours to the Omaha intake and 7.0 hours to the Council Bluffs intake were used for dose calculations.

(5) A shorewidth factor of 0.2 was used.

(6) All dose factors, transport times from receptor to individual, and usage factors are defined by Regulatory Guide 1.109 and NUREG-0172.

The discharge site was chosen to present the most conservative estimate of mRem dose for an average adult, teenager, child, and infant. A conservative approach is also presented by the assumption that Omaha and Council Bluffs receive all drinking water from the Missouri River.

B. Potential Annual Doses to Population from Liquid Releases

The LADTAP II program in its annual configuration was also used to calculate to total body and organ doses for the population of 950,006 within a 50-mile radius of the plant (based on the 2010 census). The same input was used as in the individual cases with the addition of the following:

(1) Dilution factors and transport times for the pathways of sport fish, commercial fish, recreation and biota were calculated based on a distance of two miles downstream as approximately the distance to the nearest recreation facility - DeSoto National Wildlife Preserve.

(2) The total fish harvest for both sport and commercial purposes was calculated using an average commercial fish catch for Nebraska.

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L       AAA   DDDD   TTTTT   AAA   PPPP     IIIII IIIII
L      A   A  D   D    T    A   A  P   P      I     I
L      A   A  D   D    T    A   A  P   P      I     I
L      AAAAA  D   D    T    AAAAA  PPPP       I     I
L      A   A  D   D    T    A   A  P          I     I
LLLLL  A   A  DDDD     T    A   A  P        IIIII IIIII
```

EVALUATION OF RADIATION DOSES FROM RELEASES OF RADIACTIVITY

IN NUCLEAR POWER PLANTS LIQUID EFFLUENTS

REVISION DATE: PNL VAX - OCTOBER 1985

FORT CALHOUN ANNUAL 2015, DOSE PROJECTIONS

RADIOLOGICAL ASSESSMENT BRANCH

DIVISION OF SYSTEMS INTEGRATION

U. S. NUCLEAR REGULATORY COMMISSION

WASHINGTON, D. C.

DATE OF RUN: 20160413

LOCATION IS FRESHWATER INTAKE

A D U L T D O S E S

DOSE (MREM PER YEAR INTAKE)

PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		2.95E-03	3.76E-03	2.48E-03	1.09E-04	1.30E-03	4.63E-04	1.37E-04
DRINKING		3.21E-05	4.28E-04	4.22E-04	4.47E-04	4.16E-04	4.13E-04	4.16E-04
SHORELINE	5.29E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06	4.52E-06
SWIMMING		3.80E-08	3.80E-08	3.80E-08	3.80E-08	3.80E-08	3.80E-08	3.80E-08
BOATING		1.90E-08	1.90E-08	1.90E-08	1.90E-08	1.90E-08	1.90E-08	1.90E-08
TOTAL	5.29E-06	2.98E-03	4.19E-03	2.91E-03	5.61E-04	1.72E-03	8.80E-04	5.57E-04

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)
FISH	21.0	7.3	24.00
DRINKING	730.0	30.8	18.60
SHORELINE	12.0	7.3	0.00
SWIMMING	12.0	7.3	0.00
BOATING	12.0	7.3	0.00

SHOREWIDTH FACTOR=0.2

T E E N A G E R D O S E S

DOSE (MREM PER YEAR INTAKE)

PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		3.15E-03	3.90E-03	1.39E-03	9.45E-05	1.34E-03	5.44E-04	1.04E-04
DRINKING		3.08E-05	3.06E-04	2.96E-04	3.20E-04	2.95E-04	2.92E-04	2.93E-04
SHORELINE	2.95E-05	2.53E-05	2.53E-05	2.53E-05	2.53E-05	2.53E-05	2.53E-05	2.53E-05
SWIMMING		2.12E-07	2.12E-07	2.12E-07	2.12E-07	2.12E-07	2.12E-07	2.12E-07
BOATING		1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
TOTAL	2.95E-05	3.20E-03	4.24E-03	1.71E-03	4.40E-04	1.66E-03	8.61E-04	4.22E-04

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)
FISH	16.0	7.3	24.00
DRINKING	510.0	30.8	18.60
SHORELINE	67.0	7.3	0.00
SWIMMING	67.0	7.3	0.00
BOATING	67.0	7.3	0.00

SHOREWIDTH FACTOR=0.2

C H I L D D O S E S

	DOSE (MREM PER YEAR INTAKE)						
PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		3.98E-03	3.53E-03	5.58E-04	9.06E-05	1.16E-03	4.38E-04	5.56E-05
DRINKING		9.23E-05	5.91E-04	5.64E-04	6.30E-04	5.66E-04	5.60E-04	5.59E-04
SHORELINE	6.17E-06	5.28E-06	5.28E-06	5.28E-06	5.28E-06	5.28E-06	5.28E-06	5.28E-06
SWIMMING		4.44E-08	4.44E-08	4.44E-08	4.44E-08	4.44E-08	4.44E-08	4.44E-08
BOATING		2.22E-08	2.22E-08	2.22E-08	2.22E-08	2.22E-08	2.22E-08	2.22E-08
TOTAL	6.17E-06	4.07E-03	4.13E-03	1.13E-03	7.26E-04	1.74E-03	1.00E-03	6.20E-04

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	
FISH	6.9	7.3	24.00	SHOREWIDTH FACTOR=0.2
DRINKING	510.0	30.8	18.60	
SHORELINE	14.0	7.3	0.00	
SWIMMING	14.0	7.3	0.00	
BOATING	14.0	7.3	0.00	

I N F A N T D O S E S

	DOSE (MREM PER YEAR INTAKE)						
PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DRINKING		7.92E-05	5.88E-04	5.51E-04	6.62E-04	5.57E-04	5.50E-04	5.48E-04
SHORELINE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	0.00E+00	7.92E-05	5.88E-04	5.51E-04	6.62E-04	5.57E-04	5.50E-04	5.48E-04

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	
FISH	0.0	7.3	24.00	SHOREWIDTH FACTOR=0.2
DRINKING	330.0	30.8	18.60	

LOCATION IS SITE DISCHG.

A D U L T D O S E S

	DOSE (MREM PER YEAR INTAKE)							
PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		2.15E-02	2.75E-02	1.81E-02	7.97E-04	9.49E-03	3.38E-03	1.00E-03
DRINKING		9.88E-04	1.32E-02	1.30E-02	1.38E-02	1.28E-02	1.27E-02	1.28E-02
SHORELINE	3.86E-05	3.30E-05	3.30E-05	3.30E-05	3.30E-05	3.30E-05	3.30E-05	3.30E-05
SWIMMING		2.78E-07	2.78E-07	2.78E-07	2.78E-07	2.78E-07	2.78E-07	2.78E-07
BOATING		1.39E-07	1.39E-07	1.39E-07	1.39E-07	1.39E-07	1.39E-07	1.39E-07
TOTAL	3.86E-05	2.25E-02	4.07E-02	3.11E-02	1.46E-02	2.23E-02	1.61E-02	1.38E-02

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	
FISH	21.0	1.0	24.00	
DRINKING	730.0	1.0	12.00	
SHORELINE	12.0	1.0	0.00	
SWIMMING	12.0	1.0	0.00	
BOATING	12.0	1.0	0.00	

SHOREWIDTH FACTOR=0.2

T E E N A G E R D O S E S

	DOSE (MREM PER YEAR INTAKE)							
PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		2.30E-02	2.85E-02	1.01E-02	6.90E-04	9.81E-03	3.97E-03	7.58E-04
DRINKING		9.50E-04	9.42E-03	9.11E-03	9.89E-03	9.08E-03	8.98E-03	9.02E-03
SHORELINE	2.16E-04	1.84E-04	1.84E-04	1.84E-04	1.84E-04	1.84E-04	1.84E-04	1.84E-04
SWIMMING		1.55E-06	1.55E-06	1.55E-06	1.55E-06	1.55E-06	1.55E-06	1.55E-06
BOATING		7.75E-07	7.75E-07	7.75E-07	7.75E-07	7.75E-07	7.75E-07	7.75E-07
TOTAL	2.16E-04	2.41E-02	3.81E-02	1.94E-02	1.08E-02	1.91E-02	1.31E-02	9.96E-03

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	
FISH	16.0	1.0	24.00	
DRINKING	510.0	1.0	12.00	
SHORELINE	67.0	1.0	0.00	
SWIMMING	67.0	1.0	0.00	
BOATING	67.0	1.0	0.00	

SHOREWIDTH FACTOR=0.2

C H I L D D O S E S

DOSE (MREM PER YEAR INTAKE)

PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		2.90E-02	2.58E-02	4.08E-03	6.61E-04	8.50E-03	3.20E-03	4.06E-04
DRINKING		2.84E-03	1.82E-02	1.74E-02	1.95E-02	1.74E-02	1.72E-02	1.72E-02
SHORELINE	4.50E-05	3.85E-05	3.85E-05	3.85E-05	3.85E-05	3.85E-05	3.85E-05	3.85E-05
SWIMMING		3.24E-07	3.24E-07	3.24E-07	3.24E-07	3.24E-07	3.24E-07	3.24E-07
BOATING		1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07	1.62E-07
TOTAL	4.50E-05	3.19E-02	4.40E-02	2.15E-02	2.02E-02	2.60E-02	2.05E-02	1.77E-02

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	
FISH	6.9	1.0	24.00	SHOREWIDTH FACTOR=0.2
DRINKING	510.0	1.0	12.00	
SHORELINE	14.0	1.0	0.00	
SWIMMING	14.0	1.0	0.00	
BOATING	14.0	1.0	0.00	

I N F A N T D O S E S

DOSE (MREM PER YEAR INTAKE)

PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DRINKING		2.44E-03	1.81E-02	1.70E-02	2.05E-02	1.71E-02	1.70E-02	1.69E-02
SHORELINE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	0.00E+00	2.44E-03	1.81E-02	1.70E-02	2.05E-02	1.71E-02	1.70E-02	1.69E-02

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	
FISH	0.0	1.0	24.00	SHOREWIDTH FACTOR=0.2
DRINKING	330.0	1.0	12.00	

* * * FISH CONSUMPTION POPULATION DOSES * * *
PERSON-REM

SPORT HARVEST

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH	ADULT	6.10E+04	8.55E-03	1.09E-02	7.20E-03	2.40E-04	3.77E-03	1.34E-03	3.95E-04
FISH	TEENAGER	7.12E+03	1.40E-03	1.74E-03	6.18E-04	3.11E-05	5.98E-04	2.42E-04	4.60E-05
FISH	CHILD	4.93E+03	2.84E-03	2.52E-03	3.98E-04	4.65E-05	8.31E-04	3.13E-04	3.96E-05
FISH	TOTAL	7.30E+04	1.28E-02	1.52E-02	8.21E-03	3.18E-04	5.20E-03	1.90E-03	4.81E-04

LOCATION	DILUTION	CATCH	TIME(HR)-INCLUDES FOOD PROCESSING TIME OF 1.68E+02 HR	POPULATION=1.24E+04
	7.30E+00	7.30E+04	1.69E+02	

AVERAGE INDIVIDUAL CONSUMPTION (KG/YR) ADULT=6.90E+00 TEEN=5.20E+00 CHILD=2.20E+00

* * * FISH CONSUMPTION POPULATION DOSES * * *
PERSON-REM

COMMERCIAL HARVEST

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH	ADULT	4.18E+06	9.73E-04	1.24E-03	8.19E-04	2.45E-05	4.29E-04	1.53E-04	4.49E-05
FISH	TEENAGER	4.88E+05	1.59E-04	1.97E-04	7.02E-05	3.13E-06	6.80E-05	2.75E-05	5.22E-06
FISH	CHILD	3.38E+05	3.23E-04	2.87E-04	4.53E-05	4.61E-06	9.45E-05	3.56E-05	4.50E-06
FISH	TOTAL	5.01E+06	1.45E-03	1.73E-03	9.34E-04	3.22E-05	5.91E-04	2.16E-04	5.46E-05

LOCATION	DILUTION	CATCH	TIME(HR)-INCLUDES FOOD PROCESSING TIME OF 2.40E+02 HR	POPULATION=8.53E+05
	7.30E+00	7.30E+04	2.41E+02	

AVERAGE INDIVIDUAL CONSUMPTION (KG/YR) ADULT=6.90E+00 TEEN=5.20E+00 CHILD=2.20E+00

NEPA DOSES
NOTE--TOTAL NEPA DOSE INCLUDES SPORT CATCH

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH	ADULT	1.22E+05	1.71E-02	2.18E-02	1.44E-02	4.55E-04	7.54E-03	2.68E-03	7.90E-04
FISH	TEENAGER	1.42E+04	2.80E-03	3.47E-03	1.24E-03	5.86E-05	1.20E-03	4.84E-04	9.18E-05
FISH	CHILD	9.85E+03	5.68E-03	5.05E-03	7.97E-04	8.70E-05	1.66E-03	6.25E-04	7.91E-05
FISH	TOTAL	1.46E+05	2.56E-02	3.03E-02	1.64E-02	6.01E-04	1.04E-02	3.79E-03	9.61E-04

* * * POPULATION WATER CONSUMPTION DOSES * * *

SUPPLIER-OMAHA

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
DRINKING	ADULT	1.39E+08	6.10E-03	8.15E-02	8.03E-02	8.48E-02	7.93E-02	7.86E-02	7.92E-02
DRINKING	TEENAGER	1.51E+07	9.14E-04	9.07E-03	8.77E-03	9.46E-03	8.74E-03	8.65E-03	8.69E-03
DRINKING	CHILD	2.48E+07	4.48E-03	2.87E-02	2.74E-02	3.04E-02	2.75E-02	2.72E-02	2.71E-02
DRINKING	TOTAL	1.79E+08	1.15E-02	1.19E-01	1.16E-01	1.25E-01	1.15E-01	1.14E-01	1.15E-01

POPULATION=5.29E+05 DILUTION=3.08E+01 TRANSIT TIME=3.06E+01 HR (INCLUDING 24 HR FOR TREATMENT FACILITY)

AVERAGE INDIVIDUAL CONSUMPTION (L/YR) ADULT=3.70E+02 TEEN=2.60E+02 CHILD=2.60E+02

SUPPLIER-COUNCIL BLUFFS

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
DRINKING	ADULT	2.29E+07	9.88E-04	1.32E-02	1.30E-02	1.37E-02	1.28E-02	1.27E-02	1.28E-02
DRINKING	TEENAGER	2.49E+06	1.48E-04	1.47E-03	1.42E-03	1.53E-03	1.41E-03	1.40E-03	1.41E-03
DRINKING	CHILD	4.07E+06	7.25E-04	4.64E-03	4.43E-03	4.92E-03	4.45E-03	4.40E-03	4.39E-03
DRINKING	TOTAL	2.94E+07	1.86E-03	1.93E-02	1.88E-02	2.02E-02	1.87E-02	1.85E-02	1.86E-02

POPULATION=8.70E+04 DILUTION=3.13E+01 TRANSIT TIME=3.10E+01 HR (INCLUDING 24 HR FOR TREATMENT FACILITY)

AVERAGE INDIVIDUAL CONSUMPTION (L/YR) ADULT=3.70E+02 TEEN=2.60E+02 CHILD=2.60E+02

-----CUMULATIVE TOTAL-----

PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
DRINKING	CUMUL TOTAL	2.08E+08	1.34E-02	1.39E-01	1.35E-01	1.45E-01	1.34E-01	1.33E-01	1.34E-01

HYDROSPHERE TRITIUM DOSE

AVERAGE INDIVIDUAL WATER CONSUMPTION = 3.0 L/DAY

PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
WATER	TOTAL	2.86E+11	0.00E+00	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03

* * * RECREATION POPULATION DOSES * * *

LOCATION- DOWN STREAM SWIMMING

DILUTION= 7.30E+00 TRANSIT TIME= 6.70E-01 HR SWF= 0.2

PATHWAY	AGE GROUP	USAGE	DOSE (PERSON-REM) SKIN	TOTAL BODY	THYROID
SHORELINE	TOTAL POPUL	4.10E+07	1.81E-02	1.55E-02	1.55E-02

LOCATION- DOWN STREAM SWIMMING

DILUTION= 7.30E+00 TRANSIT TIME= 6.70E-01 HR

PATHWAY	AGE GROUP	USAGE	DOSE (PERSON-REM) SKIN	TOTAL BODY	THYROID
SWIMMING	TOTAL POPUL	4.10E+07		1.30E-04	1.30E-04

LOCATION- DOWN STREAM BOATING

DILUTION= 7.30E+00 TRANSIT TIME= 6.70E-01 HR

PATHWAY	AGE GROUP	USAGE	DOSE (PERSON-REM) SKIN	TOTAL BODY	THYROID
BOATING	TOTAL POPUL	4.10E+07		6.48E-05	6.48E-05

* * * DOSE TO BIOTA * * *
MRADS PER YEAR

BIOTA DILUTION= 1.00E+00 TRANSIT TIME= 0.00E+00 HR

	INTERNAL	EXTERNAL	TOTAL
FISH	6.49E-02	1.21E-01	1.86E-01
INVERTEBRATE	4.32E-02	2.41E-01	2.84E-01
ALGAE	6.01E-02	2.03E-04	6.03E-02
MUSKRAT	3.74E-01	8.05E-02	4.54E-01
RACCOON	1.29E-01	6.03E-02	1.90E-01
HERON	1.93E+00	8.04E-02	2.01E+00
DUCK	3.45E-01	1.21E-01	4.66E-01

SECTION VI

RADIOACTIVE EFFLUENT RELEASES - SOLID RADIOACTIVE WASTE

Technical Specifications 5.9.4.a

January 1, 2015 - December 31, 2015

III. RADIOACTIVE EFFLUENT RELEASE – SOLID RADIOACTIVE WASTE EFFLUENT AND WASTE DISPOSAL REPORT

January 1, 2015 through December 31, 2015

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED)

1.	Type of Waste	Month Shipped	Number of Shipments	Volume Cu. Meter	Curie Content	Est. Total % Error
a.	Spent resins, filter	January	0	0	0	N/A
	sludges, evaporator	February	0	0	0	N/A
	bottoms, etc.	March	0	0	0	N/A
		April	0	0	0	N/A
		May	0	0	0	N/A
		June	0	0	0	N/A
		July	0	0	0	N/A
		August	0	0	0	N/A
		September	0	0	0	N/A
		October	0	0	0	N/A
		November	0	0	0	N/A
		December	0	0	0	N/A
Total		(Type a)	0	0	0	N/A
b.	Dry compressable,	January	0	0	0	N/A
	contaminated equipment,	February	0	0	0	N/A
	etc.	March	0	0	0	N/A
		April	2	145	4.55E-02	20
		May	4	290	6.07E-01	20
		June	1	72.5	2.86E-02	20
		July	0	0	0	N/A
		August	1	72.5	2.98E-02	20
		September	0	0	0	N/A
		October	0	0	0	N/A
		November	0	0	0	N/A
		December	0	0	0	N/A
Total		(Type b)	8	580	7.11E-01	20

III. RADIOACTIVE EFFLUENT RELEASE – SOLID RADIOACTIVE WASTE EFFLUENT AND WASTE DISPOSAL REPORT

(Continued)

1. Type of Waste	Month Shipped	Number of Shipments	Volume Cu. Meter	Curie Content	Est. Total % Error
c. Irradiated components and other categories.	January	0	0	0	N/A
	February	0	0	0	N/A
	March	0	0	0	N/A
	April	0	0	0	N/A
	May	0	0	0	N/A
	June	0	0	0	N/A
	July	0	0	0	N/A
	August	0	0	0	N/A
	September	0	0	0	N/A
	October	0	0	0	N/A
	November	0	0	0	N/A
	December	0	0	0	N/A
Total	(Type c)	0	0	0	N/A
d. Other	January	0	0	0	N/A
	February	0	0	0	N/A
	March	0	0	0	N/A
	April	0	0	0	N/A
	May	0	0	0	N/A
	June	0	0	0	N/A
	July	0	0	0	N/A
	August	0	0	0	N/A
	September	0	0	0	N/A
	October	0	0	0	N/A
	November	0	0	0	N/A
	December	0	0	0	N/A
Total	(Type d)	0	0	0	N/A

III. RADIOACTIVE EFFLUENT RELEASES–SOLID RADIOACTIVE

(Continued)

B. ESTIMATE OF MAJOR NUCLIDE COMPOSITION (By Type of Waste)

1. Percentage of Curies from Represented Isotopes

	Isotope	Percent	Curies
a.	N/A	N/A	N/A
b.	Cs-137	24.6	1.33E-04
	Ni-63	17.5	9.43E-05
	Nb-95	16.5	8.93E-02
	Co-60	12.4	6.71E-05
	Zr-95	9.3	5.04E-05
	Fe-55	8.6	4.64E-02
	Cr-51	6.4	3.45E-05
	Co-58	2.6	1.40E-05
	All Other Nuclides Constitute Less than 1%		
c.	N/A	N/A	N/A
d.	N/A	N/A	N/A

C. SOLID WASTE (DISPOSITION)

Number of Shipments	Transportation Mode	Destination
8	Sole Use Vehicle	Energy Solutions, Bear Creek TN

D. IRRADIATED FUEL SHIPMENTS (DISPOSITION)

Number of Shipments	Transportation Mode	Destination
N/A	N/A	N/A

SECTION VII

ATTACHMENT 1

ODCM and Process Control Program revisions for the period January 1, 2015 through December 31, 2015 in accordance with Technical Specification 5.17.d and 5.18.d, the radioactive effluent release report shall include any revisions to the Offsite Dose Calculation Manual (ODCM) and the Process Control Program.

Offsite Dose Calculation Manual (ODCM), CH-ODCM-0001, Rev 24.

Process Control Program for Radioactive Wastes, RW-AA-100, Rev 11.

CH-ODCM-0001

Off-Site Dose Calculation Manual (ODCM)

Revision 24

Safety Classification: Non-Safety

Usage Level: Reference

Change No.:	**EC 64902**
Reason for Change:	**NFPA 805 Implementation; Table 5.2 footnote correction; OCDM grace period**
Requestor:	**R. Layman**
Preparer:	**J. Shirah**
Issued:	**01-15-15 3:00pm**

Fort Calhoun Station

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PART II

1.0 PURPOSE AND SCOPE

1.1 Purpose

1.1.1 Contains methodologies for and parameters necessary for calculating offsite doses, determination of gaseous and liquid radiation monitor set points, and administrative controls for effluent instrumentation, Radiological Effluent Tech Specs (RETS), and the Radiological Environmental Monitoring Program (REMP).

1.2 Scope

1.2.1 Radioactive effluents are generated from station operations. These controls provide methodologies ensuring these effluents are properly monitored and quantified to promote accurate dose reporting. Additional controls ensure station equipment and processes are used to minimize release to the environment. The combination of minimizing release, accurately reporting dose, and monitoring the plant environs provides the basis for ensuring that station operation is not negatively impacting public health and the environment.

2.0 DEFINITIONS

2.1 Abnormal Discharge - The unplanned or uncontrolled emission of an effluent (i.e., containing plant-related, licensed radioactive material) into the unrestricted area.

2.2 Abnormal Release - The unplanned or uncontrolled emission of an effluent (i.e., containing plant-related, licensed radioactive material).

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

2.4 Channel Function Test - Injection of a simulated signal into the channel to verify that it is operable, including any alarm and/or trip initiating action.

2.5 Effluent Concentration Limit (ECL) - Radionuclide limits listed in 10 CFR Part 20, Appendix B, Table 2, Column 1.

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

2.7 Operable-Operability - A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified safety function(s) and when all necessary attendant instrumentation, controls, normal or emergency electrical power sources, 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).

2.8 Purge-Purging - PURGE or 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.

2.9 Residual Radioactivity - Residual radioactivity means radioactivity in structures, materials, soils, ground water, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but it excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR Part 20.

2.10 Site Boundary - The Site Boundary is the line beyond which the land is neither owned, or leased, nor controlled by the licensee.

2.11 Source Check - A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

2.12 Special Liquid - Non-routine release pathway in which normally non-radioactive liquid streams (such as Raw Water) found to contain radioactive material, are non-routine, and will be treated on a case specific basis if and when this occurs.

2.13 Unrestricted Area - An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes.

2.14 Venting - VENTING shall be the 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.

2.15 Water Effluent Concentration (WEC) - Radionuclide limits listed in 10 CFR Part 20, Appendix B, Table 2, Column 2.

Table 1.2 - Frequency Notation

The surveillance intervals are defined as follows:

Notation	Title	Frequency[A]
S	Shift	At least once per 12 hours
D	Daily	At least once per 24 hours
W	Weekly	At least once per 7 days
BW	Biweekly	At least once per 14 days
M	Monthly	At least once per 31 days
Q	Quarterly	At least once per 92 days
SA	Semiannual	At least once per 184 days
A	Annually	At least once per 366 days
R	Refueling	At least once per 18 months
P	Prior to	Prior to each release (Performance within 24 hrs.)

A. Each surveillance requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25 percent of the specified surveillance interval.

Table 1.3 - Radiological Effluent Controls Program Technical Specification Implementation

Technical Specification	ODCM Implementing Step
5.16.1.a	3.1.1, 3.2.1
5.16.1.b	4.1.1
5.16.1.c	Table 4.1, Table 4.2
5.16.1.d	4.1.2
5.16.1.e	4.1.2B.1, 4.2.2B.1
5.16.1.f	4.1.3A, 4.2.4A
5.16.1.g	4.2.1
5.16.1.h	4.2.2
5.16.1.i	4.2.3
5.16.1.j	4.3.1
5.16.2.a	5.1.1
5.16.2.b	5.2.1
5.16.2.c	5.3.1
5.17	6.3, 6.2.1D
5.18	6.2.1D

3.0 INSTRUMENTATION

3.1 Radioactive Liquid Effluent Instrumentation

3.1.1 Limiting Condition for Operation

A. The radioactive liquid effluent monitoring instrumentation channels shown in Table 3.1.1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Specification 3.1.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with Part II of the Off-Site Dose Calculation Manual.

APPLICABILITY: At all times

ACTION:

1. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above specification, immediately suspend the releases of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable.

2. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels operable, take the action shown in Table 3.1.1. Restore inoperable effluent monitoring instrumentation to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radiological Effluent Release Report why this inoperability was not corrected in a timely manner. The reporting requirement is limited to the following instrumentation that monitors effluent streams: RM-055, RM-054A, and RM-054B.

3.1.2 Surveillance Requirements

A. Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CALIBRATION, and CHANNEL FUNCTIONAL TEST at the frequencies shown in Table 3.1.2.

Table 3.1.1 - Radioactive Liquid Effluent Monitoring Instrumentation

Instrument	Minimum Channels Operable	Action
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release.		
1.1 Liquid Radwaste Effluent Line (RM-055)	1	1, 5
1.2 Steam Generator Blowdown Effluent Line (RM-054A and B)	1 [A]	2, 5
2. Flow Rate Measurement Devices		
2.1 Liquid Radwaste Effluent Line	1	3
2.2 Steam Generator Blowdown Effluent Line	1	3
3. Radioactivity Recorders		
3.1 Liquid Radwaste Effluent Line	1	4
3.2 Steam Generator Blowdown Effluent Line	1	4
A. If one of the two radiation monitors is inoperable, the activity of both blowdown lines shall be monitored by the operable monitor within 2 hours of the declaration of inoperability by the Shift Manager, or the action steps of ACTION 2, Table 3.1.1 should be performed on the Steam Generator that is not being monitored.		

Table 3.1.1 (continued)

Table Notation	
ACTION 1	With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue provided that prior to initiating a release: 1. At least two independent samples are analyzed in accordance with applicable chemistry procedures. 2. At least two qualified individuals independently verify the release rate calculations.
ACTION 2	With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue provided that grab samples are analyzed for principal gamma emitters at a sensitivity of 5.0E-07 µCi/gram: 1. At least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01 µCi/gram dose equivalent I-131. 2. At least daily when the specific activity of the secondary coolant is less than or equal to 0.01 µCi/gram equivalent I-131. Otherwise, suspend release of radioactive effluents via this pathway.
ACTION 3	With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue provided the flow rate is determined at least once per four hours during the actual release.
ACTION 4	With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue provided the radioactivity is recorded manually at least once per four hours during the actual release.
ACTION 5	During the performance of source checks the effluent radiation monitor is unable to respond, hence is considered inoperable. Effluent releases may continue uninterrupted during the performance of source checks provided the operator is stationed at the monitor during the check. If the effluent radiation monitor fails the source check, carryout the action(s) of the Off-Site Dose Calculation Manual for the inoperable monitor or terminate the effluent release.

Table 3.1.2 - Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements

Instrument	Channel Check	Channel		Source Check
		Calibration	Function Test	
1. Radioactivity Monitors Providing Alarm and Automatic Isolation				
1.1 RM-054A/054B	D [A]	R	Q	M
1.2 RM-055	----	R	Q	P
2. Flowrate Monitors				
2.1 Steam Generator Blowdown	D	R	Q	----

A. Visual Flowcheck Daily

3.2 Radioactive Gaseous Effluent Instrumentation

3.2.1 Limiting Condition for Operation

A. The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.2.1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Specification 3.2.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with Part II of the Off-Site Dose Calculation Manual.

APPLICABILITY: At all times

ACTION:

1. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above specification, immediately suspend the releases of radioactive gaseous effluents monitored by the affected channel or declare the channel inoperable.

2. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels operable, take the action shown in Table 3.2.1. Restore inoperable effluent monitoring instrumentation to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radiological Effluent Release Report why this inoperability was not corrected in a timely manner. The reporting requirement is limited to the following instrumentation that monitors effluent streams: RM-057, RM-043, RM-062, RM-063, and RM-052.

3.2.2 Surveillance Requirements

A. Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CALIBRATION, and CHANNEL FUNCTIONAL TEST at the frequencies shown in Table 3.2.2.

Table 3.2.1 - Radioactive Gaseous Effluent Monitoring Instrumentation

Instrument	Minimum Channels Operable	Action
1. Auxiliary Bldg. Exhaust Stack (RM-052, RM-062)		
1.1 Noble Gas	1	1, 9, 11
1.2 Iodine and Particulate	1	2, 9, 11
2. Laboratory and Radwaste Processing Building Stack (RM-043)		
2.1 Noble Gas	1	3, 9
2.2 Iodine and Particulate	1	4, 9
3. Condenser Off Gas (RM-057)		
3.1 Noble Gas	1	5, 9
4. Containment Purge Line (RM-051, RM-052)		
4.1 Noble Gas	1	1, 6, 9, 11, 12
4.2 Iodine and Particulate	1	2, 9, 11, 12
5. Containment Pressure Relief Line (RM-051, RM-052)		
5.1 Noble Gas	1	1, 9, 11
5.2 Iodine and Particulate	1	2, 9, 11
6. Containment Penetrations M72 and M74 (Integrated Leak Rate Test Depressurization Vent Path)	N/A	10
7. Flow Rate Measurement Devices		
7.1 Waste Gas Discharge Header	1	7

Table 3.2.1 - Radioactive Gaseous Effluent Monitoring Instrumentation			
	Instrument	**Minimum Channels Operable**	**Action**
7.2	Auxiliary Building Stack	1	7
7.3	Laboratory and Radwaste Processing Building Stack	1	7
7.4	Containment Purge Line	1	7
7.5	Containment Pressure Relief Line Annubar D/P	1	7
8.	Radioactivity Chart Recorders		
8.1	Auxiliary Building Exhaust Stack	1	8

Table 3.2.1 Radioactive Gaseous Effluent Monitoring Instrumentation	
TABLE NOTATION	
ACTION 1	If the Auxiliary Building Exhaust Stack Noble Gas Monitor is inoperable, releases from the containment pressure relief line and the containment purge line are to be secured in the most expeditious manner. Ventilation of the auxiliary building via the Auxiliary Building Exhaust Stack may continue provided grab samples are taken once per 12 hours. (See Table 4.2)
ACTION 2	If the Auxiliary Building Exhaust Stack Iodine and Particulate Sampler is inoperable, ventilation of the Auxiliary Building and releases from the gaseous waste discharge header, containment pressure relief line or the containment purge line may continue through the Auxiliary Building Exhaust Stack provided sample collection in accordance with Table 4.2 using auxiliary sample collection equipment is initiated within 2 hours of the declaration of inoperability by the Shift Manager.
ACTION 3	If the Noble Gas Monitor is inoperable, ventilation of the LRWPB may continue via the LRWPB stack provided grab samples are taken at least once per 12 hours. (See Table 4.2)
ACTION 4	If the Iodine and Particulate Sampler is inoperable, ventilation of the LRWPB may continue via the LRWPB Stack provided sample collection using auxiliary sample collection equipment is initiated within 2 hours of the declaration of inoperability, by the Shift Manager, in accordance with Table 4.2.
ACTION 5	During power operation, when the condenser air ejector is in service, the condenser off gas discharge shall be monitored for gross radioactivity. If this monitor is inoperable, grab samples are taken at least once per 12 hours. (See Table 4.2)
ACTION 6	The release of airborne effluents from the Containment purge line will be secured if a noble gas monitor is unavailable to monitor the containment building atmosphere.
ACTION 7	With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue provided the flowrate is estimated or recorded manually at least once per four hours during the actual release.
ACTION 8	With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue provided the radioactivity level is recorded manually at least once per four hours during the actual release.
ACTION 9	During the performance of source checks the effluent radiation monitor is unable to respond, hence is considered inoperable. Effluent releases may continue uninterrupted during the performance of source checks provided the operator is stationed at the monitor during the check. If the effluent radiation monitor fails the source check, carryout the Action(s) of the Off-Site Dose Calculation Manual for the inoperable monitor or terminate the effluent release.

Table 3.2.1 Radioactive Gaseous Effluent Monitoring Instrumentation	
TABLE NOTATION	
ACTION 10	Automatic release termination capability is not required provided manual isolation can be accomplished in accordance with the requirements of SE-ST-ILRT-0001, Containment Integrated Leakage Rate Test (CILRT).
ACTION 11	During the ventilation of airborne effluents from the Auxiliary Building Stack at least one Auxiliary Building Exhaust fan shall be in operation.
ACTION 12	IF containment purges are made without processing through at least one of the Containment Air Cooling and Filtering Units, and it is confirmed that one half of the annual dose objective listed in Section 4.2.2 will be exceeded during the calendar quarter, a special report shall be submitted to the NRC as defined in Section 4.2.4.

Table 3.2.2 - Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

Instrument	Channel Check	Calibration	Channel Function Test	Source Check
1. Radioactivity Monitors Providing Alarm and Automatic Isolation				
1.1 RM-043	D	R	Q	M
1.2 RM-057	D	R	Q	M
1.3 RM-062	D	R	Q	M, P
1.4 RM-052 [A]	D	R	Q	M, P[A]
2. Flowrate Monitors				
2.1 RM-043 Sampler	D	R	Q	----
2.2 RM-062 Sampler	D	R	Q	----
2.3 RM-052 Sampler	D	R	Q	----
2.4 Auxiliary Bldg Exhaust Stack	D	R	Q	----
2.5 Laboratory and Radwaste Process Bldg Exhaust Stack	D	R	Q	----
	Operations Check		**Air Flow Calibration**	
3. Environmental Monitors				
3.1 RM-023 - Sample Station #40	M		A	
3.2 RM-024 - Sample Station #41	M		A	
3.3 RM-025 - Sample Station #28	----		----	
3.4 RM-026 - Sample Station #36	----		----	
3.5 RM-027 - Sample Station #37	M		A	
3.6 RM-028 - Sample Station #38	----		----	
3.7 RM-029 - Sample Station #39	----		----	
3.8 RM-035 - Sample Station #1	----		----	
3.9 RM-036 - Sample Station #2	M		A	
3.10 RM-037 - Sample Station #3	----		----	
3.11 RM-038 - Sample Station #4	M		A	
3.12 RM-039 - Sample Station #5	----		----	
3.13 RM-040 - Sample Station #32	M		A	

A. Required when RM-052 is sampling the Auxiliary Building Exhaust Stack.

4.0 RADIOACTIVE EFFLUENTS

4.1 Radioactive Liquid Effluents

4.1.1 Concentration

A. Limiting Condition for Operation

1. The release rate of radioactive material in liquid effluents shall be controlled such that the instantaneous concentrations for radionuclides, other than dissolved or entrained noble gases, do not exceed the values specified in 10 CFR Part 20 for liquid effluents at site discharge. To support plant operations, Supervisor-System Chemistry may increase this limit up to the limit specified in Technical Specifications 5.16.1.b. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-04 µCi/ml, total activity.

2. Technical Specification 5.16.1.b establishes the administrative control limit on concentration of radioactive material, other than dissolved or entrained noble gases, released in liquid effluents to unrestricted areas conforming to ten times 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-04 µCi/ml total activity.

   APPLICABILITY: At all times

   ACTION:

   a. When the concentration of radioactive material released at site discharge exceeds the above limits, appropriate corrective actions shall be taken immediately to restore concentrations within the above limits.

B. Surveillance Requirements

	NOTE	
i	Radioactive liquid waste includes water used for fire suppression in areas of the plant that may contain radioactivity. These liquids are required to be monitored prior to release in accordance with SO-G-28.	i

1. Radioactive liquid waste shall be sampled and analyzed according to the sampling and analysis program in Table 4.1.

2. The results of the radioactivity analysis shall be used with the calculational methods in Part II of the Off-Site Dose Calculation Manual.

3. To assure that the concentration at the point of release is maintained within the limits of Technical Specification 5.16.1.b.

4.1.1B (continued)

4. Records shall be maintained of the radioactive concentrations and volume before dilution of each batch of liquid effluent released and of the average dilution flow and length of time over which each discharge occurred. Analytical results shall be submitted to the Commission in accordance with Part I, Section 6.0 of the Off-Site Dose Calculation Manual.

Table 4.1 - Radioactive Liquid Effluent Sampling and Analysis

A. Monitor, Hotel Waste Tanks & Special Liquid, Releases

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
Each Batch	Principal Gamma Emitters [B]	5.0E-07
Each Batch	I-131	1.0E-06
Each Batch	Dissolved Noble Gases (Gamma Emitters) [B]	1.0E-05
Monthly Composite [D]	H-3	1.0E-05
Monthly Composite [D]	Gross Alpha	1.0E-07
Quarterly Composite [D]	Sr-89, Sr-90	5.0E-08
Quarterly Composite [D]	Fe-55	1.0E-06

B. Steam Generator Blowdown

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
Weekly Composite [D]	Principal Gamma Emitters [B]	5.0E-07
Weekly Composite [D]	I-131 [C]	1.0E-06
Weekly Composite [D]	Dissolved Noble Gases (Gamma Emitters) [B]	1.0E-05
Monthly Composite [D]	H-3	1.0E-05
Monthly Composite [D]	Gross Alpha	1.0E-07
Quarterly Composite [D]	Sr-89, Sr-90	5.0E-08
Quarterly Composite [D]	Fe-55	1.0E-06

NOTES:

A. LLD is defined in Part II of the Off-Site Dose Calculation Manual.

B. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for dissolved or entrained gases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141 for fission and corrosion products. Ce-144 shall also be measured, but with a LLD of 5.0E-06.

C. A weekly grab sample and analyses program including gamma isotopic identification will be initiated for the turbine building sump effluent when the steam generator blowdown water composite analysis indicates the I-131 concentration is greater than 1.0E-06 µCi/ml.

D. To be representative of the average quantities and concentrations of radioactive materials in liquid effluents, samples should be collected in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite should be mixed in order for the composite sample to be representative of the average effluent release.

4.1.2 Dose from Radioactive Liquid Effluents

A. Limiting Condition for Operation

1. The dose or dose commitment to an individual in unrestricted areas from radioactive materials in liquid effluents shall be limited to the following:

   a. During any calendar quarter: Less than or equal to 1.5 mrem to the total body and 5 mrem to any organ; and

   b. During any calendar year: Less than or equal to 3 mrem to the total body and 10 mrem to any organ.

   APPLICABILITY: At all times

   ACTION:

   a. If the dose contribution, due to the cumulative release of radioactive materials in liquid effluents, exceeds the annual or quarterly dose objectives, submit a Special Report to the NRC, per Section 6.2.3, within 30 days.

B. Surveillance Requirements

1. Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in Part II of the Off-Site Dose Calculation Manual at least once per quarter.

4.1.3 Liquid Radwaste Treatment

A. Limiting Condition for Operation

1. The Liquid Radwaste Treatment System shall be OPERABLE, and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31-day period.

   APPLICABILITY: At all times

   ACTION:

   a. With radioactive liquid waste being discharged without treatment and in excess of the above limits and any portion of the Liquid Radwaste Treatment System not in operation, prepare and submit to the Nuclear Regulatory Commission within 30 days, pursuant to 10 CFR 50, Appendix I, a Special Report that includes the following information:

      1) Explanation of why liquid radwaste was being discharged without treatment, identification of equipment or subsystem(s) not operable and reasons for inoperability.

      2) Action(s) taken to restore the inoperable equipment to operable status.

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

B. Surveillance Requirements

1. Dose due to liquid releases shall be projected frequently and at least once per quarter, in accordance with the methodology and parameters in Part II of the Off-Site Dose Calculation Manual, when Liquid Radwaste Treatment Systems are not fully OPERABLE.

2. OPERABLE is defined as follows:

   a. A filtration/ion exchange (FIX) system will be utilized for processing liquid radwaste. The system consists of a booster pump, charcoal pretreatment filter, and pressure vessels containing organic/inorganic resins, which can be configured for optimum performance. The effluent from the FIX system is directed to the monitor tanks for release.

4.1.3B.2 (continued)

b. Waste filters (WD-17A and WD-17B) are used only on those occasions when considered necessary, otherwise the flows from the low activity fluids may bypass the filters. No credit for decontamination factors (iodines, Cs, Rb, others) was taken for these filters during the 10 CFR Part 50 Appendix I dose design objective evaluation; therefore, the inoperability of these filters does not affect the dose contributions to any individual in the unrestricted areas via liquid pathways. The inoperability of waste filters will not be considered a reportable event in accordance with the Action listed above.

4.1.4 Liquid Holdup Tanks

Tanks included in this Specification are those outdoor tanks that are not surrounded by liners, dikes, or walls capable of holding the tanks contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system.

A. Limiting Condition for Operation

1. The quantity of radioactive material contained in each unprotected outdoor liquid holdup tank shall not exceed 10 curies, excluding tritium and dissolved or entrained noble gases.

APPLICABILITY: At all times

ACTION:

a. When the quantity of radioactive material in any unprotected outdoor liquid holdup tank exceeds 10 curies, excluding tritium and dissolved or entrained noble gasses, immediately suspend all additions of radioactive material to the tank and within 48 hours reduce the tank contents to within the limit.

B. Surveillance Requirements

1. The quantity of radioactive material contained in each outdoor liquid holdup tank shall be determined to be within the above limit by analyzing a representative sample of the tank=s contents at least once per 7 days when radioactive material is being added to the tank.

4.2 Radioactive Gaseous Effluents

4.2.1 Concentration

A. Limiting Condition for Operation

1. The release rate of radioactive material in airborne effluents shall be controlled such that the instantaneous concentrations of radionuclides does not exceed the values specified in 10 CFR Part 20 for airborne effluents at the unrestricted area boundary. To support plant operations, Supervisor-System Chemistry may increase this limit up to the limits specified in Technical Specification 5.16.1.g.

2. Technical Specification 5.16.1.g establishes the administrative control limit on the concentration resulting from radioactive material, other than noble gases, released in gaseous effluents to unrestricted areas conforming to ten times 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 1. For noble gases, the concentration shall be limited to five times 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 1.

   APPLICABILITY: At all times

   ACTION:

   a. When the concentration of radioactive material released to unrestricted areas exceeds the above limits, appropriate corrective actions shall be taken immediately to restore concentrations within the above limits.

B. Surveillance Requirements

i	**NOTE** Radioactive gaseous wastes include atmospheres in areas where gaseous fire suppression systems are utilized or where smoke is produced as a result of fire in areas of the plant that may contain radioactivity. These atmospheres are required to be monitored prior to gaseous release to unrestricted areas in accordance with SO-G-28.	i

1. Radioactive gaseous wastes shall be sampled and analyzed according to the sampling and analysis program of Table 4.2. The results of the radioactivity analysis shall be used to assure the limits in Step 4.2.1A are not exceeded.

Table 4.2 - Radioactive Airborne Effluent Sampling and Analysis

A. Gas Decay Tank Releases

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
Prior to each release	Principal Gamma Emitters [B]	1.0E-04

B. Containment Purge Releases or Containment Pressure Relief Line Releases [E]

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
Prior to each release	Principal Gamma Emitters [B]	1.0E-04
Prior to each release	H-3	1.0E-06

C. Condenser Off Gas Releases [E]

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
Monthly [C]	Tritium (H-3)	1.0E-06
Monthly	Principal Gamma Emitters [B]	1.0E-04

D. Auxiliary Building Exhaust Stack [E]

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
Weekly (Charcoal Sample)	I-131	1.0E-12
Weekly (Particulate Sample)	Principal Gamma Emitters [B]	1.0E-11
Weekly (Noble Gases)	Principal Gamma Emitters [B]	1.0E-4
Weekly	Tritium (H-3)	1.0E-06
Monthly Composite [D]	Gross Alpha	1.0E-11
Quarterly Composite (Particulate Samples)	Sr-89, Sr-90	1.0E-11

Table 4.2 - Radioactive Airborne Effluent Sampling and Analysis

E. Laboratory and Radwaste Building Exhaust Stack [E]

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
Weekly (Charcoal Sample)	I-131	1.0E-12
Weekly (Particulate Sample)	Principal Gamma Emitters [B]	1.0E-11
Weekly (Noble Gases)	Principal Gamma Emitters [B]	1.0E-4
Monthly Composite [D]	Gross Alpha	1.0E-11
Quarterly Composite (Particulate Sample)	Sr-89, Sr-90	1.0E-11

NOTES:

A. LLD is defined in Part II of the Off-Site Dose Calculation Manual.

B. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for Iodine and particulate releases.

C. Required only when steam generator blowdown radioactivity for tritium (Table 4.1, Item B) exceeds 3.0E-03 µCi/milliliter.

D. Frequency requirement may be satisfied using weekly gross alpha results from particulate sampling media.

E. Particulate and Iodine samples shall be corrected for sampler deposition/transportation efficiency by using the approved software programs or by multiplying the activity obtained by the associated sampler multiplication factor (See Table 4.3).

Table 4.3 - Sampler Deposition/Transportation Correction Factors

Sampler	Sample	Particulate		Iodine	
		DF	ACTMULT	DF	ACTMULT
RM-062	AB	0.411	2.433	0.669	1.495
RM-052	AB	0.638	1.567	0.653	1.531
RM-052	CONT	0.525	1.905	0.688	1.453
RM-051	CONT	0.624	1.603	0.714	1.401
RM-043	LRWPB	0.809	1.236	0.873	1.236
PORTABLE	CONT	1.000	1.000	0.950	1.053

ACRONYM DEFINITIONS:

AB - Auxiliary Building Exhaust Stack
CONT - Containment Building
LRWPB - Laboratory and Rad Waste Processing Building
DF - Deposition Factor
ACTMULT - Activity multiplication factor to correct for sample loss.

4.2.2 Dose - Noble Gases

A. Limiting Condition for Operation

1. The dose or dose commitment to an individual at the site boundary from release of noble gases in airborne effluents shall be limited to the following:

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

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

APPLICABILITY: At all times

ACTION:

a. If the dose contribution, due to the cumulative release of noble gases in airborne effluents, exceeds the annual or quarterly dose objectives, submit a Special Report to the NRC, per Section 6.2.3, within 30 days.

B. Surveillance Requirements

1. The radiation dose contributions from radioactive noble gases in airborne effluents shall be determined, in accordance with the methodologies and parameters of Part II of the Off-Site Dose Calculation Manual, on a quarterly basis.

4.2.3 Dose - I-131, I-133, H-3, C-14, and Radioactive Material in Particulate Form with Half-Lives Greater than 8 Days (Other than Noble Gases)

A. Limiting Condition for Operation

1. The dose to an individual or dose commitment to any organ of an individual in unrestricted areas due to the release of I-131, I-133, H-3, C-14, and radioactive materials in particulate form with half-lives greater than eight days (excluding noble gases) in airborne effluents shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrem to any organ; and

4.2.3A.1 (continued)

b. During any calendar year: Less than or equal to 15 mrem to any organ.

APPLICABILITY: At all times

ACTION:

a. If the dose contribution, due to the cumulative release of I-131, I-133, H-3, C-14, and radioactive materials in particulate form with half-lives greater than eight days, exceeds the annual or quarterly dose objectives, submit a Special Report to the NRC per Section 6.2.3, within 30 days.

B. Surveillance Requirements

1. The radiation dose contributions from I-131, I-133, H-3, C-14 and radioactive materials in particulate form with half-lives greater than eight days (excluding noble gases) in airborne effluents shall be determined, in accordance with the methodologies and parameters of Part II of the Off-Site Dose Calculation Manual, on a quarterly basis.

4.2.4 Gaseous Radwaste Treatment

A. Limiting Condition for Operation

1. In accordance with Technical Specification 5.16.1.f, the Waste Gas System and the Ventilation Exhaust Systems shall be OPERABLE, and appropriate portions of these systems shall be used to reduce the releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases to areas at and beyond the SITE BOUNDARY would exceed:

a. 0.2 mrad to air from gamma radiation, or

b. 0.4 mrad to air from beta radiation, or

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

4.2.4A.1 (continued)

APPLICABILITY: At all times

ACTION:

a. With radioactive gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit a report to the Nuclear Regulatory Commission within 30 days, pursuant to 10 CFR 50, Appendix I, a special report that includes the following information:

1) Identification of equipment or subsystem(s) not operable and reasons for inoperability.

2) Action(s) taken to restore the inoperable equipment to operable status.

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

B. Surveillance Requirements

1. Dose due to gaseous releases shall be projected frequently and at least once per quarter, in accordance with the methodology and parameters in Part II of the Off-Site Dose Calculation Manual, when Waste Gas Systems and Ventilation Exhaust Systems are not fully OPERABLE.

4.2.4B (continued)

2. OPERABLE is defined as follows:

   a. Waste Gas System

      1) The waste airborne radioactive material at Fort Calhoun Station is collected in the vent header where the gas compressors take suction, compress the gas and deliver it to one of the four gas decay tanks. The waste airborne radioactive material is treated in these gas decay tanks by holding for radioactive decay prior to final controlled release to the environs. In order to provide conformance with the dose design objectives, gas decay tanks are normally stored for approximately 30 days and thus achieve decay of short half-life radioactive materials, e.g., I-131, Xe-133. Earlier release is allowed when a plant need exists and analytical results are in accordance with ALARA release objectives. If the radioactive airborne wastes from the gas decay tanks are discharged without processing in accordance with the above conditions, and it is confirmed that one half of the annual dose objective will be exceeded during the calendar quarter, a special report shall be submitted to the Commission pursuant to Section 4.2.4A.

   b. Ventilation Exhaust Systems

      1) The radioactive effluents from the controlled access area of the auxiliary building are filtered by the HEPA filters in the auxiliary building ventilation system. If the radioactive effluents are discharged without the HEPA filters, a special report shall be submitted to the NRC as defined in Action 4.2.4B.2.a above.

      2) The discharge from the gas decay tanks is routed through charcoal and HEPA filter unit VA-82. No credit was taken for the operation of hydrogen purge filters during the 10 CFR Part 50, Appendix I dose design evaluation and doses through the airborne effluent pathways were well below the design objectives. The unavailability of hydrogen purge filters will not be considered a reportable event.

4.2.4B.2.b (continued)

3) The containment air is processed through at least one of the redundant containment HEPA and charcoal filters in the Containment Air Cooling and Filtering Units prior to purging. If the containment purges are made without processing through one of the Containment Air Cooling and Filtering Units, and it is confirmed that one half of the annual dose objective will be exceeded during the calendar quarter, a special report shall be submitted to the NRC as defined in Action 4.2.4B.2.a above.

4.3 Uranium Fuel Cycle

4.3.1 Total Dose-Uranium Fuel Cycle

A. Limiting Condition for Operation

1. The dose to any real individual from uranium fuel cycle sources shall be limited to ≤ 25 mrem to the total body or any organ (except the thyroid, which shall be limited to ≤ 75 mrem) during each calendar year.

   APPLICABILITY: At all times

   ACTION:

   a. With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of specifications 4.1.2A, 4.2.2A, or 4.2.3A, calculations shall be made including direct radiation contribution from the plant and outside storage tanks to determine whether the above limits have been exceeded. If such is the case, in lieu of any other report required by Section 6.2, prepare and submit a Special Report to the Commission pursuant to Technical Specification 5.16 that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report , as defined in 10 CFR Part 20.2203(a)(4) and 20.2203(b), shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentration of radioactive material involved, and the cause of exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in the violation of 40 CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

4.3.1 (continued)

B. Surveillance Requirements

1. Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with surveillance requirements 4.1.2B, 4.2.2B and 4.2.3B and in accordance with the methodology and parameters in Part II of the Off-Site Dose Calculation Manual.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

5.1 Monitoring Program

5.1.1 Limiting Condition for Operation

A. The Radiological Environmental Monitoring Program shall be conducted as specified in Table 5.1.

APPLICABILITY: At all times

ACTION:

1. Analytical results of this program and deviations from the sampling schedule shall be reported to the Nuclear Regulatory Commission in the Annual Radiological Environmental Operating Report (Section 6.2).

2. If the level of radioactivity from calculated doses leads to a higher exposure pathway to individuals, this pathway shall be added to the Radiological Environmental Monitoring Program. Modifications to the program shall be reported in the Annual Radiological Environmental Operating Report to the Nuclear Regulatory Commission.

3. If the level of radioactivity in an environmental sampling medium exceeds the reporting level specified in Table 5.4, and the activity is attributable to plant operation, a Special Report shall be prepared and submitted to the Nuclear Regulatory Commission within 30 days (Section 6.2.3). The detection capabilities of the equipment used for the analysis of environmental samples must meet the requirements of Table 5.3 for Lower Level of Detection (LLD).

5.1.1A (continued)

4. If the level of radioactivity in a sample from either an onsite or offsite well, performed per the Site Groundwater Protection Program, exceeds the reporting level specified in Table 5.4, and the activity is attributable to plant operation, a Special Report shall be prepared and submitted to the Nuclear Regulatory Commission within 30 days (Section 6.2.3). The detection capabilities of the equipment used for the analysis of environmental samples must meet the requirements of Table 5.3 for Lower Level of Detection (LLD). Copies of the Special Report will be forwarded to State/Local authorities. **[AR 39127]**

5. If the level of radioactivity from either an onsite or offsite well, performed per the Site Groundwater Protection Program exceeds the reporting level specified in Table 5.4, and the activity is attributable to plant operations, state and local authorities shall be notified by the end of the next business day. NRC shall be notified per SO-R-1, Reportability Determinations. **[AR 39127]**

6. Radiological environmental sampling locations and the media that is utilized for analysis are presented in Table 5.2. Sampling locations are also illustrated on the map, Figure 1. Details of the quarterly emergency TLD locations are contained in surveillance test CH-ST-RV-0003, Environmental Sample Collection – Quarterly/Environmental Dosimeters (TLDs). Each TLD sample location contains one dosimeter that is exchanged quarterly for REMP sampling and as needed for Emergency Planning Zone monitoring.

7. Deviations from the monitoring program, presented in this section and detailed in Table 5.2, are permitted if specimens are unobtainable due to mitigating circumstances such as hazardous conditions, seasonal unavailability, malfunction of equipment, or if a person discontinues participation in the program, etc. If the equipment malfunctions, corrective actions will be completed as soon as practicable. If a person no longer supplies samples, a replacement will be made if possible. All deviations from the sampling schedule will be described in the Annual Radiological Environmental Operating Report, pursuant to Section 6.2.

5.1.2 Surveillance Requirements

A. The Radiological Environmental Monitoring Program (REMP) samples shall be collected and analyzed in accordance with Tables 5.1, 5.2, and 5.3.

Table 5.1 - Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Collection Site [A]	Type of Analysis [B]	Frequency
1. Direct Radiation	A. 14 TLD indicator stations, one background station[F], total of 15.	Gamma dose	Quarterly
	B. An inner-ring of 16 stations, one in each cardinal sector in the general area of the unrestricted area boundary and within 2.5 miles.	Gamma dose	Quarterly
	C. An outer-ring of 16 stations, one in each cardinal sector located outside of the inner-ring, but no more distant than approximately 5 miles.	Gamma dose	Quarterly
2. Air Monitoring	A. Indicator Stations 1. Three stations in the general area of the unrestricted area boundary 2. City of Blair 3. Desoto Township	Filter for Gross Beta [C] Charcoal for I-131 Filter for Gamma Isotopic	Weekly Weekly Quarterly composite of weekly filters
	B. One background station [F]		
3. Water	A. Missouri River at nearest downstream drinking water intake. B. Missouri River downstream near the mixing zone. C. Missouri River upstream of Plant intake (background)[F].	Gamma Isotopic, H-3 I^{131} analysis on each composite when the dose calculated for the consumption of water is > 1 mrem/year[G]	Composite sample over 2 week period when I^{131} analysis is performed, monthly otherwise for Gamma isotopic analysis. Quarterly composite for H-3 Analysis
4. Milk [D]	A. Nearest milk animal (cow or goat) within 5 miles B. Milk animal (cow or goat) between 5 miles and 18.75 miles (background)[F].	Gamma Isotopic and I-131	Biweekly grazing season (May to October), monthly at other times
5. Fish	A. Four fish samples within vicinity of Plant discharge. B. One background sample upstream of Plant discharge.	Gamma Isotopic	Once per season (May to October)

Table 5.1 - Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Collection Site [A]	Type of Analysis [B]	Frequency
6. Sediment	A. One sample from downstream area on the station side of the Missouri River. B. One sample from upstream of Plant Intake (background)[F].	Gamma Isotopic	Semiannually
7. Vegetables or Food Products [E]	A. One sample in the highest exposure pathway. B. One sample from onsite crop field C. One sample outside of 5 miles (background)[F].	Gamma Isotopic	Once per season (May to October)
8. Groundwater	A. Three samples from sources potentially affected by plant operations. B. One sample outside of 5 miles (background)[F].	H_3, Gross Beta, Gamma Isotopic, Sr-90	Quarterly
9. Vegetation in lieu of milk	A. One sample at the highest annual average D/Q offsite location. B. One sample at the second highest annual average D/Q offsite location. C. One sample outside of 5 miles (background)[F].	Gamma Isotopic	Monthly (when available)

NOTES:

A. See Table 5.3 for required detection limits.
B. The Lower Limit of Detection (LLD) for analysis is defined in the Off-Site Dose Calculation Manual in accordance with the wording of NUREG-1301.
C. When a gross beta count indicates radioactivity greater than 2.5E-13 µCi/ml or 0.25 pCi/m3, (ten times the yearly mean), a gamma spectral analysis will be performed.
D. If milk samples are temporarily not available at a sampling site due to mitigating circumstances, then vegetation (broadleaf, pasture grass, etc.) shall be collected as an alternate sample at the site. If there are no milk producers within the entire 5-mile radius of the plant, then vegetation shall be collected monthly, when available, at two offsite locations having the highest calculated annual average ground level D/Q and a background locale. (Reference Off-Site Dose Calculation Manual, Part II, Table 4 "Highest Potential Exposure Pathways for Estimating Dose")
E. Samples should be collected from garden plots of 500 ft2 or more. (Reference Reg. Guide 4.8 "Environmental Technical Specifications for Nuclear Power Plants," Dec. 1975).
F. This sample may not be located in the least prevalent wind direction. The Branch Technical Position paper, Table 1, subnote "d" says this regarding background information, or control locations. **"The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites which provide valid background data may be substituted".**
G. The dose shall be calculated for the maximum organ and age group, using methodology and parameters in the Off-Site Dose Calculation Manual.

Table 5.2 - Radiological Environmental Sampling Locations And Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
1	Onsite Station, 110-meter weather tower	0.53	293°/WNW	P			X						
2[C,E]	Onsite Station, adjacent to old plant access road	0.59	207°/SSW	K	X	X	X						
3	Offsite Station, Intersection of Hwy. 75 and farm access road	0.94	145°/SE	G			X						
4	Blair OPPD office	2.86	305°/NW	Q	X	X	X						
5[A]													
6	Fort Calhoun, NE City Hall	5.18	150°/SSE	H			X						
7	Fence around intake gate, Desoto Wildlife Refuge	2.07	102°/ESE	F			X						
8	Onsite Station, entrance to Plant Site from Hwy. 75	0.55	191°/S	J			X						
9	Onsite Station, NW of Plant	0.68	305°/NW	Q			X						
10	Onsite Station, WSW of Plant	0.61	242°/WSW	M			X						
11	Offsite Station, SE of Plant	1.07	39°/SE	G			X						

Table 5.2 - Radiological Environmental Sampling Locations And Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
12	Metropolitan Utilities Dist., Florence Treatment Plant North Omaha, NE	14.3	154°/SSE	H				X					
13	West bank Missouri River, downstream from Plant discharge	0.45	108°/ESE	F				X		X			
14[D]	Upstream from Intake Bldg, west bank of river	0.09	4°/N	A				X		X			
15	Smith Farm	1.99	134°/SE	G									X
16[A]													
17[A]													
18[A]													
19[A]													
20[D]	Mohr Dairy	9.86	186°/S	J					[B]			X	X
21[A]													
22	Fish Sampling Area, Missouri River	0.08 (R.M. 645.0)	6°/N	A							X		
23[D]	Fish Sampling Area, Missouri River	17.9 (R.M. 666.0)	358°/N	A							X		
24[A]													
25[A]													
26[A]													
27[A]													

Table 5.2 - Radiological Environmental Sampling Locations And Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
28	Alvin Pechnik Farm	0.94	163°/SSE	H								X	
29[A]													
30[A]													
31[A]													
32[D]	Valley Substation #902	19.6	221°/SW	L	X	X	X						
33[A]													
34[A]													
35	Onsite Farm Field	0.52	118°/ESE	F								X	
36	Offsite Station Intersection Hwy 75/Co. Rd. P37	0.75	227°/SW	L			X						
37	Offsite Station Desoto Township	1.57	144°/SE	G	X	X	X						
38[A]													
39[A]													
40[A]													
41[C]	Dowler Acreage	0.73	175°/S	J	X	X	X		[B,C]				
42	Sector A-1	1.94	0°/NORTH	A			X						
43	Sector B-1	1.97	16°/NNE	B			X						
44	Sector C-1	1.56	41°/NE	C			X						
45	Sector D-1	1.34	71°/ENE	D			X						
46	Sector E-1	1.54	90°/EAST	E			X						
47	Sector F-1	0.45	108°/ESE	F			X						

Table 5.2 - Radiological Environmental Sampling Locations And Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
48	Sector G-1	1.99	134°/SE	G			X						
49	Sector H-1	1.04	159°/SSE	H			X						
50	Sector J-1	0.71	179°/SOUTH	J			X						
51	Sector K-1	0.61	205°/SSW	K			X						
52	Sector L-1	0.74	229°/SW	L			X						
53	Sector M-1	0.93	248°/WSW	M			X						
54	Sector N-1	1.31	266°/WEST	N			X						
55	Sector P-1	0.60	291°/WNW	P			X						
56	Sector Q-1	0.67	307°/NW	Q			X						
57	Sector R-1	2.32	328°/NNW	R			X						
58	Sector A-2	4.54	350°/NORTH	A			X						
59	Sector B-2	2.95	26°/NNE	B			X						
60	Sector C-2	3.32	50°/NE	C			X						
61	Sector D-2	3.11	75°/ENE	D			X						
62	Sector E-2	2.51	90°/EAST	E			X						
63	Sector F-2	2.91	110°/ESE	F			X						
64	Sector G-2	3.00	140°/SE	G			X						
65	Sector H-2	2.58	154°/SSE	H			X						
66	Sector J-2	3.53	181°/SOUTH	J			X						
67	Sector K-2	2.52	205°/SSW	K			X						
68	Sector L-2	2.77	214°/SW	L			X						
69	Sector M-2	2.86	243°/WSW	M			X						

Table 5.2 - Radiological Environmental Sampling Locations And Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
70	Sector N-2	2.54	263°/WEST	N			X						
71	Sector P-2	2.99	299°/WNW	P			X						
72	Sector Q-2	3.37	311°/NW	Q			X						
73	Sector R-2	3.81	328°/NNW	R			X						
74	D. Miller Farm	0.65	203°/SSW	K									X
75[C]	Lomp Acreage	0.65	163°/SSE	H	X	X	X		B, C				X
76	Stangl Farm	3.40	169°/S	J					X				

NOTES:

A. Location is either not in use or currently discontinued and is documented in the table for reference only.

B. If milk samples are temporarily not available at a sampling site due to mitigating circumstances, then vegetation (broadleaf, pasture grass, etc.) shall be collected as an alternate sample at the site. If there are no milk producers within the entire 5-mile radius of the plant, then vegetation shall be collected monthly, when available, at two offsite locations having the highest calculated annual average ground level D/Q and a background locale. (Reference Off-Site Dose Calculation Manual, Part II, Table 4 "Highest Potential Exposure Pathways for Estimating Dose")

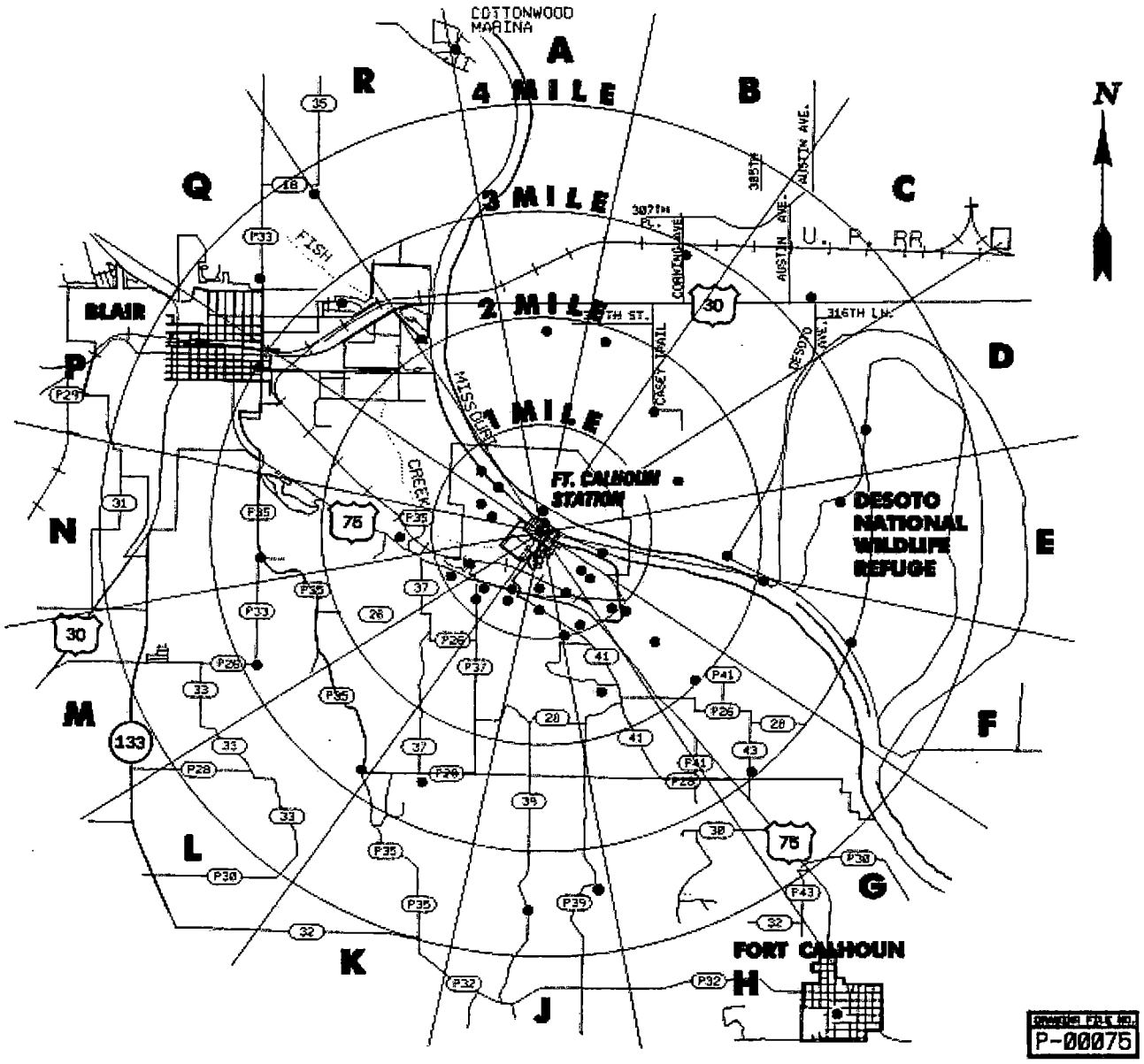
C. Locations represent highest potential exposure pathways as determined by the biennial Land Use Survey, performed in accordance with Part I, Section 7.3.2, of the Off-Site Dose Calculation Manual and are monitored as such.

D. Background location (control). All other locations are indicators.

E. Location for monitoring Sector K High Exposure Pathway Resident Receptor for inhalation.

F. When broad leaf (pasture grasses) are being collected in lieu of milk, background broad leaf samples will be collected at a background locale.

Figure 1 – Environmental Radiological Sampling Points



(*) Locations currently discontinued are not illustrated.

Table 5.3 - Detection Capabilities for Environmental Sample Analysis Lower Limit of Detection (LLD) [A, B, C]

Sample	Units	Gross Beta	H-3	Mn-54	Fe-59	Co-58, Co-60	Zn-65	Zr-95	Nb-95	I-131	Cs-134	Cs-137	Ba-140 La-140
Water	pCi/L	4	2.0E+03	1.5E+01	3.0E+01	1.5E+01	3.0E+01	1.5E+01	1.5E+01	1.0E+00[D]	1.5E+01	1.8E+01	1.5E+01
Fish	pCi/kg (wet)	---	---	1.3E+02	2.6E+02	1.3E+02	2.6E+02	---	---	---	1.3E+02	1.5E+02	---
Milk	pCi/L	---	---	---	---	---	---	---	---	1.0E+00	1.5E+01	1.8E+01	1.5E+01
Airborne Particulates or Gases	pCi/m^3	1.0E-02	---	---	---	---	---	---	---	7.0E-02	1.0E-02	1.0E-02	---
Sediment	pCi/kg (dry)	---	---	---	---	---	---	---	---	---	1.5E+02	1.8E+02	---
Grass or Broad Leaf Vegetation/ Vegetables or Food Products	pCi/kg (wet)	---	---	---	---	---	---	---	---	[E] 6.0E+01	[E] 6.0E+01	[E] 8.0E+01	---

A. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable as Plant effluents, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Part I, Section 6.2, of the Off-Site Dose Calculation Manual.
B. Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.
C. The LLD is defined in Part II of the Off-Site Dose Calculation Manual.
D. LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.
E. I-131 analysis performed on broadleaf/pasture grass samples when milk is unavailable. Gamma isotopic analysis performed on food products/vegetables.

Table 5.4 - Reporting Levels for Radioactivity Concentrations in Environmental Samples [A]

Sample	Units	H-3	Mn-54	Fe-59	Co-58	Co-60	Zn-65	Zr-95	Nb-95	I-131	Cs-134	Cs-137	Ba-140 La-140
Water	pCi/L	2.0E+04	1.0E+03	4.0E+02	1.0E+03	3.0E+02	3.0E+02	4.0E+02	4.0E+02	2.0E+00[B]	3.0E+01	5.0E+01	2.0E+02
Fish	pCi/kg (wet)	---	3.0E+04	1.0E+04	3.0E+04	1.0E+04	2.0E+04	---	---	---	1.0E+03	2.0E+03	---
Milk	pCi/L	---	---	---	---	---	---	---	---	3.0E+00	6.0E+01	7.0E+01	3.0E+02
Airborne Particulates or Gases	pCi/m^3	---	---	---	---	---	---	---	---	9.0E-01	1.0E+01	2.0E+01	---
Grass or Broad Leaf Vegetation/ Vegetables or Food Products	pCi/kg (wet)	---	---	---	---	---	---	---	---	1.0E+02	1.0E+03	2.0E+03	---

A. A Non-routine report shall be submitted when more than one of the radionuclides listed above are detected in the sampling medium and:

$$\frac{Concentration\ 1}{Reporting\ Level\ 1} + \frac{Concentration\ 2}{Reporting\ Level\ 2} + \frac{Concentration\ 3}{Reporting\ Level\ 3} + \ldots . \geq 1.0$$

When radionuclides other than those listed above are detected and are the result of Plant effluents, this report shall be submitted if the potential annual dose to a member of the general public is equal to or greater than the dose objectives of Part I, Section 4.1 and 4.2, of the Off-Site Dose Calculation Manual. This report is not required if the measured level of radioactivity was not the result of Plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

B. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

5.2 Land Use Survey

5.2.1 Limiting Condition for Operation

A. A Land Use Survey shall identify the location of the nearest milk animal, nearest meat animal, nearest vegetable garden, nearest groundwater source and the nearest residence in each of the 16 cardinal sectors within a distance of five miles. The survey shall be conducted under the following conditions:

1. Within a one-mile radius from the Plant site, enumeration by door-to-door or equivalent counting techniques.

2. Within a Five-mile radius, enumeration may be conducted door-to-door or by using referenced information from county agricultural agents or other reliable sources.

APPLICABILITY: At all times

ACTION:

a. If it is learned from this survey that milk animals, vegetable gardens and resident receptors are present at a location which yields a calculated dose greater than 20% from previously sampled location(s), the new location(s) shall be added to the monitoring program. Milk and vegetable garden sampling location(s) having the lowest calculated dose may then be dropped from the monitoring program at the end of the grazing and/or growing season during which the survey was conducted and the new location added to the monitoring program. Groundwater monitoring is based on a determination if source(s) are potentially affected by plant operations. Modifications to the air monitoring locations, vegetable garden sampling locations, and milk sampling locations will be made as soon as practicable. The Nuclear Regulatory Commission shall be notified of modifications to the program in the Annual Radiological Environmental Operating Report (Section 6.2).

5.2.1A.2 (continued)

b. If it is learned from this survey that a pathway for dose to a MEMBER OF THE GENERAL PUBLIC no longer exists, an additional pathway has been identified or site specific factors affecting the dose calculations for a pathway have changed, then this information should be documented in the Land Use Survey, the Annual Radiological Environmental Operating Report and the Annual Radioactive Effluent Release Report. This information can be used to increase the accuracy of the dose models for the Annual Radioactive Effluent Release Report as well as dose estimates performed during the reporting period (i.e., quarterly dose estimates).

5.2.2 Surveillance Requirements

A. A land use survey shall be conducted once per 24 months between the dates of June 1 and October 1. The results of the land use survey shall be submitted to the Nuclear Regulatory Commission in the Annual Radiological Environmental Operating Report (Section 6.2) for the year it was performed.

5.3 Interlaboratory Comparison Program

5.3.1 Limiting Condition for Operation

A. Analyses shall be performed on radioactive materials as part of an Interlaboratory Comparison Program that has been approved by the Nuclear Regulatory Commission.

APPLICABILITY: At all times

ACTION:

1. With analysis not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report (Section 6.2).

5.3.2 Surveillance Requirements

A. The results of these analyses shall be included in the Annual Radiological Environmental Operating Report (Section 6.2).

6.0 ADMINISTRATIVE CONTROLS

6.1 Responsibilities

6.1.1 FCS Chemistry Department is responsible for the implementation and maintenance of the Off-Site Dose Calculation Manual.

6.1.2 FCS Operations Department is responsible for the compliance with the Off-Site Dose Calculation Manual in the operation of Fort Calhoun Station.

6.2 Radioactive Effluent Reporting Requirements

The reporting requirements for radioactive effluents stated in this Section are to provide assurance that the limits set forth in Part I of the Off-Site Dose Calculation Manual are complied with. These reports will meet the requirements for documentation of radioactive effluents contained in 10 CFR Part 50.36a; Reg. Guide 1.21, Rev. 2; Reg. Guide 4.8, Table 1; and Reg. Guide 1.109, Rev. 1.

6.2.1 Annual Radioactive Effluent Release Report

A report covering the operation of the Fort Calhoun Station during the previous calendar year shall be submitted prior to May 1 of each year per the requirements of Technical Specifications 5.9.4.a. and 10 CFR Part 50.

The Radioactive Effluent Release Report shall include:

A. A summary of the quantities of radioactive liquid and airborne effluents and solid waste released from the plant as outlined in Regulatory Guide 1.21, Revision 2.

B. A summary of the annual meteorological data that provides joint frequency distributions of wind direction and wind speed by atmospheric stability class will be included in the annual report. In addition, hourly meteorological data is recorded and retained on site as outlined in Regulatory Guide 1.21, Revision 2.

C. An assessment of radiation doses from the radioactive liquid and airborne effluents released from the unit during each calendar quarter as outlined in Regulatory Guide 1.21, Revision 2. The assessment of radiation doses shall be performed in accordance with calculational methodology of the Regulatory Guide 1.109, Revision 1.

D. Changes to the Process Control Program (PCP) or to the Offsite Dose Calculation Manual (ODCM) made during the reporting period. 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 the change was implemented.

6.2.1 (continued)

E. A list and description of abnormal releases or abnormal discharges from the site to unrestricted areas of radioactive materials in gaseous and liquid effluents made during the reporting period.

F. An explanation of why instrumentation designated in Part I, Sections 3.1.1 and 3.2, of the Off-Site Dose Calculation Manual, was not restored to OPERABLE status within 30 days.

G. A description of any major design changes or modifications made to the Liquid and/or Gaseous Radwaste Treatment Systems or Ventilation Exhaust Systems during the reporting period.

H. An explanation of why the liquid and/or gaseous radwaste treatment systems were not OPERABLE, causing the limits of specifications 4.1.3A and 4.2.4A to be exceeded.

I. The results of sampling from offsite and onsite groundwater wells per the Site Groundwater Protection Plan. **[AR 39127]**

J. Non-routine planned discharges (e.g., discharges from remediation efforts like pumping contaminated groundwater from a leak).

6.2.2 Annual Radiological Environmental Operating Report

The Annual Radiological Environmental Operating Report for the previous one year of operation shall be submitted prior to May 1 of each year. This report contains the data gathered from the Radiological Environmental Monitoring Program. The content of the report shall include:

A. Summarized and tabulated results of the radiological environmental sampling/analysis activities following the format of Regulatory Guide 4.8, Table 1. In the event that some results are not available, 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.

B. Interpretations and statistical evaluation of the results, including an assessment of the observed impacts of the plant operation and environment.

C. The results of participation in a NRC approved Interlaboratory Comparison Program.

D. The results of land use survey required by Section 5.2.

6.2.2 (continued)

E. The results of specific activity analysis in which the primary coolant exceeded the limits of Technical Specification 2.1.3. The following information shall be included:

1. Reactor power history starting 48 hours prior to the first sample in which the limit was exceeded.

2. Results of the last isotopic analysis for radioiodine performed prior to exceeding the limit, results of analysis while limit was exceeded and results of one analysis after the radioiodine activity was reduced to less than the limit. Each result should include date and time of sampling and the radioiodine concentrations.

3. Purification system flow history starting 48 hours prior to the first sample in which the limit was exceeded.

4. Graph of the I-131 concentration and one other radioiodine isotope concentration in micro-curies per gram as a function of time for the duration of the specific activity above the steadystate level, AND

5. The time duration when the specific activity of the primary coolant exceeded the radioiodine limit.

F. A map of the current environmental monitoring sample locations.

6.2.3 Special Report

If the limits or requirements of Sections 4.1.2A, 4.1.3A, 4.2.2A, 4.2.3A, 4.2.4A, 4.3.1A, and/or 5.1.1A.3 and/or 5.1.1A.4 are exceeded, a Special Report shall be issued to the Commission, pursuant to Technical Specification 5.16. This report shall include: **[AR 39127]**

A. The results of an investigation to identify the causes for exceeding the specification.

B. Define and initiate a program of action to reduce levels to within the specification limits.

C. The report shall also include an evaluation of any release conditions, environmental factors, or other aspects necessary to explain the condition.

6.2.4 EPA 40 CFR Part 190 Reporting Requirements

With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of dose from specifications 4.1.2A, 4.2.2A, or 4.2.3A, calculations shall be made including direct radiation calculations, to prepare and submit a special report to the Commission within 30 days and limit the subsequent releases such that the dose to any real individual from uranium fuel cycle sources is limited to ≤ 25 mrem to the total body or any organ (except thyroid, which is limited to ≤ 75 mrem) over the calendar year. This special report shall include an analysis which demonstrates that radiation exposures to any member of the public from uranium fuel cycle sources (including all effluent pathways and direct radiation) are less than the 40 CFR Part 190 standard. Otherwise, obtain a variance from the Commission to permit releases which exceed the 40 CFR Part 190 standard. The submittal of the report is to be considered a timely request and a variance is granted pending the final action on the variance request from the Commission.

6.3 Change Mechanism

The Off-Site Dose Calculation Manual is the controlling document for all radioactive effluent releases. It is defined as a procedure under the guidance of Technical Specification 5.8. It will be revised and reviewed by the Plant Review Committee and approved by the Plant Manager in accordance with Technical Specification 5.17. All changes to the Off-Site Dose Calculation Manual will be forwarded to the Nuclear Regulatory Commission during the next reporting period for the Annual Radioactive Effluent Release Report in accordance with the requirements of Technical Specification 5.17.

6.4 Meteorological Data

The Annual Average χ/Q is utilized to determine the concentrations of radionuclides at the unrestricted area boundary. It is also the factor used in conjunction with the parameters and methodologies in Part II, of the Off-Site Dose Calculation Manual to determine unrestricted area dose on a quarterly bases or as needed. It is based on an average of the highest calculated sector χ/Q values, using all 16 sectors for each of the three previous year Annual Radioactive Effluent Release Reports, and the XOQDOQ plume trajectory model. An additional 10 percent will be added to the average for unrestricted area dose estimates performed quarterly or as needed for conservatism. When calculating χ/Q data for the Annual Radiological Effluent Release Report, if the highest calculated χ/Q for the reporting period is observed to be greater than ± 10% of the Annual Average χ/Q previously calculated, contact the Supervisor-System Chemistry for further instructions. This model conforms with the Nuclear Regulatory Commissions Regulatory Guide 1.111.

Current year meteorological data will be utilized in the preparation of the Annual Radioactive Effluent Release Report. This data is used to calculate the joint frequency table, the dispersion coefficients and deposition factors in all 16 sectors. These are used in the calculation of doses to individuals in unrestricted areas as a result of the operation of Fort Calhoun Station. The models used, GASPAR 2 and LADTAP 2, meet the intent of Nuclear Regulatory Commissions Reg. Guide 1.109 and 1.21 for the reporting of doses due to routine radioactive effluent releases.

6.5 References

6.5.1 Regulatory Guide 1.109, Rev. 1 - Calculation of Annual Dose to man from Routine Releases of Reactor Effluents for the purpose of evaluation compliance with 10 CFR Part 50, Appendix I

6.5.2 Regulatory Guide 1.111, Rev. 1 - Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors.

6.5.3 Regulatory Guide 1.113, Rev. 1 - Estimating Aquatic Dispersion of Effluents from Accidental and Routine Releases for the purpose of Implementing Appendix I.

6.5.4 Regulatory Guide 4.8, Environmental Technical Specification for Nuclear Power Plants.

6.5.5 NRC Branch Technical Position, March 1978

6.5.6 NUREG-0133 - Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants.

6.5.7 NUREG-1301 - Offsite Dose Calculation Manual Guidance.

6.5.8 Regulatory Guide 1.21, Rev. 2 - Measuring, Evaluating, and Reporting Radioactivity in solid wastes and Releases of Radioactivity Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants.

6.5.9 Code of Federal Regulations, Title 10, Part 20

6.5.10 Code of Federal Regulations, Title 10, Part 50

6.5.11 Code of Federal Regulations, Title 40, Part 190

6.5.12 Fort Calhoun Revised Environmental Report (Unit No. 1)-1972

6.5.13 Fort Calhoun Technical Specifications (Unit No. 1)

6.5.14 Updated Safety Analysis Report

6.5.15 AR 12357, Implement Recommendations of Memo FC-0133-92, Part I, Table 3.2.1 Action 4, of the Off-Site Calculation Manual

6.5.16 AR 39127, NEI Industry Initiative on Groundwater Protection

6.5.17 Regulatory Guide 4.1, Rev. 2 – Radiological Environmental Monitoring for Nuclear Power Plants

6.5.18 SO-G-28 – Station Fire Plan

7.0 BASIS

7.1 Instrumentation

7.1.1 Radioactive Liquid Effluent Instrumentation

The Radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive material in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip setpoints for these instruments shall be calculated in accordance with Part II of the Offsite Dose Calculation Manual 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.

7.1.2 Radioactive Gaseous Effluent Instrumentation

The Radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive material in gaseous effluents during actual or potential releases of gaseous effluents. The Alarm/Trip setpoints for these instruments shall be calculated in accordance with Part II of the Offsite Dose Calculation Manual 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.

7.2 Radioactive Effluents

7.2.1 Radioactive Liquid Effluents

A. Concentration

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site to unrestricted areas will be less than 10 times the concentration levels specified in 10 CFR Part 20, Appendix B, Table II, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water outside the site will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, and (2) the limits of 10 CFR Part 20.1001-20.2401 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-133 is the controlling isotope and its effluent concentration in air (submersion) was converted to an equivalent concentration in water.

7.2.1 (continued)

B. Dose

This specification is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation 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, with fresh water sites with drinking water supplies which 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 Part II of the Off-Site Dose Calculation Manual, implement the requirements in Section III.A that conformance with the guides of Appendix I is to be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in Part II of the Off-Site Dose Calculation Manual, for calculating the doses due to the actual release rates of radioactive material 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.

C. Liquid Waste Treatment System

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 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 specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix I to 10 CFR Part 50 and design objective and in Section II.D of Appendix A to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified to ensure the design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50 for liquid effluents are not exceeded.

7.2.1 (continued)

D. Liquid Holdup Tanks

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of the tanks' contents, the resulting concentrations would be less than the limits of 10 CFR Part 20, Appendix B, Table II, Column 2, at the nearest potable water supply and the nearest surface water supply in an unrestricted area.

7.2.2 Radioactive Gaseous Effluents

A. Concentration

This specification, in conjunction with Steps 4.2.2A and 4.2.3A, is provided to ensure that the dose at or beyond the Site Boundary from gaseous effluents will be within the annual dose limits of 10 CFR Part 20 for MEMBERS OF THE PUBLIC. The release rate of radioactive material in airborne effluents shall be controlled such that the instantaneous concentrations for these radionuclides do not exceed the values specified in 10 CFR Part 20 for airborne effluents at the unrestricted area boundary. To support plant operations, Supervisor-System Chemistry may increase this limit up to the limits specified in Technical Specifications 5.16.1.g. Technical Specification 5.16.1.g. establishes the administrative control limit on the concentration resulting from radioactive material, other than noble gases, released in gaseous effluents to unrestricted areas conforming to ten times 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 1. For noble gases, the concentration shall be limited to five times 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 1. Because these concentrations are applied on an instantaneous basis and because of the overriding 10 CFR Part 50 Appendix I cumulative dose limitations, these limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC either within or outside the Site Boundary, to annual average concentrations that would result in exceeding the annual total effective dose equivalent limit specified in 10 CFR Part 20.1301(a).

7.2.2 (continued)

B. Dose - Noble Gases

This specification is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition For Operation implements 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 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 conform with the guides of Appendix I to be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in Part II of the Off-Site Dose Calculation Manual, for calculating the doses due to 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 Off-Site Dose Calculation Manual, equations provided for determining the air doses at the site boundary are consistent with Regulatory Guides 1.109 and 1.111.

7.2.2 (continued)

C. Dose - I-131, Radioactive Material in Particulate Form with Half-Lives Greater than Eight Days (Other than Noble Gases) and Tritium

This specification is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition For Operation implements 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 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 conform with the guides of Appendix I to be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in Part II of the Off-Site Calculation Manual, for calculating the doses due to 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 release rate specification for I-131, radioactive material in particulate form with half-lives greater than eight days (other than noble gases) and tritium are dependent on the existing radionuclide pathways to man in the areas at or 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.

7.2.2 (continued)

D. Gaseous Waste Treatment

The OPERABILITY of the gaseous radwaste treatment system and the ventilation exhaust treatment systems ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in gaseous effluents will be kept as low as is reasonably achievable. This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix I to 10 CFR Part 50 and design objective and in Section II.D of Appendix A to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified to ensure the design objectives set forth in Section II.B and II.C of Appendix I, 10 CFR Part 50 for gaseous effluents are not exceeded.

7.2.2 (continued)

E. Total Dose - Uranium Fuel Cycle

This specification is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20.1301(d). This 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. 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 plant remains within twice the dose design objectives of Appendix I, 10 CFR Part 50, and if direct radiation doses (including outside storage tanks, etc.) are kept small. The Special Report shall 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 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, the Special Report, 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) and 20.2203(b) is considered to be a timely request and fulfills the requirements 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle. 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.

7.3 Radiological Environmental Monitoring

7.3.1 Monitoring Program

The radiological environmental monitoring program required by this specification provides measurements of radiation and radioactive materials in those exposure pathways and for radionuclides which lead to the highest potential radiation exposures of individuals resulting from the station operation. This monitoring program 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 modeling of the environmental exposure pathways. The initially specified monitoring program was effective for at least the first three years of commercial operation. Following this period, program changes are initiated based on operational experience.

7.3.2 Land Use Survey

This specification is provided to ensure that changes in the use of unrestricted areas are identified and that modifications to the monitoring program are made if required by the results of this survey. The frequency of the Land Use Survey has been reduced to a biennial requirement in site procedures because persons knowledgeable in land use census monitor usage characteristics perform routine REMP sampling. This approach allows knowledge gained during sample collection to be integrated into the program, maintaining its effectiveness. The best survey information from door to door, aerial or consulting with local agricultural authorities, or equivalent, shall be used. This survey satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the survey to gardens of greater than 500 square feet 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 used, 1) that 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.

For milk, the survey is restricted to only milk animals (cow or goat) producing milk for human consumption. Air monitoring stations are strategically located to monitor the resident receptors who could potentially receive the highest doses from airborne radioactive material. For groundwater, samples shall be taken when sources are determined to potentially be affected by plant operations, and when sources are tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination. Guidance provided in the Branch Technical Position and Technical Specification 5.16.2 is used to meet the intent of NUREG-1301.

7.3.3 Interlaboratory Comparison Program

The requirement for participation in an Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of a 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.

7.4 Abnormal Release or Abnormal Discharge Reporting

7.4.1 Specific information should be reported concerning abnormal (airborne and/or liquid) releases on site and abnormal discharges to the unrestricted area. The report should describe each event in a way that would enable the NRC to adequately understand how the material was released and if there was a discharge to the unrestricted area. The report should describe the potential impact on the ingestion exposure pathway involving surface water and ground water, as applicable. The report should also describe the impact (if any) on other affected exposure pathways (e.g., inhalation from pond evaporation).

7.4.2 The following are the thresholds for reporting abnormal releases and abnormal discharges in the supplemental information section:

A. Abnormal release or Abnormal Discharges that are voluntarily reported to local authorities under NEI 07-07, Industry Ground Water Protection Initiative. **[AR 39127]**

B. Abnormal release or Abnormal discharges estimated to exceed 100 gallons of radioactive liquid where the presence of licensed radioactive material is positively identified (either in the on-site environs or in the source of the leak or spill) as greater than the minimum detectable activity for the laboratory instrumentation.

C. Abnormal releases to on-site areas that result in detectable residual radioactivity after remediation.

D. Abnormal releases that result in a high effluent radiation alarm without an anticipated trip occurring.

E. Abnormal discharges to an unrestricted area.

7.4.3 Information on Abnormal releases or Abnormal discharges should include the following, as applicable:

- Date and duration
- Location
- Volume
- Estimated activity of each radionuclide
- Effluent monitoring results (if any)
- On-site monitoring results (is any)
- Depth to the local water table
- Classification(s) of subsurface aquifer(s) (e.g., drinking water, unfit for drinking water, not used for drinking water)
- Size and extent of any ground water plume
- Expected movement/mobility of any ground water plume
- Land use characteristics (e.g., water used for irrigation)
- Remedial actions considered or taken and results obtained
- Calculated member of the public dose attributable to the release
- Calculated member of the public dose attributable to the discharge
- Actions taken to prevent recurrence, as applicable
- Whether the NRC was notified, the date(s), and the contact organization

PART II

CALCULATIONS

1.0 EFFLUENT MONITOR SETPOINTS

1.1 Liquid Effluents

1.1.1 There are two liquid discharge pathways to the Missouri River. These pathways originate with the radioactive liquid waste processing system (monitor or hotel tanks) and the steam generator blowdown system. Both of these pathways empty into the circulating water system which discharges to the Missouri River (see Figure 1). Figure 2 depicts the liquid discharge pathways and associated radiation monitors. Figure 3 depicts the methods of liquid effluent treatment.

1.1.2 The flowrate for dilution water varies with the number of circulating water pumps in service, the number of raw water pumps in service, and with the operation of the warm water recirculation. Some warm water from the condenser outlet is diverted from the circulating water discharge to upstream of the intake structure to help prevent ice from forming on the circulating water pump intakes during winter months. The varying dilution flowrate and utilization of warm water recirculation is accounted for in the dilution calculations for monitor tank and stream generation releases.

1.1.3 Technical Specification 5.16.1.b establishes the administrative control limit on concentration of radioactive material, other than dissolved or entrained noble gases, released in liquid effluents to unrestricted areas conforming to ten times 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to 2.0 E-04 µCi/ml total activity.

1.1.4 The liquid effluent monitoring instrumentation ALERT setpoints shall be established low enough to ensure that the concentration of radioactive material released in liquid effluents at site discharge will be less than the concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2.

1.1.5 The liquid effluent monitoring instrumentation HIGH ALARM setpoints shall be established low enough to ensure that the concentration of radioactive material released in liquid effluents at site discharge will be less than 10 times the concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2.

1.1.6 Cs-137 is used to calibrate the liquid effluent monitors.

i	**NOTE** If the annual average χ/Q value exceeds 1.4E-04 sec/m^3, consideration should be given to basing liquid radiation monitor setpoints on an I-131 instantaneous limit of 2.0E-09 µCi/ml at the unrestricted area boundary with 10% vapor/liquid separation. Contact the Supervisor-System Chemistry for further instructions.	i

1.1.7 Liquid Effluent Radiation Monitors

A. Steam Generator Blowdown Monitors (RM-054A and B)

1. These process radiation detectors monitor the flow through the steam generator blowdown lines and automatically close the blowdown isolation valves if the monitor high alarm setpoint is reached. The monitor controls liquid effluent releases so that 10 times the 10 CFR Part 20 limit at the unrestricted area boundary of 1.0E-06 µCi/cc, is not exceeded at the site discharge.

2. The following calculations for maximum concentration and alarm setpoints are valid for simultaneous radioactive liquid releases of steam generator blowdown and monitor tank discharge.

3. The maximum allowable concentration in the blowdown line is calculated as follows:

$$C_{MAX} = \frac{(1.0E-05\,\mu Ci/ml)(F)}{f}$$

Where:

1.0E-05 µCi/ml = Ten times 10 CFR Part 20 Limit for unidentified radionuclides at site discharge (10 CFR Part 20, Appendix B, Note 2).

F = Total dilution flow in the discharge tunnel (gpm). (Normal flow is based on 1 circulating water pump at 120,000 gpm. Other flowrates may be used, as required.)

f = Blowdown flow rate (gpm). (Normal blowdown flow rate is based on 2 transfer pumps with a design flow of 135 gpm each, 270 gpm total. Other flow rates may be used, as required.)

C_{MAX} = Maximum allowable blowdown concentration (µCi/ml).

1.1.7A (continued)

i	**NOTE** Setpoints may be recalculated based on adjusted dilution flow and adjusted blowdown flow.	i

The **High Alarm Setpoint** (CPM):

$$Setpoint = 0.75\left[\left((K_4)(S_f)(C_{MAX})\right) + B\right]$$

Where:

0.75 = An administrative correction factor which includes the following:

15% tolerance to ensure radmonitor response in accordance with License Event Report 77-17, Docket Number 050-0285 and Telecon FC-472-77.

10% tolerance to account for the difference in detector sensitivity for the range of isotopes detected.

S_f = Detector sensitivity factor (CPM/µCi/ml). (Sensitivity based on Cs-137).

K_4 = Allocation factor for Individual Steam Generator Release (See Table 1)

B = Background (CPM)

C_{MAX} = Maximum allowable blowdown line activity (µCi/ml).

The **Alert Setpoint** will be chosen less than or equal to one tenth (1/10) the value of the high alarm setpoint value so that significant increases in activity will be identified prior to exceeding an Unrestricted Area fractional sum of 1.0. It will also provide additional time for corrective actions prior to exceeding the Alarm Setpoint.

1.1.7 (continued)

B. Overboard Discharge Header Monitor (RM-055)

1. This process radiation monitor provides control of the waste monitor tank effluent by monitoring the overboard header prior to its discharge into the circulating water discharge tunnel. The concentration of activity at discharge is controlled below ten times the 10 CFR Part 20 limit of 1.0E-06 µCi/ml at site discharge for unidentified isotopes by the high alarm setpoint which closes the overboard flow control valve.

2. The following calculations for maximum concentration and alarm setpoints are valid for simultaneous radioactive liquid releases of monitor tank discharge and steam generator blowdown.

3. The maximum allowable concentration in the overboard discharge header is:

$$C_{MAX} = \frac{(1.0E-05\,\mu Ci/ml)\,(F)}{f}$$

Where:

1.0E-05 µCi/ml = Ten times 10 CFR Part 20 Limit for unidentified radionuclides at site discharge (10 CFR Part 20, Appendix B, Note 2).

F = Total dilution flow in the discharge tunnel (gpm). (Normal flow is based on 1 circulating water pump at 120,000 gpm. Other flowrates such as raw water pump(s) may be used, as required.)

f = Maximum monitor tank discharge flow rate (gpm). (Normal monitor tank maximum flow is 50 gpm. Other flow rates such as raw water pump(s) may be used, as required.)

C_{MAX} = Maximum allowable activity in discharge header (µCi/ml).

1.1.7B (continued)

The **High Alarm Setpoint** (CPM):

$$Setpoint = 0.75\left[\left((K_5)(S_f)(C_{MAX})\right) + B\right]$$

Where:

0.75 = An administrative correction factor which includes the following:

15% tolerance to ensure radmonitor VIAS response in accordance with License Event Report 77-17, Docket Number 050-0285 and Telecon FC-472-77.

10% tolerance to account for the difference in detector sensitivity for the range of isotopes detected.

S_f = Detector sensitivity factor (CPM/µCi/ml). (Sensitivity based on Cs-137).

K_5 = Allocation factor for Waste Liquid Releases (See Table 1)

C_{MAX} = Maximum allowable concentration in discharge header (µCi/ml).

B = Background (CPM)

The **Alert Setpoint** will be chosen less than or equal to one tenth (1/10) the value of the high alarm setpoint value so that significant increases in activity will be identified prior to exceeding an Unrestricted Area fractional sum of 1.0. It will also provide additional time for corrective actions prior to exceeding the Alarm Setpoint.

1.2 Airborne Effluents

1.2.1 There are three air effluent discharge pathways at the Fort Calhoun Station: Condenser Offgas, Laboratory and Radioactive Waste Processing Building Exhaust Stack, and the Auxiliary Building Exhaust Stack. An airborne radioactive waste flow diagram with the applicable, associated radiation monitoring instrumentation and controls is presented as Figure 4. The airborne waste disposal system is presented in Figure 5.

- Auxiliary Building - The Auxiliary Building Exhaust Stack receives discharges from the waste gas decay tanks, containment purge, containment vent systems and the auxiliary building ventilation system. Radiation Monitor RM-062 provides noble gas monitoring and iodine and particulate sampling for the Auxiliary Building Exhaust Stack. Backup noble gas monitoring and iodine and particulate sampling is provided by RM-052. Ventilation Isolation Actuation Signal (VIAS) is actuated by exceeding a monitor's alarm setpoint. Actuation of VIAS will isolate releases from containment and waste gas decay tanks. The Auxiliary Building Exhaust fans will remain in operation.

- Laboratory and Radioactive Waste Processing Building (LRWPB) - Noble gas monitoring and particulate and iodine sampling is provided by RM-043. This radiation monitor/sampler does not serve a control function.

- Condenser Off-Gas Monitors - Noble gas activity is monitored by RM-057. The condenser off-gas is discharged directly to the environment. Exceeding the high alarm setpoint on RM-057 will activate isolation of main steam to the Auxiliary Steam System.

  Technical Specification 5.16.1.g. establishes the administrative control limit on the concentration resulting from radioactive material, other than noble gases, released in gaseous effluents to unrestricted areas conforming to ten times 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 1. For noble gases, the concentration shall be limited to five times 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 1.

  The airborne effluent monitoring instrumentation ALERT setpoints shall be established low enough to ensure that the concentration of radioactive material released in air effluents at site discharge will be less than the concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 1.

  The airborne effluent monitoring instrumentation HIGH ALARM setpoints shall be established low enough to ensure that the concentration of radioactive material released in air effluents at site discharge will be less than 5 times the concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 1.

1.2.2 Airborne Effluent Radiation Monitors

A. Auxiliary Building Exhaust Stack Noble Gas Activity Monitor (RM-062/RM-052)

1. Either of these monitors may be used to measure the noble gas activity in the exhaust stack. The noble gas is monitored after passing through a particulate filter, and charcoal cartridge. The monitor controls airborne releases so that five times the 10 CFR Part 20 limit at the unrestricted area boundary of 5.0E-07 µCi/cc, based upon Xe-133, is not exceeded. The Ventilation Isolation Actuation Signal is initiated when the high alarm setpoint is reached.

2. The following calculations for maximum release rate and alarm setpoint are valid for simultaneous airborne releases from Auxiliary Building Exhaust Stack, Condenser Off-gas and the LRWPB Exhaust Stack.

3. The maximum allowable release rate for stack airborne activity is calculated as follows:

$$R_{MAX}\,\mu Ci/sec = \left(\frac{2.5E-06\,\mu Ci/cc}{\chi/Q\ sec/m^3}\right) 1.0E+06\,cc/m^3$$

Where:

2.5E-06 µCi/cc = 5 times the 10 CFR Part 20 Limit at the unrestricted area boundary (based upon Xe-133).

χ/Q sec/m^3 = Annual average dispersion factor at the unrestricted area boundary from Part II Table 4, of the Off-Site Dose Calculation Manual.

1.0E+06 cc/m^3 = Constant of unit conversion.

1.2.2A (continued)

The **High Alarm Setpoint** (CPM):

$$Setpoint = 0.75\left[K_1\left(\frac{(R_{MAX})(S_f)(60)}{(F_V)(28317)}\right)+B\right]$$

Where:

0.75 = An administrative correction factor which includes the following:

15% tolerance to ensure radmonitor VIAS response in accordance with License Event Report 77-17, Docket Number 050-0285 and Telecon FC-472-77.

10% tolerance to allow for the contribution of noble gases other than Xe-133 towards the total ECL fraction sum.

S_f = Detector sensitivity factor (CPM/µCi/cc). (Sensitivity based on Xe-133)

K_1 = Allocation factor for Auxiliary Building Exhaust Stack (See Table 1)

60 = Conversion (seconds to minutes).

28317 = Conversion factor (ft^3 to cc).

F_v = Auxiliary Building Exhaust stack flow rate (SCFM). (Default maximum flow rate is 122,500 cfm for 3 Auxiliary Building exhaust fans and 2 containment purge fans in operation. Other flow rates may be used, as required.)

R_{MAX} = Maximum Allowable Release Rate in µCi/sec

B = Background (CPM)

The **Alert Setpoint** will be chosen less than or equal to one fifth (1/5) the value of the high alarm setpoint value so that significant increases in activity will be identified, prior to exceeding an Unrestricted Area fractional sum of 1.0. It will also provide additional time for corrective actions prior to exceeding the Alarm Setpoint and VIAS actuation.

1.2.2 (continued)

B. Condenser Off Gas Monitor (RM-057)

1. This monitor is located in the turbine building and monitors the condenser off-gas. The purpose of this monitor is to monitor the condenser off-gas discharges so that five times the 10 CFR Part 20 limit at the unrestricted area boundary of 5.0E-07 µCi/cc, based upon Xe-133, is not exceeded.

2. The following calculations for maximum release rate and alarm setpoint are valid for simultaneous airborne releases from condenser off-gas, Auxiliary Building Exhaust Stack, and the LRWPB Exhaust Stack.

3. The maximum allowable release rate for condenser air ejector monitor is as follows:

$$R_{MAX}\,\mu Ci/sec = \left(\frac{2.5E-06\,\mu Ci/cc}{\chi/Q\,sec/m^3}\right) 1.0E+06\,cc/m^3$$

Where:

2.5E-06 µCi/cc = 5 times the 10 CFR Part 20 Limit at the unrestricted area boundary (based upon Xe-133).

χ/Q sec/m^3 = Annual average dispersion factor at the unrestricted area boundary from Part II, Table 4, of the Off-Site Dose Calculation Manual.

1.0E+06 cc/m^3 = Constant of unit conversion.

1.2.2B (continued)

The **High Alarm Setpoint** (CPM):

$$Setpoint = 0.75\left[K_2\left(\frac{(R_{MAX})(S_f)(60)}{(F_V)(28317)}\right)+B\right]$$

Where:

0.75 = An administrative correction factor which includes the following:

15% tolerance to ensure radmonitor VIAS response in accordance with License Event Report 77-17, Docket Number 050-0285 and Telecon FC-472-77.

10% tolerance to allow for the contribution of noble gases other than Xe-133 towards the total ECL fraction sum.

S_f = Detector sensitivity factor (CPM/µCi/cc). (Sensitivity based on Xe-133)

K_2 = Allocation factor for Condenser Off Gas (See Table 1)

60 = Conversion (seconds to minutes).

28317 = Conversion factor (ft; to cc).

F_v = Vent stack flow rate (SCFM). Default maximum flow rate is 4,755 scfm (3 vacuum pumps in hogging mode. Other flow rates may be used, as required.)

R_{MAX} = Maximum Allowable Release Rate in µCi/sec.

B = Background (CPM)

The **Alert Setpoint** will be chosen less than or equal to one fifth (1/5) the value of the high alarm setpoint value so that significant increases in activity will be identified, prior to exceeding an Unrestricted Area fractional sum of 1.0. It will also provide additional time for corrective actions prior to exceeding the Alarm Setpoint and tripping of the auxiliary steam supply valve, RCV-978.

1.2.2 (continued)

C. Laboratory and Radioactive Waste Processing Building Exhaust Stack Noble Gas Activity Monitor and Iodine and Particulate Sampler (RM-043)

1. RM-043 is located in the Radwaste Building and samples the LRWPB Exhaust Stack. The monitor alarm setpoint is based on five times the 10 CFR Part 20 limit for Xe-133 at the unrestricted area boundary.

2. The following calculations for maximum release rate and alarm setpoint are valid for simultaneous airborne releases from condenser off-gas, Auxiliary Building Exhaust Stack, and the LRWPB Exhaust Stack.

$$R_{MAX}\,\mu Ci/\text{sec} = \left(\frac{2.5E-06\,\mu Ci/cc}{\chi/Q\ sec/m^3}\right) 1.0E+06\,cc/m^3$$

The maximum allowable release rate for RM-043 is as follows:

Where:

2.5E-06 µCi/cc = 5 times the 10 CFR Part 20 Limit at the unrestricted area boundary (based upon Xe-133).

χ/Q = Annual average dispersion factor at the unrestricted area boundary from Part II of the Off-Site Dose Calculation Manual, Table 4.

1.0E+06 cc/m^3 = Constant of unit conversion

1.2.2C (continued)

i	**NOTE** This monitor alarms in the Control Room. There are no automatic control functions associated with the actuation of the alarm.	i

The **High Alarm Setpoint** (CPM):

$$Setpoint = 0.75\left[K_3\left(\frac{(R_{MAX})(S_f)(60)}{(F_V)(28317)}\right)+B\right]$$

Where:

0.75 = An administrative correction factor which includes the following:

15% tolerance to ensure radmonitor VIAS response in accordance with License Event Report 77-17, Docket Number 050-0285 and Telecon FC-472-77.

10% tolerance to allow for the contribution of noble gases other than Xe-133 towards the total ECL fraction sum.

S_f = Detector sensitivity factor (CPM/µCi/cc). (Sensitivity based on Xe-133)

K_3 = Allocation factor for LRWPB Exhaust Stack (See Table 1)

60 = Conversion (seconds to minutes).

28317 = Conversion factor (ft^3 to cc).

F_v = LRWPB Exhaust stack flow rate (SCFM). (Default flow rate is 28,700 cfm. Other flow rates may be used if required.)

R_{MAX} = Maximum Allowable Release Rate in µCi/sec.

B = Background (CPM)

The **Alert Setpoint** will be chosen less than or equal to one fifth (1/5) the value of the high alarm setpoint value so that significant increases in activity will be identified, prior to exceeding an Unrestricted Area fractional sum of 1.0. It will also provide additional time for corrective actions prior to exceeding the Alarm Setpoint.

Table 1 - Allocation Factors for Simultaneous Releases

	NOTE The Fort Calhoun Station is capable of performing simultaneous airborne releases. The factors below may be adjusted to meet release requirements, provided that the sum of the Unrestricted Area Fraction Sum for all airborne releases remains less than or equal to 1.0.			
A.	Allocation Factors for Simultaneous Airborne Releases			
1.	Auxiliary Building Exhaust Stack			Total: 0.80
K1	Noble Gases (RM-062 or RM-052)			0.70
	Iodine/Particulate/Tritium			0.10
	Contributing Pathways: a) Auxiliary Building	0.10		
	b) Containment Building	0.65		
	c) Waste Gas Decay Tanks	0.05		
2.	Condenser/Off Gas			Total: 0.10
K_2	Noble Gases (RM-057)			0.05
	Tritium			0.05
	Contributing Pathways:			
	a) Condenser Off Gas	0.10		
3.	Laboratory and Radioactive Waste Building Exhaust Stack			Total: 0.10
K_3	Noble Gases (RM-043)			0.05
	Iodine/Particulate			0.05
	Contributing Pathways:			
	a) Laboratory and Radioactive Waste Building Exhaust Stack	0.10		
Airborne Release Total				**1.00**
	NOTE The Fort Calhoun Station is capable of performing simultaneous liquid releases. The factors below may be adjusted to meet release requirements provided that the sum of the Unrestricted Area Fraction Sum for all liquid releases remains less than or equal to 1.0.			
B.	Allocation Factors for Simultaneous Liquid Releases			
1.	K_4 Steam Generator Releases (RM-054A/054B)			Total: 0.30
	Contributing Pathways: a) Alpha Steam Generator (RM-054A)	0.15		
	b) Bravo Steam Generator (RM-054B)	0.15		
2.	K_5 Waste Liquid Releases (RM-055)			0.70
Liquid Release Total				**1.00**

Figure 1 - Exclusion and Site Boundary Map

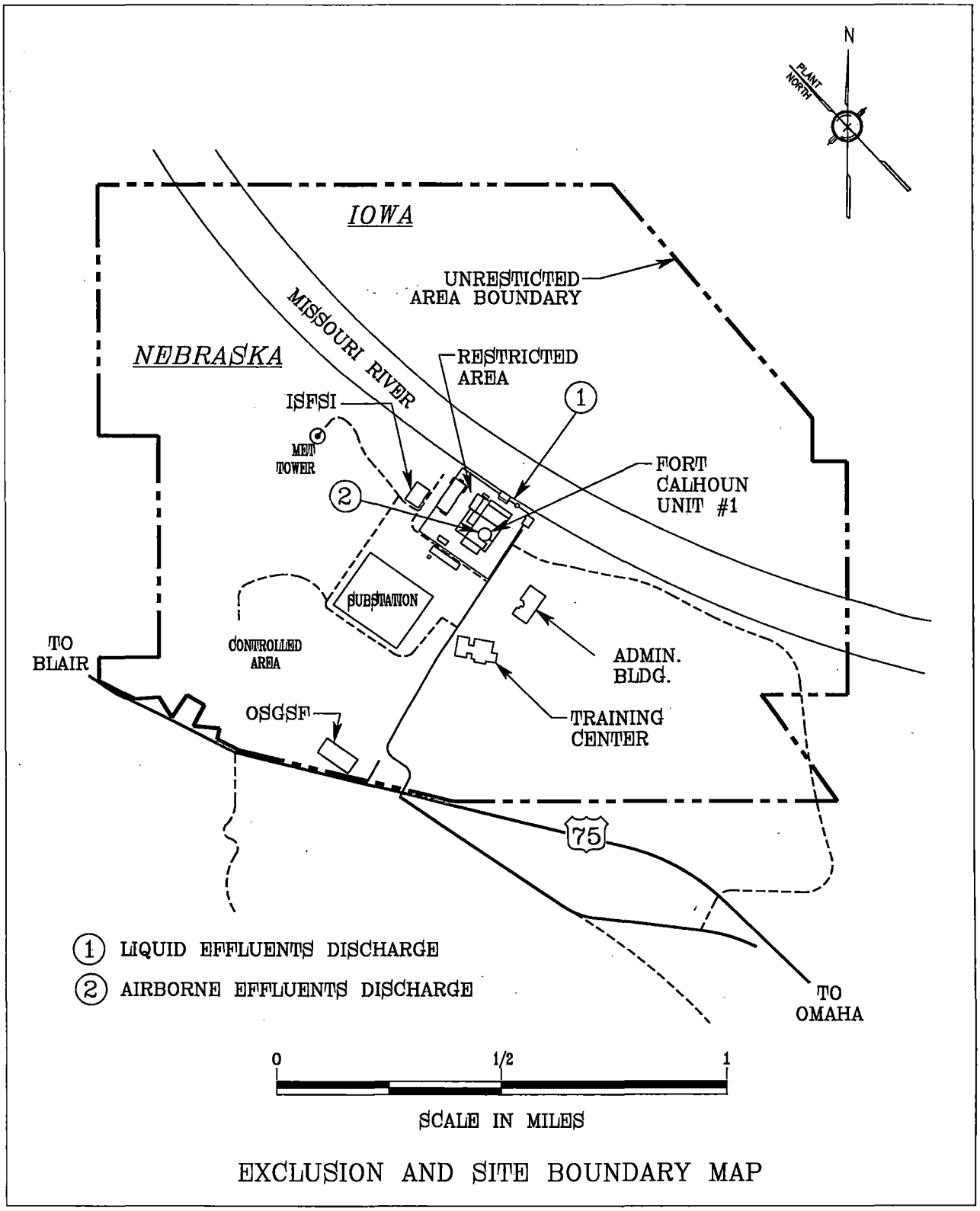
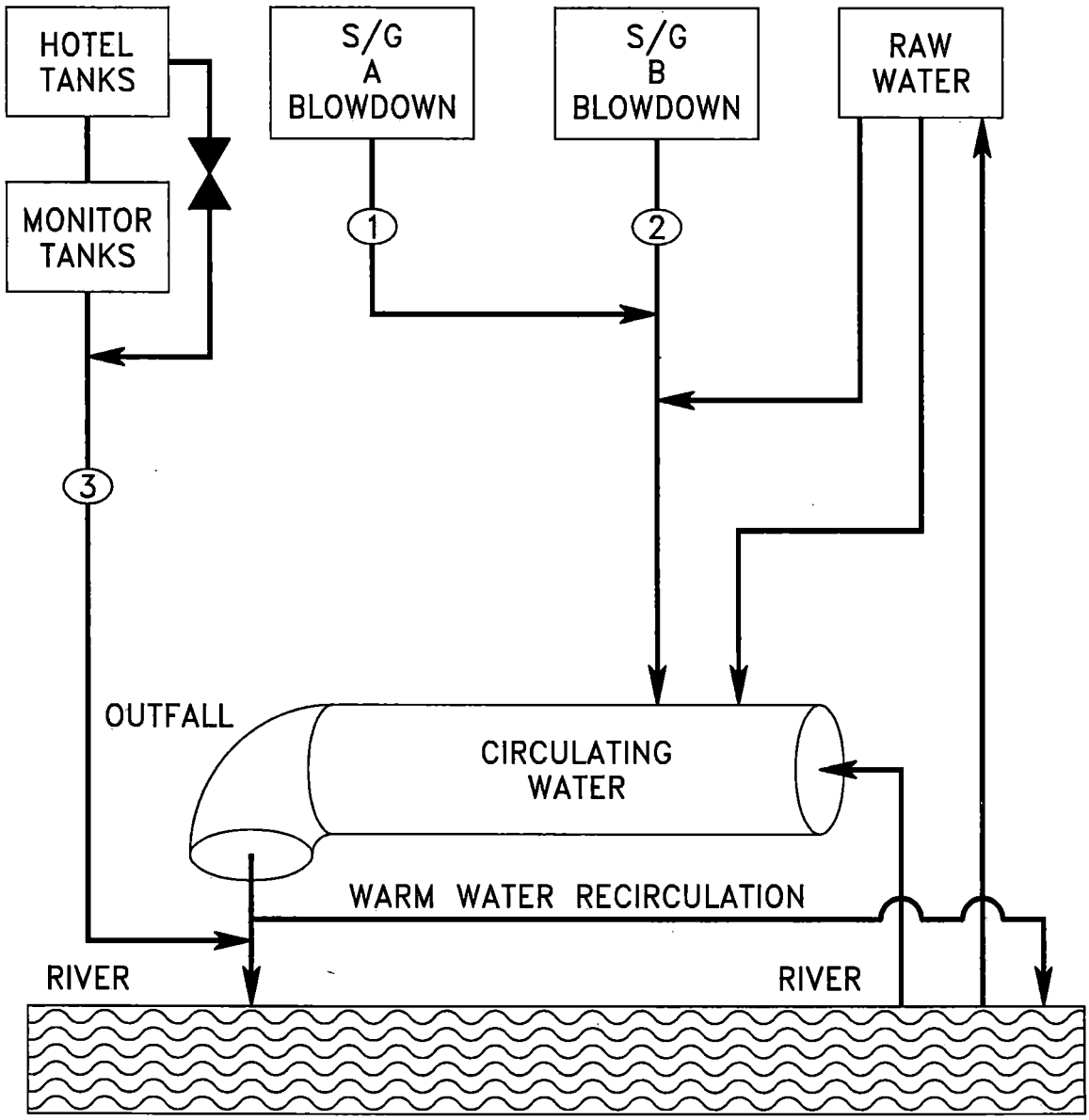


Figure 2 - Liquid Radioactive Discharge Pathways



(1) RM-054A
(2) RM-054B
(3) RM-055

LIQUID RADIOACTIVE DISCHARGE PATHWAYS

Figure 3 - Liquid Radioactive Waste Disposal System

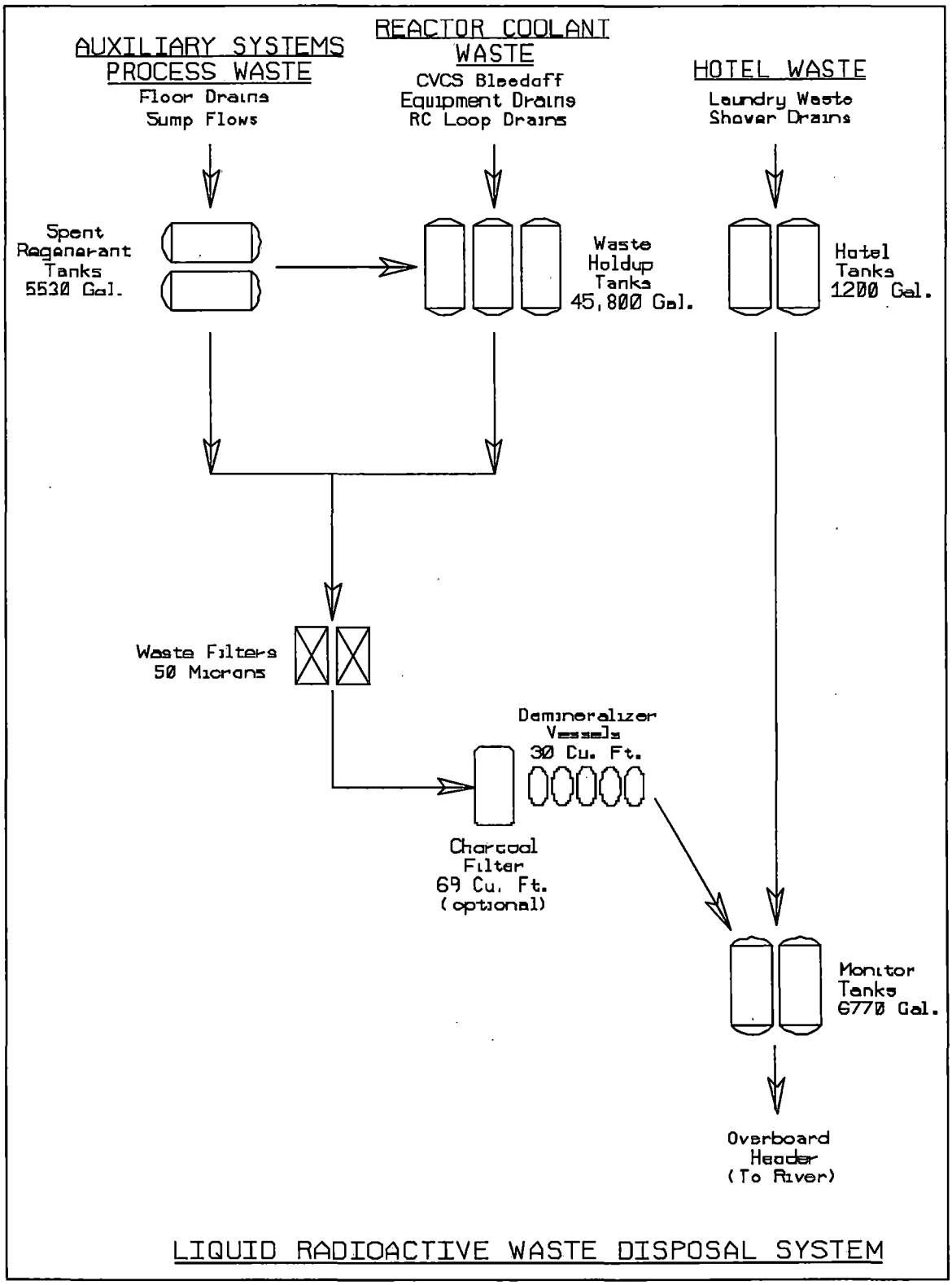


Figure 4 - Airborne Effluent Discharge Pathways

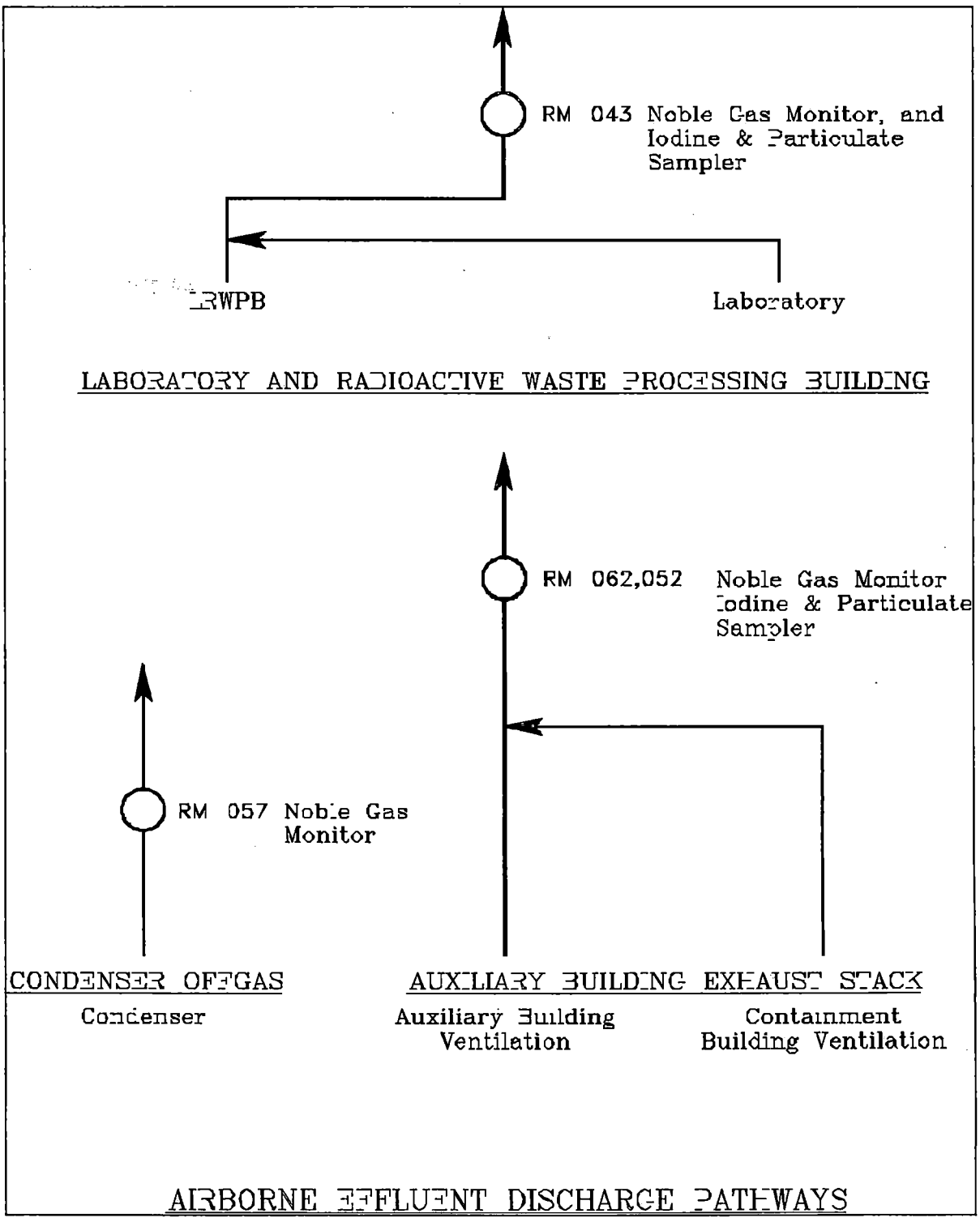
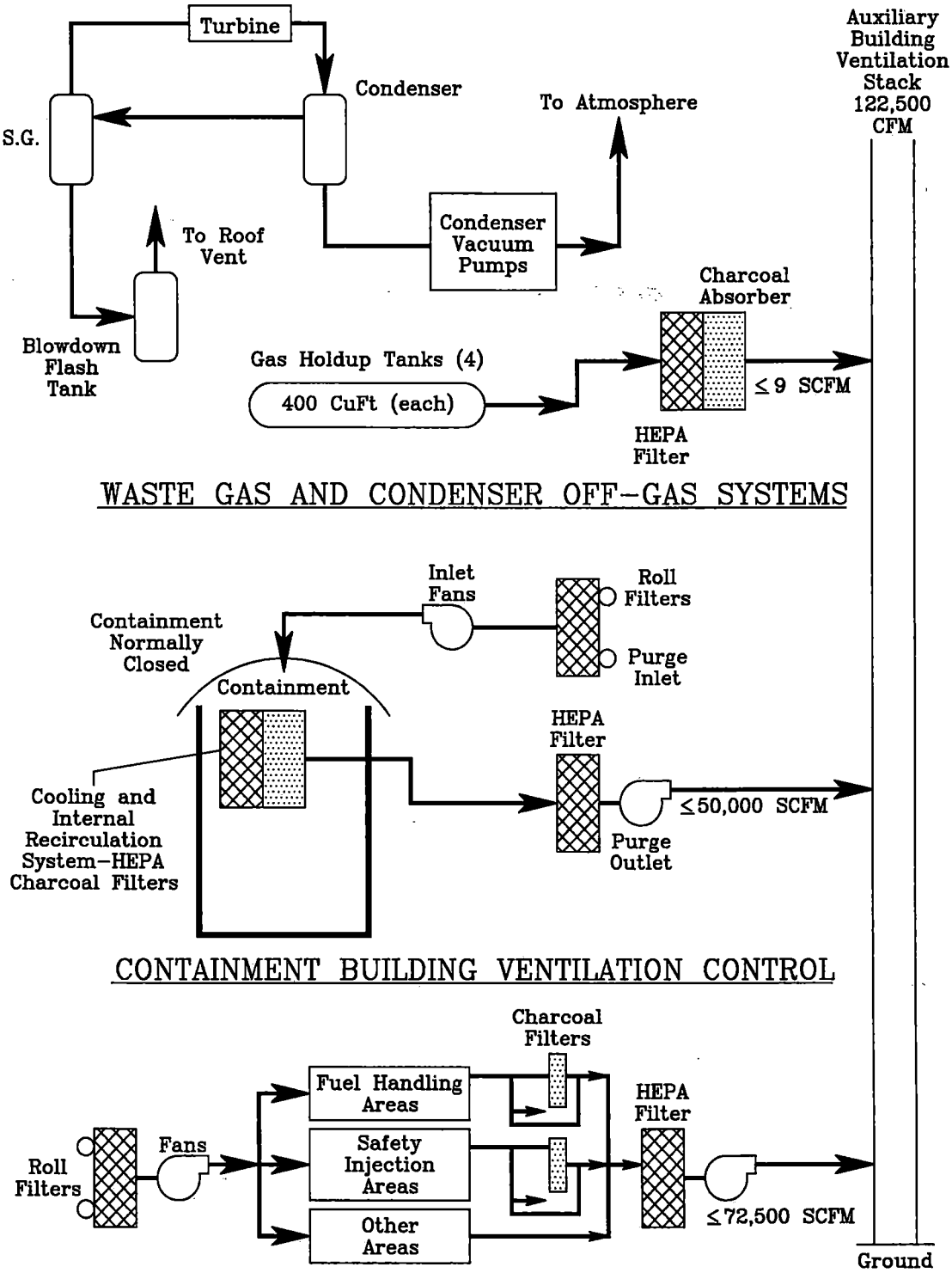


Figure 5 - Airborne Radioactive Waste Disposal System



2.0 EFFLUENT CONCENTRATIONS

2.1 Liquid Effluent Concentrations

2.1.1 The concentration of radioactive material in liquid effluents (after dilution in the Circulating Water System) will be limited to the concentrations as specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. For batch releases (Monitor and Hotel Waste Tanks and Steam Generators) and for continuous releases (Steam Generator Blowdown), the analyses will be performed in accordance with Part I, Table 4.1, of the Off-Site Dose Calculation Manual, and the concentration of each radionuclide at site discharge will be calculated, based on the following equation:

$$A_i = \frac{a_i f}{F + f}$$

$$and \sum_{i=1}^{n} \frac{A_i}{wec_i} \leq 1$$

Radionuclide concentration at site discharge:

Where:

A_i = concentration at site discharge for radionuclide (I), in µCi/ml.

a_i = concentration of radionuclide (I) in the undiluted effluent, in µCi/ml.

f = undiluted effluent flowrate, in gpm.

F = total diluted effluent flowrate in gpm.

wec_i = water effluent concentration limit for radionuclide (I) per 10 CFR Part 20, Appendix B, Table 2, Column 2.

i	**NOTE** In addition to the above defined method, Notes 1 through 4 of 10 CFR Part 20, Appendix B, will also be applicable.

2.2 Airborne Effluent Concentrations

2.2.1 The concentration at the unrestricted area boundary, due to airborne effluent releases, will be limited to less than Appendix B, Table 2, Column 1, values. Radiation monitor alarm setpoints are established to ensure that these release limits are not exceeded. In the event an airborne effluent release from the station result in an alarm setpoint being exceeded, an evaluation of the unrestricted area boundary concentration resulting from the release will be performed:

2.2.2 To determine the concentration and air effluent concentration (aec) fraction summation at the unrestricted area boundary, the following equations will be used:

$$A_i = K_0 \, Q_i \, (\chi/Q)$$

$$and \sum_{i=1}^{n} \frac{A_i}{ECL_i} \leq 1$$

Where:

A_i = Concentration of radionuclide (I) at the unrestricted area boundary

K_0 = Constant of unit conversion. (1.0E-6 m3/cc)

ECL_i = Effluent concentration limit (10 CFR Part 20, Appendix B, Table 2, Column 1 value for radionuclide(I))

Q_i = The release rate of radionuclide (I) in airborne effluents from all vent releases (in µCi/sec.)

(χ/Q) = Annual Average Dispersion Factor at the Unrestricted Area Boundary from Part II, Table 4, of the Off-Site Dose Calculation Manual.

2.2.3 As appropriate, simultaneous releases from the Auxiliary Building Ventilation Stack, Laboratory and Radwaste Building Stack and condenser off gas will be considered in evaluating compliance with the release rate limits of 10 CFR Part 20. Monitor indications (readings) may be averaged over a time period not to exceed 15 minutes when determining noble gas release rate based on correlation of the monitor reading and monitor sensitivity. Historical annual average dispersion parameters, as presented in Table 4, may be used for evaluating the airborne effluent dose rate.

2.2.4 For administrative purposes, more conservative alarm setpoints than those as prescribed above may be imposed. However, conditions exceeding those more limiting alarm setpoints do not necessarily indicate radioactive material release rates exceeding 10 CFR Part 20 limits. Provided actual releases do not result in radiation monitor indications exceeding alarm setpoint values based upon the above criteria, no further analyses are required for demonstrating compliance with 10 CFR Part 20.

3.0 RADIOACTIVE EFFLUENT DOSE CALCULATIONS

3.1 Liquid Effluent Dose Calculations

3.1.1 Three pathways for human exposure to liquid releases from FCS to the Missouri River exists: 1) fish, 2) drinking water, and 3) Shoreline deposition. Fish are considered to be taken from the vicinity of the plant discharge. The drinking water for Omaha is located 19 miles downstream from FCS. The dilution factors for these pathways are derived from the Revised Environmental Report for FCS, (1974), (page 4-29 and 4-31). This report states that during Low-Low river conditions, the concentration at Omaha's water intake will be ≤14% of the concentration at discharge from FCS and will average 3%. This equates to a dilution factor of 7.14, which is used to calculate the maximum dose to an individual from liquid pathways and a dilution factor of 33.33, for calculating the average dose. All pathways combine to give the dose to an individual in unrestricted areas.

3.1.2 10 CFR Part 50, Appendix I restricts the dose to individuals in the unrestricted areas from radioactive materials in liquid effluents from the Fort Calhoun Station to the following limits:

- during any calendar quarter
  ≤ 1.5 mrem to total body
  ≤ 5.0 mrem to any organ

and

- during any calendar year
  ≤ 3.0 mrem to total body
  ≤ 10.0 mrem to any organ

The following calculational methods shall be used for determining the dose or dose commitment from liquid effluents.

3.1.3 Doses from Liquid Effluent Pathways

A. Potable Water

$$R_{apj} = 1100 \frac{U_{ap} M_p}{F} \sum_{i=1}^{n} Q_i D_{aipj} \exp(-\lambda_i t_p)$$

Where:

R_{apj} = is the total annual dose to organ(j) of individuals of age group (a) from all of the radionuclides (I) in pathway (p), in mrem/yr.

U_{ap} = is a usage factor that specifies the intake rate for an individual of age group (a) associated with pathway (p), in ℓ/yr. (Table 6)

M_p = is the mixing ratio (reciprocal of the dilution factor) at the point of withdrawal of drinking water, dimensionless. (Table 17)

F = is the flow rate of the liquid effluent, in ft^3/ sec.

Q_i = is the annual release rate of radionuclide (I), in Ci/yr.

D_{aipj} = is the dose factor specific to a given age group (a), radionuclide (I), pathway (p), and organ (j) which can be used to calculate the radiation dose from an intake of a radionuclide, in mrem/pCi. (Tables 13-16)

λ_i = is the radiological decay constant of radionuclide (I), in hr^{-1}.

t_p = is the average transit time required for radionuclides to reach the point of exposure. For internal dose, t_p is the total time elapsed between release of the radionuclides and ingestion of water, in hours. (Table 17)

1100 = Constant (pCi * yr * ft^3/Ci * sec * L)

3.1.3 (continued)

B. Aquatic Foods

$$R_{apj} = 1100 \frac{U_{ap} M_p}{F} \sum_{i=1}^{n} Q_i B_{ip} D_{aipj} \exp(-\lambda_i t_p)$$

Where:

R_{apj} = is the total annual dose to organ (j) of individuals of age group (a) from all of the radionuclides (I) in pathway (p), in mrem/yr.

U_{ap} = is a usage factor that specifies the intake rate for an individual of age group (a) associated with pathway (p), in kg/yr. (Table 6)

M_p = is the mixing ratio (reciprocal of the dilution factor) at the point of harvest of aquatic food, dimensionless. (Table 17)

F = is the flow rate of the liquid effluent, in ft^3/sec.

Q_i = is the annual release rate of radionuclide (I), in Ci/yr.

B_{ip} = is the equilibrium bioaccumulation factor for radionuclide (I) in pathway (p) expressed as the ratio of the concentration in biota (in pCi/kg) to the radionuclide concentration in water (in pCi/liter), in (pCi/kg)/(pCi/liter). (Table 3)

D_{aipj} = is the dose factor specific to a given age group (a), radionuclide (I), pathway (p), and organ (j), which can be used to calculate the radiation dose from an intake of a radionuclide, in mrem/pCi. (Tables 13-16)

λ_i = is the radiological decay constant of radionuclide (I), in hr^{-1}.

t_p = is the average transit time required for radionuclides to reach the point of exposure. For internal dose, t_p is the total time elapsed between release of the radionuclides and ingestion of food, in hours. (Table 17)

1100 = Constant (pCi * yr * ft^3/Ci * sec * L)

3.1.3 (continued)

C. Shoreline Deposits

$$R_{apj} = 110{,}000\ \frac{U_{ap} M_p W}{F} \sum_{i=1}^{n} Q_i T_{ip} D_{aipj} \left[\exp(-\lambda_i t_p)\right] \left[1 - \exp(-\lambda_i t_b)\right]$$

Where:

R_{apj} = is the total annual dose to organ (j) of individuals of age group (a) from all of the radionuclides (I) in pathway (p), in mrem/yr.

U_{ap} = is a usage factor that specifies the exposure time for an individual of age group (a) associated with pathway (p), in hr/yr. (Table 6)

M_p = is the mixing ratio (reciprocal of the dilution factor) at the point of exposure, dimensionless. (Table 17)

W = is the shore-width factor, dimensionless. (Table 17)

F = is the flow rate of the liquid effluent, in ft^3/sec.

Q_i = is the annual release rate of radionuclide (I), in Ci/yr.

T_{ip} = is the radioactive half life of radionuclide (I), in days.

D_{aipj} = is the dose factor specific radionuclide (I) which can be used to calculate the radiation dose from exposure to a given concentration of a radionuclide in sediment, expressed as a ratio of the dose rate (in mrem/hr) and the real radionuclide concentration (in pCi/m^2). (Table 8)

λ_i = is the radiological decay constant of radionuclide (I), in hr^{-1}.

t_p = is the average transit time required for radionuclides to reach the point of exposure, in hours. (Table 17)

t_b = is the period of time for which sediment or soil is exposed to the contaminated water, in hours. (Table 17)

110,000 = Constant [(100 * pCi * yr * ft^3)/(Ci * sec * L)]

3.2 Airborne Effluent Dose Calculations

3.2.1 Noble Gas

10 CFR Part 50, Appendix I, restricts the dose to individuals in the unrestricted areas from noble gases in airborne effluents from the Fort Calhoun Station to the following limits:

- During any calendar quarter
  ≤ 5 mrad-gamma air dose
  ≤ 10 mrad-beta air dose

and

- During any calendar year
  ≤ 10 mrad-gamma air dose
  ≤ 20 mrad-beta air dose

The following general equations shall be used to calculate the gamma-air and beta-air doses:

A. Doses from Noble Gases

1. Annual Gamma/Beta Air Dose from All Other Noble Gas Releases

$$D^{\gamma}(r,\theta) or\ D^{\beta}(r,\theta) = 3.17\ x\ 10^{4} \sum_{i=1}^{n} Q_i[\chi/Q]^{D}(r,\theta)(DF_i^{\gamma}\ or\ DF_i^{\beta})$$

Where:

DF_i^{γ} or DF_i^{β} = are the gamma and beta air dose factors for a uniform semi-infinite cloud of radionuclide (I), in mrad-m^3/pCi-yr. (Table 2)

$D^{\gamma}(r,\theta)$ or $D^{\beta}(r,\theta)$ = are the annual gamma and beta air doses at distance r, in the sector at angle σ, from the discharge point, in mrad/yr.

Q_i = is the annual release rate of radionuclide (I), in Ci/yr.

$[\chi/Q]^{D}(r,\theta)$ = is the annual average gaseous dispersion factor at distance r, in the sector at angle θ, in sec/m^3. (Table 4)

$3.17x10^{4}$ = is the number of pCi per Ci divided by the number of seconds per year.

3.2.1A (continued)

2. Annual Total Body Dose from All Other Noble Gas Releases

$$D_{\infty}^{T}(r,\theta) = S_f \sum_{i=1}^{n} X_i(r,\theta) DFB_i$$

Where:

DFB_i = is the total body dose factor for a semi-infinite cloud of the radionuclide (I), which includes the attenuation of 5 g/cm^2 of tissue, in mrem-m^3/pCi-yr. (Table 2)

$D_4^T(r,\theta)$ = is the annual total body dose due to immersion in a semi-infinite cloud at distance r, in the sector at angle θ, in mrem/yr.

$\chi_i(r,\theta)$ = is the annual average ground-level concentration of radionuclide (I) at distance r, in the sector at angle θ, in pCi/m^3. (Table 4)

S_f = Shielding Factor (Table 17)

3. Annual Skin Dose from All Other Noble Gas Releases

$$D_{\infty}^{T}(r,\theta) = 1.11\, S_f \sum_{i=1}^{n} X_i(r,\theta) DF_i^{\gamma} + \sum_{i=1}^{n} X_i(r,\theta) DFS_i$$

Where:

$D_4^T(r,\theta)$ = is the annual skin dose due to immersion in a semi-infinite cloud at distance r, in the sector at angle θ, in mrem/yr.

DFS_i = is the beta skin dose factor for a semiinfinite cloud of radionuclide (I), in mrem-m^3/pCi-yr. (Table 2)

1.11 = is the average ratio of tissue to air energy absorption coefficients.

3.2.2 Radioiodine, Tritium, and Particulates

10 CFR Part 50, Appendix I, restricts the dose to individuals in the unrestricted areas from radioactive materials in gaseous airborne from the Fort Calhoun Station to:

- During any calendar quarter
  ≤ 7.5 mrem to any organ

and

- During any calendar year
  ≤ 15 mrem to any organ

The dose to an individual from radioiodines, radioactive materials in particulate form, and radionuclides other than noble gases with half-lives greater than 8 days in airborne effluents released to unrestricted areas should be determined by the following expressions:

Radioiodine, Tritium, and Particulates (continued)

3.2.2 (continued)

	NOTE	
i	In all cases, for releases of tritium, use the dispersion parameter for inhalation (χ/Q).	i

A. Annual Organ Dose from External Irradiation from Radioactivity Deposited on the Ground Plane

The ground plane concentration of radionuclide (I) at distance r, in the sector at angle θ, with respect to the release point, may be determined by:

$$C_i^G\ (r,\theta) = \frac{[1.0x10^{12}][\delta_i\ (r,\theta)Q_i]}{\lambda_i}\ [1-\exp(-\lambda_i t_b)]$$

Where:

C_I^G = is the ground plane concentration of the radionuclide (I) at distance r, in the sector at angle θ, from the release point, in pCi/m^2.

Q_i = is the annual release rate of radionuclide (I) to the atmosphere, in Ci/yr.

t_b = is the time period over which the accumulation is evaluated, which is assumed to be 20 years (mid-point of plant operating life). (Table 17)

δi(r,θ) = is the annual average relative deposition of radionuclide (I) at distance r, in the sector at angle θ, considering depletion of the plume by deposition during transport, in m-2. Table 4

λ i = is the radiological decay constant for radionuclide (I), in yr-1.

$1.0x10^{12}$ = is the number of pCi/Ci

3.2.2A (continued)

The annual organ dose is then calculated using the following equation:

$$D_i^G\ (r,\theta) = 8760\ S_f \sum_{i=1}^{n} C_i^G\ (r,\theta) DFG_{ij}$$

Where:

$C_j^G(r,\theta)$ = is the ground plane concentration of radionuclide (i) at distance r, in the sector at angle θ, in pCi/m^2.

DFG_{ij} = is the open field ground plane dose conversion factor for organ (j) from radionuclide (i), in mrem-m^2/pCi-hr. (Table 8)

$D_j^G(r,\theta)$ = is the annual dose to the organ (j) at distance r, in the sector at angle θ, in mrem/yr.

S_f = is the shielding factor that accounts for the dose reduction due to shielding provided by residential structures during occupancy, dimensionless. (Table 17)

8760 = is the number of hours in a year

B. Annual Dose from Inhalation of Radionuclides in Air

The annual average airborne concentration of radionuclide (i) at distance r, in the sector at angle θ, with respect to the release point, may be determined as:

$$X_i\ (r,\theta) = 3.17\ x\ 10^4\ Q_i\ [\chi/Q]^D\ (r,\theta)$$

Where:

Q_i = is the annual release rate of radionuclide (i) to the atmosphere, in Ci/yr.

$\chi_i(r,\theta)$ = is the annual average ground-level concentration of radionuclide (i) in air at distance r, in the sector at angle θ, in pCi/m^3.

$[\chi/Q]^D\ (r,\theta)$ = is the annual average atmosphere dispersion factor, in sec/m^3 (see Reg Guide 1.111). This includes depletion (for radioiodines and particulates) and radiological decay of the plume. (Table 4)

$3.17x10^4$ = is the number of pCi/Ci divided by the number of sec/yr.

3.2.2B (continued)

The annual dose associated with inhalation of all radionuclides to organ (j) of an individual in age group (a), is then:

$$D_{ja}^{A}(r,\theta) = R_a \sum_{i=1}^{n} X_i(r,\theta) DFA_{ija}$$

Where:

$D_{ja}^{A}(r,\theta)$ = is the annual dose to organ (j) of an individual in the age group (a) at distance r, in the sector at angle θ, due to inhalation, in mrem/yr.

R_a = is the annual air intake for individuals in the age group (a), in m^3/yr. (Table 6)

DFA_{ija} = is the inhalation dose factor for radionuclide (i), organ (j), and age group (a), in mrem/pCi. (Tables 9-12)

3.2.3 Concentrations of Radionuclides in Foods and Vegetation from Atmospheric Releases

A. Parameters for Calculating Concentrations in Forage, Produce, and Leafy Vegetables, excluding Tritium

$$C_i^V(r,\theta) = d_i(r,\theta)\left[\frac{r[1-\exp(-\lambda_{Ei}t_e)]}{Y_v\lambda_{Ei}} + \frac{B_{iv}[1-\exp(-\lambda_i t_b)]}{P\lambda_i}\right]\exp(-\lambda_i t_h)$$

Where:

$C_i^V(r,\theta)$ = is the concentration of radionuclide (i) in and on vegetation at distance r, in the sector at angle θ, in pCi/kg.

$d_i(r,\theta)$ = is the deposition rate of radionuclide (i) at distance r, in the sector at angle θ, in pCi/m^2 hr.

3.2.3A (continued)

The deposition rate from the plume is defined by (Reg. Guide 1.109, Rev. 1, Page 1.109-26, Equa. C-6):

$$d_i\,(r,\theta) = 1.1\,x\,10^8\,\delta_i\,(r,\theta)Q_i$$

Where:

$d_i(r,\theta)$ = is the deposition rate of radionuclide (i).

$\delta_i(r,\theta)$ = is the relative deposition of radionuclide (i), considering depletion and decay, in m^{-2} (see Reg Guide 1.111). (Table 4)

$1.1x10^8$ = is the number of pCi/Ci (10^{12}) divided by the number of hours per year (8760).

Q_i = is the annual release rate of radionuclide (i) to the atmosphere, in Ci/yr.

3.2.3 (continued)

B. For radioiodines, the model considers only the elemental fraction of the effluent:

$$d_i\,(r,\theta) = 3.3\,x\,10^7\,\delta_i\,(r,\theta)Q_i$$

Where:

$d_i\,(r,\theta)$ = The deposition rate of radioiodine (i).
3.3×10^7 = The number of pCi/Ci (1012) divided by the number of hours per year (8760), then multiplied by the amount of radioiodine emissions considered to be elemental (0.5).
$\delta i\,(r,\theta)$ = The relative deposition of radioiodine (i), considering depletion and decay, in m-2. (Table 4)
Qi = The total (elemental and nonelemental) radioiodine (i) emission rate.
r = is the fraction of deposited activity retained on crops, dimensionless. (Table 17)
λEi = is the effective removal rate constant for radionuclide (i) from crops, in hr-1.
$\lambda_{Ei} = \lambda_i + \lambda_w$
$\lambda_w = 0.0021/hr$. (Table 17)
te = is the time period that crops are exposed to contamination during the growing season, in hours. (Table 17)
Yv = is the agricultural productivity (yield) in kg (wet weight)/m2. (Table 17)
Biv = is the concentration factor for uptake of radionuclide (i) from soil by edible parts of crops, in pCi/ kg (wet weight) per pCi/kg dry soil. (Table 5)
λi = is the radiological decay constant of radionuclide (I), in hr-1
t_b = is the period of time for which sediment or soil is exposed to the contaminated water, in hours (mid-point of plant life). (Table 17)
P = is the effective "surface density" for soil, in kg (dry soil)/m2. (Table 17)
t_h = is the holdup time that represents the time interval between harvest and consumption of the food, in hours. (Table 17)

Different values for the parameters te, Yv, and th, may be used to allow the use of the Equation for different purposes: estimating concentrations in produce consumed by man; in leafy vegetables consumed by man; in forage consumed directly as pasture grass by dairy cows, beef cattle, or goats; and in forage consumed as stored feed by dairy cows, beef cattle or goats. See Table 17.

3.2.3 (continued)

C. Parameters for Calculating the Concentration of Radionuclide (i) in the Animal's Feed (Milk Cow, Beef Cow, and Goat)

$$C_i^V(r,\theta) = f_p f_S C_i^P(r,\theta) + (1-f_p)C_i^S(r,\theta) + f_p(1-f_S)C_i^S(r,\theta)$$

Where:

$C_i^V(r,\theta)$ = is the concentration of radionuclide (i) in the animal's feed, in pCi/kg.

$C_i^P(r,\theta)$ = is the concentration of radionuclide (i) on pasture grass (calculated using Equation 3.2.3C with t_h=0), in pCi/kg.

$C_i^S(r,\theta)$ = is the concentration of radionuclide (i) in stored feeds (calculated using Equation 3.2.3C with t_h=90 days), in pCi/kg.

f_p = is the fraction of the year that animals graze on pasture. (Table 17)

f_s = is the fraction of daily feed that is pasture grass while the animal grazes on pasture. (Table 17)

3.2.4 Parameters for Calculating Radionuclide Concentration in Cow and Goat Milk

$$C_i^M(r,\theta) = F_m C_i^V(r,\theta) Q_F \exp(-\lambda_i t_f)$$

Where:

$C_i^M(r,\theta)$ = is the concentration of radionuclide (i) in milk, in pCi/liter.

$C_i^V(r,\theta)$ = is the concentration of radionuclide (i) in the animal's feed, in pCi/kg.

F_m = is the average fraction of the animal's daily intake of radionuclide (i) which appears in each liter of milk, in days/liter. (Table 5)

Q_F = is the amount of feed consumed by the animal per day, in kg/day. (Table 7)

t_f = is the average transport time of the radionuclide (i) from the feed to the milk and to the receptor (a value of 2 days is assumed). (Table 17)

λ_i = is the radiological decay constant of radionuclide (i), in $days^{-1}$.

3.2.5 Parameters for Calculating Radionuclide Concentration in Cow Meat, excluding Tritium

$$C_i^F\ (r,\theta) = F_f\ C_i^V\ (r,\theta) Q_F \exp(-\lambda_i\ t_f)$$

Where:

$C_i^F\ (r,\theta)$ = is the concentration of radionuclide (i) in meat, in pCi/liter.

F_f = is the average fraction of the animal's daily intake of radionuclide (i) which appears in each kilogram of flesh, in days/kilogram. (Table 5)

t_s = is the average time from slaughter to consumption. (Table 17)

3.2.6 Parameters for Calculating Tritium Concentrations in Vegetation

The concentration of tritium in vegetation is calculated from its concentration in the air surrounding the vegetation.

$$C_T^V\ (r,\theta) = 3.17\ x\ 10^7\ Q_T\ \frac{[\chi/Q](r,\theta)(0.75)(0.5)}{H} = 1.2\ x\ 10^7\ Q_T\ \frac{[\chi/Q](r,\theta)}{H}$$

Where:

$C_T^V(r, \theta)$ = is the concentration of tritium in vegetation grown at distance r, in the sector at angle θ, in pCi/kg.

H = is the absolute humidity of the atmosphere at distance r, in the sector at angle θ, in g/m^3. H=8 gm/kg.

Q_T = is the annual release rate of tritium, in Ci/yr.

$[\chi/Q](r,\theta)$ = is the atmospheric dispersion factor, in sec/m^3. (Table 4)

0.5 = is the ratio of tritium concentration in plant water to tritium concentration in atmospheric water, dimensionless.

0.75 = is the fraction of total plant mass that is water, dimensionless.

3.2.7 Annual Dose from Atmospherically Released Radionuclides in Foods

A. The total annual dose to organ (j) of an individual in age group (a) resulting from ingestion of all radionuclides in produce, milk, and leafy vegetables is given by:

$$D_{ja}^{D}(r,\theta) = \sum_{i} DFI_{ija}\left[U_a^V f_g C_i^V(r,\theta) + U_a^M C_i^M(r,\theta) + U_a^F C_i^F(r,\theta) + U_a^L f_\ell C_i^L(r,\theta)\right]$$

Where:

$D_{ja}^{D}(r,\theta)$ = is the annual dose to organ (j) of an individual in age group (a) from dietary intake of atmospherically released radionuclides, in mrem/yr.

DFI_{ija} = is the dose conversion factor for the ingestion of radionuclide (i), organ (j), and age group (a), in mrem/pCi. Tables 13-16.

U_a^V, U_a^M = are the ingestion rates of produce (non-leafy vegetables, fruits, and grains); milk, meat, and leafy UFa,Ula vegetables, respectively for individuals in age group (a). (Table 6)

f_g = Fraction of ingested produce grown in garden of interest (Table 17)

f_ℓ = Fraction of leafy vegetables grown in garden of interest (Table 17)

3.2.7 (continued)

B. Calculating the Ingested Dose from Leafy and Non-Leafy (produce) Vegetation for Radionuclide (i) to Each Organ (j) and Age Group (a)

$$D_{ja}^{D}(r,\theta) = DFI_{ja}\,[U_a^L\, f_\ell\, C_i^L\,(r,\theta) + U_a^V\, f_g\, C_i^V\,(r,\theta)]$$

Where:

$D_{ja}^{D}(r,\theta)$ = is the annual dose from the ingestion of radionuclide (i) to organ (j) of an individual in age group (a) from dietary intake of atmospherically released radionuclides in vegetation, in mrem/yr.

DFI_{ija} = is the dose conversion factor for the ingestion of radionuclide (i), organ (j), and age group (a), in mrem/pci. Tables 13-16

ULa,UVa = are the ingestion rates of leafy vegetables and produce (non-leafy vegetables, fruits, and grains), for individuals in age group (a), in kg/yr. (Table 6)

CLi = is the concentration of radionuclide (i) in and on leafy vegetation, in pCi/kg.

CVi = is the concentration of radionuclide (i) in and on produce, in pCi/kg.

C. Calculation Determining the Ingested Dose from Cow Milk for Radionuclide (i), Organ (j), and Age Group (a)

$$D_{ja}^{D}(r,\theta) = DFI_{ija}\,[U_a^M\, C_i^M\,(r,\theta)]$$

Where:

$D_{ja}^{D}(r,\theta)$ = is the annual dose from the ingestion of radionuclide (i), organ (j) of an individual in age group (a) from dietary intake of atmospherically released radionuclides in cow milk, in mrem/yr.

DFI_{ija} = is the dose conversion factor for the ingestion of radionuclide (i), organ (j), and age group (a), in mrem/pCi. (Tables 13-16)

U_a^M = is the ingestion rate of cow milk for individuals in age group (a), in P/yr. (Table 6)

C_i^M = is the radionuclide concentration in cow milk, in pCi/kg. Equation 3.2.4

3.2.7 (continued)

D. Calculation Determining the Ingested Dose from Meat for Radionuclide (i) to Organ (j) and Age Group (a)

$$D_{ja}^{D}(r,\theta) = DFI_{ija}\,[U_a^F\,C_i^F\,(r,\theta)]$$

Where:

$D^{D}_{ja}(r,\theta)$ = is the annual dose from the ingestion of radionuclide (i), organ (j) of an individual in age group (a) from dietary intake of atmospherically released radionuclides in meat, in mrem/yr.

DFI_{ija} = is the dose conversion factor for the ingestion of radionuclide (i), organ (j), and age group (a), in mrem/pCi. (Tables 13-16)

U^{F}_{a} = is the ingestion rate of meat for individuals in age group (a), in kg/yr. (Table 6)

C^{F}_{i} = is the radionuclide (i) concentration in meat, in pCi/kg.

3.2.8 Annual Dose from Carbon 14

A. This is a calculated value based on power generation and days of operation. Critical organ doses from C-14 were calculated using a ratio of 15% as CO_2. This ratio was determined during an NRC in-plant source term study conducted at the Fort Calhoun Station between 1976 and 1977, NUREG/CR-0140.

4.0 LOWER LIMIT OF DETECTION (LLD)

4.1 The lower limit of detection (LLD) for liquid and airborne effluent discharges and environmental samples referenced in Part I, Tables 4.1, 4.2 and 5.3, of the Off-Site Dose Calculation Manual, is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66 * S_b}{E * V * D * Y * \exp(-\lambda \Delta t)}$$

Where:

LLD = the lower limit of detection as defined above, in either picoCuries or microCuries, per unit mass or volume as a function of the value of D

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

E = the counting efficiency, as counts per disintegration

V = the sample size in units of mass or volume

D = 2.22E+06 of disintegrations per minute per microCurie or 2.22 disintegrations per minute per picoCurie

Y = the fractional radiochemical yield, when applicable

λ = the radioactive decay constant for the particular radionuclide

Δt = the elapsed time between the midpoint of sample collection and time of counting

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

4.3 It should be recognized that the LLD is defined as an A Priori limit representing the capability of a measurement system and not as a limit for a particular measurement.

4.4 LLD verifications will be performed on a periodic basis. This determination is to ensure that the counting system is able to detect levels of radiation at the LLD values for the specific type of analysis required. They will be performed with a blank (non-radioactive) sample in the same counting geometry as the actual sample.

Table 2 - Dose Factors for Exposure to a Semi-Infinite Cloud of Noble Gases

Nuclide	β-Air[1] (Df^{β}_i)	β-Skin[2] (DFSi)	γ-Air[1] (Df^{γ}_i)	γ-Body[2] (DFB_i)
Kr-83m	2.88E-04	---	1.93E-05	7.56E-08
Kr-85m	1.97E-03	1.46E-03	1.23E-03	1.17E-03
Kr-85	1.95E-03	1.34E-03	1.72E-05	1.61E-05
Kr-87	1.03E-02	9.73E-03	6.17E-03	5.92E-03
Kr-88	2.93E-03	2.37E-03	1.52E-02	1.47E-02
Kr-89	1.06E-02	1.01E-02	1.73E-02	1.66E-02
Kr-90	7.83E-03	7.29E-03	1.63E-02	1.56E-02
Xe-131m	1.11E-03	4.67E-04	1.56E-04	9.15E-05
Xe-133m	1.48E-03	9.94E-04	3.27E-04	2.51E-04
Xe-133	1.05E-03	3.06E-04	3.53E-04	2.94E-04
Xe-135m	7.39E-04	7.11E-04	3.36E-03	3.12E-03
Xe-135	2.46E-03	1.86E-03	1.92E-03	1.81E-03
Xe-137	1.27E-02	1.22E-02	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

1. $\frac{mrad - m^3}{pCi - yr}$

2. $\frac{mrem - m^3}{pCi - r}$

3. $2.88E - 04 = 2.88\ x\ 10^{-4}$

Table 3 - Bioaccumulation Factors
(pCi/kg per pCi/liter)

FRESHWATER

Element	Fish	Invertebrate
H	9.0E-01	9.0E-01
C	4.6E+03	9.1E+03
Na	1.0E+02	2.0E+02
P	1.0E+05	2.0E+04
Cr	2.0E+02	2.0E+03
Mn	4.0E+02	9.0E+04
Fe	1.0E+02	3.2E+03
Co	5.0E+01	2.0E+02
Ni	1.0E+02	1.0E+02
Cu	5.0E+01	4.0E+02
Zn	2.0E+03	1.0E+04
Br	4.2E+02	3.3E+02
Rb	2.0E+03	1.0E+03
Sr	3.0E+01	1.0E+02
Y	2.5E+01	1.0E+03
Zr	3.3E+00	6.7E+00
Nb	3.0E+04	1.0E+02
Mo	1.0E+01	1.0E+01
Tc	1.5E+01	5.0E+00
Ru	1.0E+01	3.0E+02
Rh	1.0E+01	3.0E+02
Te	4.0E+02	6.1E+03
I	1.5E+01	5.0E+00
Cs	2.0E+03	1.0E+03
Ba	4.0E+00	2.0E+02
La	2.5E+01	1.0E+03
Ce	1.0E+00	1.0E+03
Pr	2.5E+01	1.0E+03
Nd	2.5E+01	1.0E+03
W	1.2E+03	1.0E+01
Np	1.0E+01	4.0E+02

Table 4 - Highest Potential Exposure Pathways for Estimating Dose

i	**NOTE** The Annual Radiological Effluent Report uses the highest calculated value from real time meteorological data obtained for the entire year for calculating dose.	i

Exposure Pathway	Location [B]	Direction [B]	Distance from Containment (miles) [B]	X/Q [A] {χ/Q (r,θ)} (sec/m^3)	D/Q [A] {δ (r,θ)} (m^{-2})
Direct Exposure	Site Boundary	SSE	0.60	1.30E-05	N/A
Inhalation	Site Boundary	SSE	0.60	1.30E-05	N/A
Ingestion	Residence	SSE	0.60	N/A	7.6E-08

A. These values are used for calculating quarterly dose estimates during the annual reporting period and are based on a 2 year average, updated only upon a +10% change from the previous value. At least ten percent (10%) should be added to these values for dose estimates during the reporting periods.

B. The location is subject to change based on an annual evaluation and is utilized only for ingestion exposure pathway dose estimates. This location may differ from the highest ingestion exposure pathway for offsite air monitoring locations as determined by the Land Use Survey performed biennially in accordance with Part 1, Section 7.3.2, of the Off-Site Dose Calculation Manual.

Table 5 - Stable Element Transfer Data

Element	B_{iv} Veg./Soil	F_m (cow) Milk (d/l)	F_f Meat (d/kg)
H	4.8E+00	1.0E-02	1.2E-02
C	5.5E+00	1.2E-02	3.1E-02
Na	5.2E-02	4.0E-02	3.0E-02
P	1.1E+00	2.5E-02	4.6E-02
Cr	2.5E-04	2.2E-03	2.4E-03
Mn	2.9E-02	2.5E-04	8.0E-04
Fe	6.6E-04	1.2E-03	4.0E-02
Co	9.4E-03	1.0E-03	1.3E-02
Ni	1.9E-02	6.7E-03	5.3E-02
Cu	1.2E-01	1.4E-02	8.0E-03
Zn	4.0E-01	3.9E-02	3.0E-02
Rb	1.3E-01	3.0E-02	3.1E-02
Sr	1.7E-02	8.0E-04	6.0E-04
Y	2.6E-03	1.0E-05	4.6E-03
Zr	1.7E-04	5.0E-06	3.4E-02
Nb	9.4E-03	2.5E-03	2.8E-01
Mo	1.2E-01	7.5E-03	8.0E-03
Tc	2.5E-01	2.5E-02	4.0E-01
Ru	5.0E-02	1.0E-06	4.0E-01
Rh	1.3E+1	1.0E-02	1.5E-03
Ag	1.5E-01	5.0E-02	1.7E-02
Te	1.3E+00	1.0E-03	7.7E-02
I	2.0E-02	6.0E-03	2.9E-03
Cs	1.0E-02	1.2E-02	4.0E-03
Ba	5.0E-03	4.0E-04	3.2E-03
La	2.5E-03	5.0E-06	2.0E-04
Ce	2.5E-03	1.0E-04	1.2E-03
Pr	2.5E-03	5.0E-06	4.7E-03
Nd	2.4E-03	5.0E-06	3.3E-03
W	1.8E-02	5.0E-04	1.3E-03
Np	2.5E-03	5.0E-06	2.0E-04

Table 6 - Recommended Values for U_{ap} to Be Used for the Maximum Exposed Individual in Lieu of Site Specific Data

Pathway	Infant	Child	Teen	Adult
Fruits, vegetables, & grain (kg/yr)	---	520	630	520
Leafy vegetables (kg/yr)	---	26	42	64
Milk (P/yr)	330	330	400	310
Meat & poultry (kg/yr)	---	41	65	110
Fish (fresh or salt)(kg/yr)	---	6.9	16	21
Other Seafood (kg/yr)	---	1.7	3.8	5
Drinking water (P/yr)	330	510	510	730
Shoreline recreation (hr/yr)	---	14	67	12
Inhalation (m^3/yr)	1400	3700	8000	8000

Table 7 - Animal Consumption Rates

Animal	Q_F Feed or Forage [Kg/day (wet weigh)]	Q_{AW} Water (ℓ/day)
Milk Cow	50	60
Beef Cattle	50	50
Goats	6	8

Table 8 - External Dose Factors for Standing on Contaminated Ground
(mrem/hr per pCi/m^2)

Element	Total Body	Skin
H-3	---	---
C-14	---	---
Na-24	2.50E-08	2.90E-08
P-32	---	---
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	---	---
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	---	---
Nr-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	---	---
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	---	---
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91M	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Mo-99	1.90E-09	2.20E-09
Tc-99M	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09
Ru-103	3.60E-09	4.20E-09

Table 8 - External Dose Factors for Standing on Contaminated Ground
(mrem/hr per pCi/m^2)

Element	Total Body	Skin
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110M	1.80E-08	2.10E-08
Te-125M	3.50E-11	4.80E-11
Te-127M	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129M	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131M	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
I-130	1.40E-08	1.70E-08
I-131	2.80E-09	3.40E-09
I-132	1.70E-08	2.00E-08
I-133	3.70E-09	4.50E-09
I-134	1.60E-08	1.90E-08
I-135	1.20E-08	1.40E-08
Cs-134	1.20E-08	1.40E-08
Cs-136	1.50E-08	1.70E-08
Cs-137	4.20E-09	4.90E-09
Cs-138	2.10E-08	2.40E-08
Ba-139	2.40E-09	2.70E-09
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
Ba-142	7.90E-09	9.00E-09
La-140	1.50E-08	1.70E-08
La-142	1.50E-08	1.80E-08
Ce-141	5.50E-10	6.20E-10
Ce-143	2.20E-09	2.50E-09
Ce-144	3.20E-10	3.70E-10
Pr-143	---	---
Pr-144	2.00E-10	2.30E-10
Nd-147	1.00E-09	1.20E-09
W-187	3.10E-09	3.60E-09
Np-239	9.50E-10	1.10E-09

Table 9 - Inhalation Dose Factors for Adult
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	8.98E-08	8.98E-08	8.98E-08	8.98E-08	8.98E-08	8.98E-08
C-14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
Na-24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P-32	1.65E-04	9.64E-06	6.26E-06	---	---	---	1.08E-05
Cr-51	---	---	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	---	4.95E-06	7.87E-07	---	1.23E-06	1.75E-04	9.67E-06
Mn-56	---	1.55E-10	2.29E-11	---	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	---	---	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	---	---	1.27E-04	2.35E-05
Co-58	---	1.98E-07	2.59E-07	---	---	1.16E-04	1.33E-05
Co-60	---	1.44E-06	1.85E-06	---	---	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.93E-06	1.81E-06	---	---	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	---	---	7.00E-07	1.54E-06
Cu-64	---	1.83E-10	7.69E-11	---	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	---	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	---	5.27E-12	1.15E-07	2.04E-09
Br-83	---	---	3.01E-08	---	---	---	2.90E-08
Br-84	---	---	3.91E-08	---	---	---	2.05E-13
Br-85	---	---	1.60E-09	---	---	---	---
Rb-86	---	1.69E-05	7.37E-06	---	---	---	2.08E-06
Rb-88	---	4.84E-08	2.41E-08	---	---	---	4.18E-19
Rb-89	---	3.20E-08	2.12E-08	---	---	---	1.16E-21
Sr-89	3.80E-05	---	1.09E-06	---	---	1.75E-04	4.37E-05
Sr-90	3.59E-03	---	7.21E-05	---	---	1.20E-03	9.02E-05
Sr-91	7.74E-09	---	3.13E-10	---	---	4.56E-06	2.39E-05
Sr-92	8.43E-10	---	3.64E-11	---	---	2.06E-06	5.38E-06
Y-90	2.61E-07	---	7.01E-09	---	---	2.12E-05	6.32E-05
Y-91M	3.26E-11	---	1.27E-12	---	---	2.40E-07	1.66E-10
Y-91	5.78E-05	---	1.55E-06	---	---	2.13E-04	4.81E-05
Y-92	1.29E-09	---	3.77E-11	---	---	1.96E-06	9.19E-06
Y-93	1.18E-08	---	3.26E-10	---	---	6.06E-06	5.27E-05
Zr-95	1.34E-05	4.30E-06	2.91E-06	---	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	---	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	---	9.67E-07	6.31E-05	1.30E-05
Mo-99	---	1.51E-08	2.87E-09	---	3.64E-08	1.14E-05	3.10E-05
Tc-99M	1.29E-13	3.64E-13	4.63E-12	---	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	---	1.35E-13	4.99E-08	1.36E-21

Table 9 - Inhalation Dose Factors for Adult
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.91E-07	---	8.23E-08	---	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	---	3.89E-11	---	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	---	1.09E-06	---	1.67E-05	1.17E-03	1.14E-04
Ag-110M	1.35E-06	1.25E-06	7.43E-07	---	2.46E-06	5.79E-04	3.78E-05
Te-125M	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
Te-127M	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
Te-127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
Te-129M	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
Te-129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
Te-131M	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
Te-131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
Te-132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I-130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	---	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	---	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	---	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	---	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	---	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	---	6.56E-07
Cs-134	4.66E-05	1.06E-04	9.10E-05	---	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	---	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	---	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-08	7.76E-08	4.05E-08	---	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	---	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	---	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	---	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	---	2.86E-15	1.49E-07	1.96E-26
La-140	4.30E-08	2.17E-08	5.73E-09	---	---	1.70E-05	5.73E-05
La-142	8.54E-11	3.88E-11	9.65E-12	---	---	7.91E-07	2.64E-07
Ce-141	2.49E-06	1.69E-06	1.91E-07	---	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	---	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	---	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	---	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	---	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	---	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	---	---	3.63E-06	1.94E-05
Np-239	2.87E-08	2.54E-08	1.55E-09	---	8.75E-09	4.70E-06	1.49E-05

Table 10 - Inhalation Dose Factors for Teenager
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08
C-14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.019E-07	6.09E-07	6.09E-07
Na-24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P-32	2.36E-04	1.37E-05	8.95E-06	---	---	---	1.16E-05
Cr-51	---	---	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	---	6.39E-06	1.05E-06	---	1.59E-06	2.48E-04	8.35E-06
Mn-56	---	2.12E-10	3.15E-11	---	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	---	---	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	---	---	1.91E-04	2.23E-05
Co-58	---	2.59E-07	3.47E-07	---	---	1.68E-04	1.19E-05
Co-60	---	1.89E-06	2.48E-06	---	---	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	---	---	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	---	---	1.17E-06	4.59E-06
Cu-64	---	2.54E-10	1.06E-10	---	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	---	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	---	7.53E-12	1.98E-07	3.56E-08
Br-83	---	---	4.30E-08	---	---	---	---
Br-84	---	---	5.41E-08	---	---	---	---
Br-85	---	---	2.29E-09	---	---	---	---
Rb-86	---	2.38E-05	1.05E-05	---	---	---	2.21E-06
Rb-88	---	6.82E-08	3.40E-08	---	---	---	3.65E-15
Rb-89	---	4.40E-08	2.91E-08	---	---	---	4.22E-17
Sr-89	5.43E-05	---	1.56E-06	---	---	3.02E-04	4.64E-05
Sr-90	4.14E-03	---	8.33E-05	---	---	2.06E-03	9.56E-05
Sr-91	1.10E-08	---	4.39E-10	---	---	7.59E-06	3.24E-05
Sr-92	1.19E-09	---	5.08E-11	---	---	3.43E-06	1.49E-05
Y-90	3.73E-07	---	1.00E-08	---	---	3.66E-05	6.99E-05
Y-91M	4.63E-11	---	1.77E-12	---	---	4.00E-07	3.77E-09
Y-91	8.26E-05	---	2.21E-06	---	---	3.67E-04	5.11E-05
Y-92	1.84E-09	---	5.36E-11	---	---	3.35E-06	2.06E-05
Y-93	1.69E-08	---	4.65E-10	---	---	1.04E-05	7.24E-05
Zr-95	1.82E-05	5.73E-06	3.94E-06	---	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	---	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	---	1.25E-06	9.39E-05	1.21E-05
Mo-99	---	2.11E-08	4.03E-09	---	5.14E-08	1.92E-05	3.36E-05
Tc-99M	1.73E-13	4.83E-13	6.24E-12	---	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	---	1.90E-13	8.34E-08	1.09E-16

Table 10 - Inhalation Dose Factors for Teenager
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	2.63E-07	---	1.12E-07	---	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	---	5.42E-11	---	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	---	1.55E-06	---	2.38E-05	2.01E-03	1.20E-04
Ag-110M	1.73E-06	1.64E-06	9.99E-07	---	3.13E-06	8.44E-04	3.41E-05
Te-125M	6.10E-07	2.80E-07	8.34E-08	1.75E-07	---	6.70E-05	9.38E-06
Te-127M	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
Te-127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
Te-129M	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
Te-129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
Te-131M	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
Te-131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
Te-132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	---	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	---	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	---	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	---	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	---	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	---	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	---	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	---	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	---	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	---	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	---	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	---	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	---	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	---	3.92E-15	2.39E-07	5.99E-20
La-140	5.99E-08	2.95E-08	7.82E-09	---	---	2.68E-05	6.09E-05
La-142	1.20E-10	5.31E-11	1.32E-11	---	---	1.27E-06	1.50E-06
Ce-141	3.55E-06	2.37E-06	2.71E-07	---	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	---	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	---	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	---	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	---	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	---	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	---	---	5.92E-06	2.21E-05
Np-239	4.23E-08	3.60E-08	2.21E-09	---	1.25E-08	8.11E-06	1.65E-05

Table 11 - Inhalation Dose Factors for Child
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	1.73E-07	1.73E-07	1.73E-07	1.73E-07	1.73E-07	1.73E-07
C-14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
Na-24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P-32	7.04E-04	3.09E-05	2.67E-05	---	---	---	1.14E-05
Cr-51	---	---	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	---	1.16E-05	2.57E-06	---	2.71E-06	4.26E-04	6.19E-06
Mn-56	---	4.48E-10	8.43E-11	---	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	---	---	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	---	---	3.43E-04	1.91E-05
Co-58	---	4.79E-07	8.55E-07	---	---	2.99E-04	9.29E-06
Co-60	---	3.55E-06	6.12E-06	---	---	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	---	---	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	---	---	2.21E-06	2.27E-05
Cu-64	---	5.39E-10	2.90E-10	---	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	---	1.93E-05	2.69E-04	4.41E-06
Zn-69	1.81E-11	2.61E-11	2.41E-12	---	1.58E-11	3.84E-07	2.75E-06
Br-83	---	---	1.28E-07	---	---	---	---
Br-84	---	---	1.48E-07	---	---	---	---
Br-85	---	---	6.84E-09	---	---	---	---
Rb-86	---	5.36E-05	3.09E-05	---	---	---	2.16E-06
Rb-88	---	1.52E-07	9.90E-08	---	---	---	4.66E-09
Rb-89	---	9.33E-08	7.85E-08	---	---	---	5.11E-10
Sr-89	1.62E-04	---	4.66E-06	---	---	5.83E-04	4.52E-05
Sr-90	1.04E-02	---	2.07E-04	---	---	3.99E-03	9.28E-05
Sr-91	3.28E-08	---	1.24E-09	---	---	1.44E-05	4.70E-05
Sr-92	3.54E-09	---	1.42E-10	---	---	6.49E-06	6.55E-05
Y-90	1.11E-06	---	2.99E-08	---	---	7.07E-05	7.24E-05
Y-91M	1.37E-10	---	4.98E-12	---	---	7.60E-07	4.64E-07
Y-91	2.47E-04	---	6.59E-06	---	---	7.10E-04	4.97E-05
Y-92	5.50E-09	---	1.57E-10	---	---	6.46E-06	6.46E-05
Y-93	5.04E-08	---	1.38E-09	---	---	2.01E-05	1.05E-04
Zr-95	5.13E-05	1.13E-05	1.00E-05	---	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	---	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	---	2.33E-06	1.66E-04	1.00E-05
Mo-99	---	4.66E-08	1.15E-08	---	1.06E-07	3.66E-05	3.42E-05
Tc-99M	4.81E-13	9.41E-13	1.56E-11	---	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	---	3.92E-13	1.58E-07	4.41E-09

Table 11 - Inhalation Dose Factors for Child
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	7.55E-07	---	2.90E-07	---	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	---	1.50E-10	---	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	---	4.57E-06	---	4.97E-05	3.87E-03	1.16E-04
Ag-110M	4.56E-06	3.08E-06	2.47E-06	---	5.74E-06	1.48E-03	2.71E-05
Te-125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	---	1.29E-04	9.13E-06
Te-127M	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
Te-127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129M	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
Te-129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
Te-131M	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
Te-131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
Te-132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I-130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	---	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	---	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	---	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	---	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	---	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	---	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	---	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	---	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	---	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	---	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	---	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	---	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	---	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	---	7.87E-15	4.44E-07	7.41E-10
La-140	1.74E-07	6.08E-08	2.04E-08	---	---	4.94E-05	6.10E-05
La-142	3.50E-10	1.11E-10	3.49E-11	---	---	2.35E-06	2.05E-05
Ce-141	1.06E-05	5.28E-06	7.83E-07	---	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.89E-08	5.37E-08	7.77E-09	---	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	---	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	---	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	---	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	---	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	---	---	1.11E-05	2.46E-05
Np-239	1.26E-07	8.14E-08	6.35E-09	---	2.63E-08	1.57E-05	1.73E-05

Table 12 - Inhalation Dose Factors for Infant
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	2.63E-07	2.63E-07	2.63E-07	2.63E-07	2.63E-07	2.63E-07
C-14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
Na-24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P-32	1.45E-03	8.03E-05	5.53E-05	---	---	---	1.15E-05
Cr-51	---	---	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	---	1.81E-05	3.56E-06	---	3.56E-06	7.14E-04	5.04E-06
Mn-56	---	1.10E-09	1.58E-10	---	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	---	---	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	---	---	7.25E-04	1.77E-05
Co-58	---	8.71E-07	1.30E-06	---	---	5.55E-04	7.95E-06
Co-60	---	5.73E-06	8.41E-06	---	---	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	---	---	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	---	---	5.80E-06	3.58E-05
Cu-64	---	1.34E-09	5.53E-10	---	2.84E-09	6.64E-06	1.07E-05
Zn-65	1.38E-05	4.47E-05	2.22E-05	---	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	---	2.87E-11	1.05E-06	9.44E-06
Br-83	---	---	2.72E-07	---	---	---	---
Br-84	---	---	2.86E-07	---	---	---	---
Br-85	---	---	1.46E-08	---	---	---	---
Rb-86	---	1.36E-04	6.30E-05	---	---	---	2.17E-06
Rb-88	---	3.98E-07	2.05E-07	---	---	---	2.42E-07
Rb-89	---	2.29E-07	1.47E-07	---	---	---	4.87E-08
Sr-89	2.84E-04	---	8.15E-06	---	---	1.45E-03	4.57E-05
Sr-90	1.11E-02	---	2.23E-04	---	---	8.03E-03	9.36E-05
Sr-91	6.83E-08	---	2.47E-09	---	---	3.76E-05	5.24E-05
Sr-92	7.50E-09	---	2.79E-10	---	---	1.70E-05	1.00E-04
Y-90	2.35E-06	---	6.30E-08	---	---	1.92E-04	7.43E-05
Y-91M	2.91E-10	---	9.90E-12	---	---	1.99E-06	1.68E-06
Y-91	4.20E-04	---	1.12E-05	---	---	1.75E-03	5.02E-05
Y-92	1.17E-08	---	3.29E-10	---	---	1.75E-05	9.04E-05
Y-93	1.07E-07	---	2.91E-09	---	---	5.46E-05	1.19E-04
Zr-95	8.24E-05	1.99E-05	1.45E-05	---	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	---	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	---	3.37E-06	3.42E-04	9.05E-06
Mo-99	---	1.18E-07	2.31E-08	---	1.89E-07	9.63E-05	3.48E-05
Tc-99M	9.98E-13	2.06E-12	2.66E-11	---	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-14	5.80E-13	---	6.99E-13	4.17E-07	6.03E-07

Table 12 - Inhalation Dose Factors for Infant
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.44E-06	---	4.85E-07	---	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	---	2.93E-10	---	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	---	7.77E-06	---	7.61E-05	8.26E-03	1.17E-04
Ag-110M	7.13E-06	5.16E-06	3.57E-06	---	7.80E-06	2.62E-03	2.36E-05
Te-125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	---	3.19E-04	9.22E-06
Te-127M	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
Te-127	1.59E-09	6.81E-10	3.40E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
Te-129M	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
Te-129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
Te-131M	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
Te-131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
Te-132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I-130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	---	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	---	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	---	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	---	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	---	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	---	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	---	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	---	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	---	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	---	2.93E-07	4.67E-08	6.26E-07
Ba-139	119.06E-09	7.03E-13	3.07E-11	---	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	---	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	---	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	---	1.36E-14	1.11E-06	4.95E-07
La-140	3.61E-07	1.43E-07	3.68E-08	---	---	1.20E-04	6.06E-05
La-142	7.36E-10	2.69E-10	6.46E-11	---	---	5.87E-06	4.25E-05
Ce-141	1.98E-05	1.19E-05	1.42E-06	---	3.75E-06	3.69E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	---	4.03E-08	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	---	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	---	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	---	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	---	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	---	---	2.83E-05	2.54E-05
Np-239	2.65E-07	2.13E-07	1.34E-08	---	4.73E-08	4.25E-05	1.78E-05

Table 13 - Ingestion Dose Factors for Adult
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	5.99E-08	5.99E-08	5.99E-08	5.99E-08	5.99E-08	5.99E-08
C-14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
Na-24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P-32	1.93E-04	1.20E-05	7.46E-06	---	---	---	2.17E-05
Cr-51	---	---	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	---	4.57E-06	8.72E-07	---	1.36E-06	---	1.40E-05
Mn-56	---	1.15E-07	2.04E-08	---	1.46E-07	---	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	---	---	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	---	---	2.85E-06	3.40E-05
Co-58	---	7.45E-07	1.67E-06	---	---	---	1.51E-05
Co-60	---	2.14E-06	4.72E-06	---	---	---	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	---	---	---	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	---	---	---	1.74E-06
Cu-64	---	8.33E-08	3.91E-08	---	2.10E-07	---	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	---	1.03E-05	---	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	---	1.28E-08	---	2.96E-09
Br-83	---	---	4.02E-08	---	---	---	5.79E-08
Br-84	---	---	5.21E-08	---	---	---	4.09E-13
Br-85	---	---	2.14E-09	---	---	---	---
Rb-86	---	2.11E-05	9.83E-06	---	---	---	4.16E-06
Rb-88	---	6.05E-08	3.21E-08	---	---	---	8.36E-19
Rb-89	---	4.01E-08	2.82E-08	---	---	---	2.33E-21
Sr-89	3.08E-04	---	8.84E-06	---	---	---	4.94E-05
Sr-90	8.71E-03	---	1.75E-04	---	---	---	2.19E-04
Sr-91	5.67E-06	---	2.29E-07	---	---	---	2.70E-05
Sr-92	2.15E-06	---	9.30E-08	---	---	---	4.26E-05
Y-90	9.62E-09	---	2.58E-10	---	---	---	1.02E-04
Y-91M	9.09E-11	---	3.52E-12	---	---	---	2.67E-10
Y-91	1.41E-07	---	3.77E-09	---	---	---	7.76E-05
Y-92	8.45E-10	---	2.47E-11	---	---	---	1.48E-05
Y-93	2.68E-09	---	7.40E-11	---	---	---	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	---	1.53E-08	---	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	---	5.12E-10	---	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	---	3.42E-09	---	2.10E-05
Mo-99	---	4.31E-06	8.20E-07	---	9.76E-06	---	9.99E-06
Tc-99M	2.47E-10	6.98E-10	8.89E-09	---	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	---	6.59E-09	1.87E-10	1.10E-21

Table 13 - Ingestion Dose Factors for Adult
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.85E-07	---	7.97E-08	---	7.06E-07	---	2.16E-05
Ru-105	1.54E-08	---	6.08E-09	---	1.99E-07	---	9.42E-06
Ru-106	2.75E-06	---	3.48E-07	---	5.31E-06	---	1.78E-04
Ag-110M	1.60E-07	1.48E-07	8.79E-08	---	2.91E-07	---	6.04E-05
Te-125M	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	---	1.07E-05
Te-127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	---	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	---	8.68E-06
Te-129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	---	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	---	2.37E-08
Te-131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	---	8.40E-05
Te-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	---	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	---	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	---	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	---	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	---	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	---	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	---	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	---	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	---	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	---	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	---	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	---	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	---	6.46E-11	3.92E-11	1.72E-07
Ba-140	2.03E-05	2.55E-08	1.33E-06	---	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	---	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	---	1.85E-11	1.24E-11	3.00E-26
La-140	2.50E-09	1.26E-09	3.33E-10	---	---	---	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	---	---	---	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	---	2.94E-09	---	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	---	5.37E-10	---	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	---	1.21E-07	---	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	---	2.13E-09	---	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	---	7.05E-12	---	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	---	4.25E-09	---	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	---	---	---	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	---	3.65E-10	---	2.40E-05

Table 14 - Ingestion Dose Factors for Teenager
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	--	6.04E-08	6.04E-08	6.04E-08	6.04E-08	6.04E-08	6.04E-08
C-14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
Na-24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P-32	2.76E-04	1.71E-05	1.07E-05	---	---	---	2.32E-05
Cr-51	---	---	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
Mn-54	---	5.90E-06	1.17E-06	---	1.76E-06	---	1.21E-05
Mn-56	---	1.58E-07	2.81E-08	---	2.00E-07	---	1.04E-05
Fe-55	3.78E-06	2.68E-06	6.25E-07	---	---	1.70E-06	1.16E-06
Fe-59	5.87E-06	1.37E-05	5.29E-06	---	---	4.32E-06	3.24E-05
Co-58	---	9.72E-07	2.24E-06	---	---	---	1.34E-05
Co-60	---	2.81E-06	6.33E-06	---	---	---	3.66E-05
Ni-63	1.77E-04	1.25E-05	6.00E-06	---	---	---	1.99E-06
Ni-65	7.49E-07	9.57E-08	4.36E-08	---	---	---	5.19E-06
Cu-64	---	1.15E-07	5.41E-08	---	2.91E-07	---	8.92E-06
Zn-65	5.76E-06	2.00E-05	9.33E-06	---	1.28E-05	---	8.47E-06
Zn-69	1.47E-08	2.80E-08	1.96E-09	---	1.83E-08	---	5.16E-08
Br-83	---	---	5.74E-08	---	---	---	---
Br-84	---	---	7.22E-08	---	---	---	---
Br-85	---	---	3.05E-09	---	---	---	---
Rb-86	---	2.98E-05	1.40E-05	---	---	---	4.41E-06
Rb-88	---	8.52E-08	4.54E-08	---	---	---	7.30E-15
Rb-89	---	5.50E-08	3.89E-08	---	---	---	8.43E-17
Sr-89	4.40E-04	---	1.26E-05	---	---	---	5.24E-05
Sr-90	1.02E-02	---	2.04E-04	---	---	---	2.33E-04
Sr-91	8.07E-06	---	3.21E-07	---	---	---	3.66E-05
Sr-92	3.05E-06	---	1.30E-07	---	---	---	7.77E-05
Y-90	1.37E-08	---	3.69E-10	---	---	---	1.13E-04
Y-91M	1.29E-10	---	4.93E-12	---	---	---	6.09E-09
Y-91	2.01E-07	---	5.39E-09	---	---	---	8.24E-05
Y-92	1.21E-09	---	3.50E-11	---	---	---	3.32E-05
Y-93	3.83E-09	---	1.05E-10	---	---	---	1.17E-04
Zr-95	4.12E-08	1.30E-08	8.94E-09	---	1.91E-08	---	3.00E-05
Zr-97	2.37E-09	4.69E-10	2.16E-10	---	7.11E-10	---	1.27E-04
Nb-95	8.22E-09	4.56E-09	2.51E-09	---	4.42E-09	---	1.95E-05
Mo-99	---	6.03E-06	1.15E-06	---	1.38E-05	---	1.08E-05
Tc-99M	3.32E-10	9.26E-10	1.20E-08	---	1.38E-08	5.14E-10	6.08E-07
Tc-101	3.60E-10	5.12E-10	5.03E-09	---	9.26E-09	3.12E-10	8.75E-17

Table 14 - Ingestion Dose Factors for Teenager
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	2.55E-07	---	1.09E-07	---	8.99E-07	---	2.13E-05
Ru-105	2.18E-08	---	8.46E-09	---	2.75E-07	---	1.76E-05
Ru-106	3.92E-06	---	4.94E-07	---	7.56E-06	---	1.88E-04
Ag-110M	2.05E-07	1.94E-07	1.18E-07	---	3.70E-07	---	5.45E-05
Te-125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	---	---	1.13E-05
Te-127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	---	2.41E-05
Te-127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	---	1.22E-05
Te-129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	---	6.12E-05
Te-129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	---	2.45E-07
Te-131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	---	9.39E-05
Te-131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	---	2.29E-09
Te-132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	---	7.00E-05
I-130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	---	2.29E-06
I-131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	---	1.62E-06
I-132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	---	3.18E-07
I-133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	---	2.58E-06
I-134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	---	5.10E-09
I-135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	---	1.74E-06
Cs-134	8.37E-05	1.97E-04	9.14E-05	---	6.26E-05	2.39E-05	2.45E-06
Cs-136	8.59E-06	3.38E-05	2.27E-05	---	1.84E-05	2.90E-06	2.72E-06
Cs-137	1.12E-04	1.49E-04	5.19E-05	---	5.07E-05	1.97E-05	2.12E-06
Cs-138	7.76E-08	1.49E-07	7.45E-08	---	1.10E-07	1.28E-08	4.76E-11
Ba-139	1.39E-07	9.78E-11	4.05E-09	---	9.22E-11	6.74E-11	1.24E-06
Ba-140	2.84E-05	3.48E-08	1.83E-06	---	1.18E-08	2.34E-08	4.38E-05
Ba-141	6.71E-08	5.01E-11	2.24E-09	---	4.65E-11	3.43E-11	1.43E-13
Ba-142	2.99E-08	2.99E-11	1.84E-09	---	2.53E-11	1.99E-11	9.18E-20
La-140	3.48E-09	1.71E-09	4.55E-10	---	---	---	9.28E-05
La-142	1.79E-10	7.95E-11	1.98E-11	---	---	---	2.42E-06
Ce-141	1.33E-08	8.88E-09	1.02E-09	---	4.18E-09	---	2.54E-05
Ce-143	2.35E-09	1.71E-06	1.91E-10	---	7.67E-10	---	5.14E-05
Ce-144	6.96E-07	2.88E-07	3.74E-08	---	1.72E-07	---	1.75E-04
Pr-143	1.31E-08	5.23E-09	6.52E-10	---	3.04E-09	---	4.31E-05
Pr-144	4.30E-11	1.76E-11	2.18E-12	---	1.01E-11	---	4.74E-14
Nd-147	9.38E-09	1.02E-08	6.11E-10	---	5.99E-09	---	3.68E-05
W-187	1.46E-07	1.19E-07	4.17E-08	---	---	---	3.22E-05
Np-239	1.76E-09	1.66E-10	9.22E-11	---	5.21E-10	---	2.67E-05

Table 15 - Ingestion Dose Factors for Child
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	1.16E-07	1.16E-07	1.16E-07	1.16E-07	1.16E-07	1.16E-07
C-14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
Na-24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P-32	8.25E-04	3.86E-05	3.18E-05	---	---	---	2.28E-05
Cr-51	---	---	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
Mn-54	---	1.07E-05	2.85E-06	---	3.00E-06	---	8.98E-06
Mn-56	---	3.34E-07	7.54E-08	---	4.04E-07	---	4.84E-05
Fe-55	1.15E-05	6.10E-06	1.89E-06	---	---	3.45E-06	1.13E-06
Fe-59	1.65E-05	2.67E-05	1.33E-05	---	---	7.74E-06	2.78E-05
Co-58	---	1.80E-06	5.51E-06	---	---	---	1.05E-05
Co-60	---	5.29E-06	1.56E-05	---	---	---	2.93E-05
Ni-63	5.38E-04	2.88E-05	1.83E-05	---	---	---	1.94E-06
Ni-65	2.22E-06	2.09E-07	1.22E-07	---	---	---	2.56E-05
Cu-64	---	2.45E-07	1.48E-07	---	5.92E-07	---	1.15E-05
Zn-65	1.37E-05	3.65E-05	2.27E-05	---	2.30E-05	---	6.41E-06
Zn-69	4.38E-08	6.33E-08	5.85E-09	---	3.84E-08	---	3.99E-06
Br-83	---	---	1.71E-07	---	---	---	---
Br-84	---	---	1.98E-07	---	---	---	---
Br-85	---	---	9.12E-09	---	---	---	---
Rb-86	---	6.70E-05	4.12E-05	---	---	---	4.31E-06
Rb-88	---	1.90E-07	1.32E-07	---	---	---	9.32E-09
Rb-89	---	1.17E-07	1.04E-07	---	---	---	1.02E-09
Sr-89	1.32E-03	---	3.77E-05	---	---	---	5.11E-05
Sr-90	2.56E-02	---	5.15E-04	---	---	---	2.29E-04
Sr-91	2.40E-05	---	9.06E-07	---	---	---	5.30E-05
Sr-92	9.03E-06	---	3.62E-07	---	---	---	1.71E-04
Y-90	4.11E-08	---	1.10E-09	---	---	---	1.17E-04
Y-91M	3.82E-10	---	1.39E-11	---	---	---	7.48E-07
Y-91	6.02E-07	---	1.61E-08	---	---	---	8.02E-05
Y-92	3.60E-09	---	1.03E-10	---	---	---	1.04E-04
Y-93	1.14E-08	---	3.13E-10	---	---	---	1.70E-04
Zr-95	1.16E-07	2.55E-08	2.27E-08	---	3.65E-08	---	2.66E-05
Zr-97	6.99E-09	1.01E-09	5.96E-10	---	1.45E-09	---	1.53E-04
Nb-95	2.25E-08	8.76E-09	6.26E-09	---	8.23E-09	---	1.62E-05
Mo-99	---	1.33E-05	3.29E-06	---	2.84E-05	---	1.10E-05
Tc-99M	9.23E-10	1.81E-09	3.00E-08	---	2.63E-08	9.19E-10	1.03E-06
Tc-101	1.07E-09	1.12E-09	1.42E-08	---	1.91E-08	5.92E-10	3.56E-09

Table 15 - Ingestion Dose Factors for Child
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	7.31E-07	---	2.81E-07	---	1.84E-06	---	1.89E-05
Ru-105	6.45E-08	---	2.34E-08	---	5.67E-07	---	4.21E-05
Ru-106	1.17E-05	---	1.46E-06	---	1.58E-05	---	1.82E-04
Ag-110M	5.39E-07	3.64E-07	2.91E-07	---	6.78E-07	---	4.33E-05
Te-125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	---	---	1.10E-05
Te-127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	---	2.34E-05
Te-127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	---	1.84E-05
Te-129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	---	5.94E-05
Te-129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	---	8.34E-06
Te-131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	---	1.01E-04
Te-131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	---	4.36E-07
Te-132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	---	4.50E-05
I-130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	---	2.76E-06
I-131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	---	1.54E-06
I-132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	---	1.73E-06
I-133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	---	2.95E-06
I-134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	---	5.16E-07
I-135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	---	2.40E-06
Cs-134	2.34E-04	3.84E-04	8.10E-05	---	1.19E-04	4.27E-05	2.07E-06
Cs-136	2.35E-05	6.46E-05	4.18E-05	---	3.44E-05	5.13E-06	2.27E-06
Cs-137	3.27E-04	3.13E-04	4.62E-05	---	1.02E-04	3.67E-05	1.96E-06
Cs-138	2.28E-07	3.17E-07	2.01E-07	---	2.23E-07	2.40E-08	1.46E-07
Ba-139	4.14E-07	2.21E-10	1.20E-08	---	1.93E-10	1.30E-10	2.39E-05
Ba-140	8.31E-05	7.28E-08	4.85E-06	---	2.37E-08	4.34E-08	4.21E-05
Ba-141	2.00E-07	1.12E-10	6.51E-09	---	9.69E-11	6.58E-10	1.14E-07
Ba-142	8.74E-08	6.29E-11	4.88E-09	---	5.09E-11	3.70E-11	1.14E-09
La-140	1.01E-08	3.53E-09	1.19E-09	---	---	---	9.84E-05
La-142	5.24E-10	1.67E-10	5.23E-11	---	---	---	3.31E-05
Ce-141	3.97E-08	1.98E-08	2.94E-09	---	8.68E-09	---	2.47E-05
Ce-143	6.99E-09	3.79E-06	5.49E-10	---	1.59E-09	---	5.55E-05
Ce-144	2.08E-06	6.52E-07	1.11E-07	---	3.61E-07	---	1.70E-04
Pr-143	3.93E-08	1.18E-08	1.95E-09	---	6.39E-09	---	4.24E-05
Pr-144	1.29E-10	3.99E-11	6.49E-12	---	2.11E-11	---	8.59E-08
Nd-147	2.79E-08	2.26E-08	1.75E-09	---	1.24E-08	---	3.58E-05
W-187	4.29E-07	2.54E-07	1.14E-07	---	---	---	3.57E-05
Np-239	5.25E-09	3.77E-10	2.65E-10	---	1.09E-09	---	2.79E-05

Table 16 - Ingestion Dose Factors for Infant
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	1.76E-07	1.76E-07	1.76E-07	1.76E-07	1.76E-07	1.76E-07
C-14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
Na-24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P-32	1.70E-03	1.00E-04	6.59E-05	---	---	---	2.30E-05
Cr-51	---	---	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
Mn-54	---	1.99E-05	4.51E-06	---	4.41E-06	---	7.31E-06
Mn-56	---	8.18E-07	1.41E-07	---	7.03E-07	---	7.43E-05
Fe-55	1.39E-05	8.98E-06	2.40E-06	---	---	4.36E-06	1.14E-06
Fe-59	3.08E-05	5.38E-05	2.12E-05	---	---	1.59E-05	2.57E-05
Co-58	---	3.60E-06	8.98E-06	---	---	---	8.97E-06
Co-60	---	1.08E-05	2.55E-05	---	---	---	2.57E-05
Ni-63	6.34E-04	3.92E-05	2.20E-05	---	---	---	1.95E-06
Ni-65	4.70E-06	5.32E-07	2.42E-07	---	---	---	4.05E-05
Cu-64	---	6.09E-07	2.82E-07	---	1.03E-06	---	1.25E-05
Zn-65	1.84E-05	6.31E-05	2.91E-05	---	3.06E-05	---	5.33E-05
Zn-69	9.33E-08	1.68E-07	1.25E-08	---	6.98E-08	---	1.37E-05
Br-83	---	---	3.63E-07	---	---	---	---
Br-84	---	---	3.82E-07	---	---	---	---
Br-85	---	---	1.94E-08	---	---	---	---
Rb-86	---	1.70E-04	8.40E-05	---	---	---	4.35E-06
Rb-88	---	4.98E-07	2.73E-07	---	---	---	4.85E-07
Rb-89	---	2.86E-07	1.97E-07	---	---	---	9.74E-08
Sr-89	2.51E-03	---	7.20E-05	---	---	---	5.16E-05
Sr-90	2.83E-02	---	5.74E-04	---	---	---	2.31E-04
Sr-91	5.00E-05	---	1.81E-06	---	---	---	5.92E-05
Sr-92	1.92E-05	---	7.13E-07	---	---	---	2.07E-04
Y-90	8.69E-08	---	2.33E-09	---	---	---	1.20E-04
Y-91M	8.10E-10	---	2.76E-11	---	---	---	2.70E-06
Y-91	1.13E-06	---	3.01E-08	---	---	---	8.10E-05
Y-92	7.65E-09	---	2.15E-10	---	---	---	1.46E-04
Y-93	2.43E-08	---	6.62E-10	---	---	---	1.92E-04
Zr-95	2.06E-07	5.02E-08	3.56E-08	---	5.41E-08	---	2.50E-05
Zr-97	1.48E-08	2.54E-09	1.16E-09	---	2.56E-09	---	1.62E-04
Nb-95	4.20E-08	1.73E-08	1.00E-08	---	1.24E-08	---	1.46E-05
Mo-99	---	3.40E-05	6.63E-06	---	5.08E-05	---	1.12E-05
Tc-99M	1.92E-09	3.96E-09	5.10E-08	---	4.26E-08	2.07E-09	1.15E-06
Tc-101	2.27E-09	2.86E-09	2.83E-08	---	3.40E-08	1.56E-09	4.86E-07

Table 16 - Ingestion Dose Factors for Infant
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.48E-06	---	4.95E-07	---	3.08E-06	---	1.80E-05
Ru-105	1.36E-07	---	4.58E-08	---	1.00E-06	---	5.41E-05
Ru-106	2.41E-05	---	3.01E-06	---	2.85E-05	---	1.83E-04
Ag-110M	9.96E-07	7.27E-07	4.81E-07	---	1.04E-06	---	3.77E-05
Te-125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	---	---	1.11E-05
Te-127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	---	2.36E-05
Te-127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	---	2.10E-05
Te-129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	---	5.97E-05
Te-129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	---	2.27E-05
Te-131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	---	1.03E-04
Te-131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	---	7.11E-06
Te-132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	---	3.81E-05
I-130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	---	2.83E-06
I-131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	---	1.51E-06
I-132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	---	2.73E-06
I-133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	---	3.08E-06
I-134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	---	1.84E-06
I-135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	---	2.62E-06
Cs-134	3.77E-04	7.03E-04	7.10E-05	---	1.81E-04	7.42E-05	1.91E-06
Cs-136	4.59E-05	1.35E-04	5.04E-05	---	5.38E-05	1.10E-05	2.05E-06
Cs-137	5.22E-04	6.11E-04	4.33E-05	---	1.64E-04	6.64E-05	1.91E-06
Cs-138	4.81E-07	7.82E-07	3.79E-07	---	3.90E-07	6.09E-08	1.25E-06
Ba-139	8.81E-07	5.84E-10	2.55E-08	---	3.51E-10	3.54E-10	5.58E-05
Ba-140	1.71E-04	1.71E-07	8.81E-06	---	4.06E-08	1.05E-07	4.20E-05
Ba-141	4.25E-07	2.91E-10	1.34E-08	---	1.75E-10	1.77E-10	5.19E-06
Ba-142	1.84E-07	1.53E-10	9.06E-09	---	8.81E-11	9.26E-11	7.59E-07
La-140	2.11E-08	8.32E-09	2.14E-09	---	---	---	9.77E-05
La-142	1.10E-09	4.04E-10	9.67E-11	---	---	---	6.86E-05
Ce-141	7.87E-08	4.80E-08	5.65E-09	---	1.48E-08	---	2.48E-05
Ce-143	1.48E-08	9.82E-06	1.12E-09	---	2.86E-09	---	5.73E-05
Ce-144	2.98E-06	1.22E-06	1.67E-07	---	4.93E-07	---	1.71E-04
Pr-143	8.13E-08	3.04E-08	4.03E-09	---	1.13E-08	---	4.29E-05
Pr-144	2.74E-10	1.06E-10	1.38E-11	---	3.84E-11	---	4.93E-06
Nd-147	5.53E-08	5.68E-08	3.48E-09	---	2.19E-08	---	3.60E-05
W-187	9.03E-07	6.28E-07	2.17E-07	---	---	---	3.69E-05
Np-239	1.11E-08	9.93E-10	5.61E-10	---	1.98E-09	---	2.87E-05

Table 17 - Recommended Values for Other Parameters

Parameter Symbol	Definition	Values
f_g	Fraction of ingested produce grown in garden of interest.	0.76
f_P	Fraction of leafy vegetables grown in garden of interest.	1.0
P	Effective surface density of soil (assumes a 15 cm plow layer, expressed in dry weight)	240 kg/m^2
r	Fraction of deposited activity retained on crops, leafy vegetables, or pasture grass	0.25 1.0 (iodines) 0.2 (other particulates)
S_f	Attenuation factor accounting for shielding provided by residential structures	0.7 (maximum individual) 0.5 (general population)
t_b	Period of long-term buildup for activity in sediment or soil (20 years)	1.752E5 hr
t_e	Period of crop, leafy vegetable, or pasture grass exposure during growing season	30 days (grass-cow-milk-man pathway) 60 days (crop/vegetation-man pathway)
f	Transport time from animal feed-milk-man provided by residential structures	2 days (maximum individual) 4 days (general population)
t_h	Time delay between harvest of vegetation or crops and ingestion:	
	• For ingestion of forage by animals	Zero (pasture grass) 90 days (stored feed)
	• For ingestion of crops by man	1 day (leafy vegetables and max. individual feed) 60 days (produce and max. individual) 14 days (general population)
f_s	The fraction of daily feed that is pasture grass while the animals graze on pasture.	1.0
M_p	The mixing ratio at the point of withdrawal of drinking water.	Site Discharge 7.14 M.U.D. Intake 30.8
f_p	Fraction of the year that animals graze on pasture.	0.5

Table 17 - Recommended Values for Other Parameters

Parameter Symbol	Definition	Values
t_p	Environmental transit time, release to receptor (add time from release to exposure individual point to minimums shown for distribution)	12 hrs. (maximum) 1 day (maximum individual) 1 day (general population) 7 days (population--sport fish doses) 10 days (population--commercial fish doses)
t_s	Average time from slaughter of meat animal to consumption	20 days
Y_v	Agricultural productivity by unit area (measured in wet weight)	0.7 kg/m^2 (grass-cow-milk-man pathway) 2.0 kg/m^2 (produce or leafy vegetable ingested by man)
W	Shore-width factor for river shoreline	0.2
λ_w	Rate constant for removal of activity on plant or leaf structures by weathering (corresponds to a 14-day half-life)	0.0021 hr^{-1}
$\%CO_2$	Fraction of C-14 used for organ dose calculations from gaseous releases.	0.15

Table 18 - Estimated Doses Received by the General Public from On-Site Exposure

NOTE

The Dose Estimates are based on normal public activities conducted within the Fort Calhoun Station Site Boundary.

Location	Direction	Distance from Containment (miles)	Estimated Individual Dose Rate (mR/hour)		Estimated Total Combined Annual Dose (mRem)[B]	
			Direct Exposure (Total Body)	Inhalation (Critical Organ[A])	Direct Exposure (Total Body)	Inhalation (Critical Organ[A])
Firing Range	200°	0.24	4.08E-05	9.67E-06	5.08E+00	1.20E+00
Burn Pad	241°	0.33	1.95E-05	4.63E-06	1.41E-01	3.34E-02
On-Site Farming	118°	0.52	2.12E-05	5.03E-06	2.38E-02	5.64E-03
On-Site Farming	200°	0.51	1.03E-05	2.45E-06	2.30E-02	5.50E-03
On-Site Farming	308°	0.50	2.77E-05	6.64E-06	4.66E-02	1.12E-02
Site Maintenance Admin Bldg	145°	0.20	1.18E-04	2.84E-05	5.50E-02	1.33E-02
Site Maintenance Training Center	180°	0.20	1.45E-04	3.50E-05	6.78E-02	1.64E-02

A. Critical organ doses are based on adult thyroid.
B. Estimated totals are based on summation of all individual doses for members of the General Public while within the Fort Calhoun Station site boundary.

Process Control Program (PCP) for Radioactive Wastes

RW-AA-100, Process Control Program for Radioactive Wastes, revision 11, was implemented on July 16, 2015. This procedure replaced the previous Process Control Program, as contained in RW-AD-300, Process Control Program. RW-AA-100 implemented the Fleet procedural guidance for the Fort Calhoun Station Process Control Program.

SECTION VII

ATTACHMENT 2

JOINT FREQUENCY DISTRIBUTION WIND DIRECTION VS. WIND SPEED
BY STABILITY CLASS AND METEOROLOGICAL DATA

(Regulatory Guide 1.21)

January 1, 2015 - December 31, 2015

JOINT FREQUENCY DISTRIBUTION WIND DIRECTION VS. WIND SPEED BY STABILITY CLASS AND METEOROLOGICAL DATA

A. Meteorological Data Recovery

Data availability from the on-site weather tower for the period January 1, 2015 through December 31, 2015 had a cumulative recovery rate of 99.90% from the meteorological tower with the remaining 0.1% provided by Eppley Airfield Weather Station, a branch of the National Weather Service. The data provided by Eppley Airfield Weather Station. The following table is a summary of the parameters and their respective recovery rates for the period.

The tabulations of the Weather Tower Data for the period January 1, 2015 through December 31, 2015 look appropriate for the season indicated. The Pasquill Classes observed for the twelve-month period are detailed below.

Pasquill Class	A	B	C	D	E	F	G	Total
% Obs.	11.51	5.25	5.88	32.32	30.82	10.30	3.93	100

On the basis of the data and its cross-checks, the weather data as amended is completely valid for use in tabulating atmospheric releases.

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
EXTREMELY UNSTABLE (delta T/ delta z <= -1.9)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL A
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0	2	4	11	17	17	9	4	4	0	0	68
NNE	0	3	8	4	8	11	2	0	0	0	0	36
NE	0	4	5	1	3	6	4	1	0	0	0	24
ENE	0	0	4	1	7	11	2	0	0	0	0	25
E	0	0	5	1	11	14	5	0	0	0	0	36
ESE	0	0	2	7	9	32	6	1	0	0	0	57
SE	0	1	3	5	12	11	14	7	4	0	0	57
SSE	0	0	1	2	9	21	23	19	18	2	0	95
S	0	0	1	3	6	34	19	13	20	3	2	101
SSW	0	0	1	2	10	22	13	9	10	0	0	67
SW	0	0	2	3	11	10	19	7	2	1	0	55
WSW	0	1	3	2	7	0	1	1	3	0	0	18
W	0	1	2	10	15	3	2	1	0	0	0	34
WNW	0	0	1	8	17	10	8	0	0	0	0	44
NW	0	4	1	3	12	14	18	18	14	1	1	86
NNW	0	0	3	9	36	46	45	44	22	0	0	205
Total	0	16	46	72	190	262	190	125	97	7	3	1008

Number of Calms 0
Number of Invalid Hours 0
Number of Valid Hours 1008

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
MODERATELY UNSTABLE (-1.9 < delta T/ delta z <= -1.7)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL B
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0	2	2	4	13	5	2	3	1	0	0	32
NNE	0	2	2	3	6	0	3	0	0	0	0	16
NE	0	0	2	3	2	3	1	0	0	0	0	11
ENE	0	1	1	3	3	2	1	1	0	0	0	12
E	0	0	1	4	7	2	1	0	0	0	0	15
ESE	0	0	1	1	10	6	3	1	0	0	0	22
SE	0	0	0	0	3	5	10	6	1	1	0	26
SSE	0	1	0	0	2	11	16	4	8	0	0	42
S	0	0	1	0	11	12	15	9	6	4	0	58
SSW	0	1	1	2	3	6	7	5	8	2	0	35
SW	0	0	1	2	7	5	3	1	3	0	0	22
WSW	0	0	2	3	7	2	0	0	0	1	0	15
W	0	0	1	5	3	1	2	0	2	0	0	14
WNW	0	1	1	2	9	4	2	0	0	0	0	19
NW	0	1	2	0	6	7	9	1	5	0	0	33
NNW	0	0	7	5	27	25	9	8	5	2	0	88
Total	0	9	25	37	119	96	84	39	39	10	0	458

Number of Calms 2
Number of Invalid Hours 0
Number of Valid Hours 460

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
SLIGHTLY UNSTABLE (-1.7 < delta T/ delta z <= -1.5)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL C
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0	1	3	13	17	11	7	2	1	0	0	55
NNE	0	1	9	5	5	0	2	0	0	0	0	22
NE	0	1	4	2	4	2	0	0	0	0	0	13
ENE	0	0	4	2	4	1	1	0	0	0	0	12
E	0	0	1	1	6	0	3	0	1	0	0	12
ESE	0	0	0	2	6	8	6	2	2	0	0	26
SE	0	0	3	4	9	11	8	4	0	0	0	39
SSE	0	0	1	0	7	15	8	9	4	0	0	44
S	0	0	1	4	7	13	8	3	2	1	1	40
SSW	0	0	0	6	7	7	5	6	8	1	1	41
SW	0	1	2	2	6	7	5	1	4	3	1	32
WSW	0	0	0	2	4	4	2	1	0	0	0	13
W	0	0	0	1	4	1	0	0	3	0	0	9
WNW	0	0	1	1	7	2	4	2	0	0	0	17
NW	0	1	2	2	10	8	7	6	3	1	0	41
NNW	0	0	3	10	24	33	12	11	6	0	0	99
Total	0	5	34	57	127	123	78	47	34	6	3	514

Number of Calms 1
Number of Invalid Hours 0
Number of Valid Hours 515

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
NEUTRAL (-1.5 < delta T/ delta z <= -0.5)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL D
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	1	19	29	41	82	32	13	7	2	0	0	226
NNE	0	16	26	13	12	10	2	0	1	0	0	80
NE	1	8	28	15	15	12	3	0	0	0	0	82
ENE	0	4	34	16	30	8	1	0	0	0	0	93
E	0	5	19	20	49	20	6	0	0	0	0	119
ESE	0	5	13	29	50	31	16	8	8	1	0	161
SE	0	3	16	26	62	57	49	19	8	1	0	241
SSE	2	7	8	19	69	71	71	55	48	5	1	356
S	0	5	6	12	30	36	56	47	45	14	0	251
SSW	0	4	9	13	22	19	25	23	14	6	2	137
SW	0	3	7	6	20	15	19	10	15	1	2	98
WSW	0	4	5	12	18	12	11	4	2	0	0	68
W	0	5	9	10	19	13	11	5	10	5	0	87
WNW	0	8	17	11	15	23	22	10	3	1	0	110
NW	1	10	12	16	21	42	52	31	30	13	2	230
NNW	1	9	35	43	134	121	75	44	26	3	1	492
Total	6	115	273	302	648	522	432	263	212	50	8	2831

Number of Calms 0
Number of Invalid Hours 0
Number of Valid Hours 2831

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
SLIGHTLY STABLE (-0.5 < delta T/ delta z <= 1.5)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL E
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	2	18	16	18	9	4	0	2	0	0	0	69
NNE	3	21	8	5	4	1	1	0	1	0	0	44
NE	3	19	13	11	9	0	0	0	0	0	0	55
ENE	2	19	19	8	11	0	1	0	0	0	0	60
E	3	12	24	15	26	5	0	0	1	0	0	86
ESE	4	18	46	37	44	18	3	3	0	0	0	173
SE	3	19	46	64	107	74	39	9	4	0	0	365
SSE	5	15	19	27	95	115	98	44	38	3	0	459
S	5	9	11	13	44	51	66	40	29	3	0	271
SSW	3	16	4	4	19	18	33	19	41	8	2	167
SW	15	13	3	4	9	12	10	13	25	6	1	111
WSW	5	12	8	3	14	19	9	3	5	1	0	79
W	3	14	15	19	39	29	8	5	2	0	0	134
WNW	8	35	24	29	71	35	9	2	1	0	0	214
NW	5	32	25	35	49	28	6	0	3	0	0	183
NNW	6	28	43	42	68	34	3	6	0	0	0	230
Total	75	300	324	334	618	443	286	146	150	21	3	2700

Number of Calms 0
Number of Invalid Hours 0
Number of Valid Hours 2700

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
MODERATELY STABLE (1.5 < delta T/ delta z <= 4.0)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL F
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	2	3	1	0	0	0	1	0	0	0	0	7
NNE	1	4	2	1	0	0	0	0	0	0	0	8
NE	6	1	1	0	0	0	0	0	0	0	0	8
ENE	4	8	3	3	0	0	0	0	0	0	0	18
E	6	23	7	7	11	1	0	0	0	0	0	55
ESE	1	11	20	12	9	7	0	0	0	0	0	60
SE	3	19	29	25	42	17	3	0	0	0	0	138
SSE	11	21	10	11	27	8	2	0	0	0	0	90
S	11	15	4	7	19	20	9	2	1	0	0	88
SSW	11	23	10	3	11	17	14	1	1	0	0	91
SW	14	24	2	2	9	7	9	4	2	0	0	73
WSW	13	30	3	2	2	6	4	0	0	0	0	60
W	16	35	13	3	6	3	0	0	0	0	0	76
WNW	11	27	20	13	12	4	1	0	0	0	0	88
NW	3	13	10	3	6	1	0	0	0	0	0	36
NNW	2	4	0	0	0	0	0	0	0	0	0	6
Total	115	261	135	92	154	91	43	7	4	0	0	902

Number of Calms 0
Number of Invalid Hours 0
Number of Valid Hours 902

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
EXTREMELY STABLE (delta T/ delta z > 4.0)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL G
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	1	3	0	0	0	0	0	0	0	0	0	4
NNE	2	1	1	0	0	0	0	0	0	0	0	4
NE	2	6	1	0	0	0	0	0	0	0	0	9
ENE	3	12	1	2	0	0	0	0	0	0	0	18
E	3	11	1	2	1	0	0	0	0	0	0	18
ESE	3	18	11	4	4	3	0	0	0	0	0	43
SE	8	23	6	8	9	1	1	0	0	0	0	56
SSE	3	14	6	1	1	0	0	0	0	0	0	25
S	3	18	5	2	4	0	0	0	0	0	0	32
SSW	4	17	2	1	0	2	0	0	0	0	0	26
SW	6	20	3	1	3	0	1	1	0	0	0	35
WSW	7	17	1	0	1	0	0	0	0	0	0	26
W	5	10	5	1	0	0	0	0	0	0	0	21
WNW	4	8	6	2	0	0	0	0	0	0	0	20
NW	0	5	0	0	0	0	0	0	0	0	0	5
NNW	0	1	0	0	0	1	0	0	0	0	0	2
Total	54	184	49	24	23	7	2	1	0	0	0	344

Number of Calms 0
Number of Invalid Hours 0
Number of Valid Hours 344

Hours Accounted For: 8760

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
EXTREMELY UNSTABLE (delta T/ delta z <= -1.9)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL A
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.00	0.02	0.05	0.13	0.19	0.19	0.10	0.05	0.05	0.00	0.00	0.78
NNE	0.00	0.03	0.09	0.05	0.09	0.13	0.02	0.00	0.00	0.00	0.00	0.41
NE	0.00	0.05	0.06	0.01	0.03	0.07	0.05	0.01	0.00	0.00	0.00	0.27
ENE	0.00	0.00	0.05	0.01	0.08	0.13	0.02	0.00	0.00	0.00	0.00	0.29
E	0.00	0.00	0.06	0.01	0.13	0.16	0.06	0.00	0.00	0.00	0.00	0.41
ESE	0.00	0.00	0.02	0.08	0.10	0.37	0.07	0.01	0.00	0.00	0.00	0.65
SE	0.00	0.01	0.03	0.06	0.14	0.13	0.16	0.08	0.05	0.00	0.00	0.65
SSE	0.00	0.00	0.01	0.02	0.10	0.24	0.26	0.22	0.21	0.02	0.00	1.08
S	0.00	0.00	0.01	0.03	0.07	0.39	0.22	0.15	0.23	0.03	0.02	1.15
SSW	0.00	0.00	0.01	0.02	0.11	0.25	0.15	0.10	0.11	0.00	0.00	0.76
SW	0.00	0.00	0.02	0.03	0.13	0.11	0.22	0.08	0.02	0.01	0.00	0.63
WSW	0.00	0.01	0.03	0.02	0.08	0.00	0.01	0.01	0.03	0.00	0.00	0.21
W	0.00	0.01	0.02	0.11	0.17	0.03	0.02	0.01	0.00	0.00	0.00	0.39
WNW	0.00	0.00	0.01	0.09	0.19	0.11	0.09	0.00	0.00	0.00	0.00	0.50
NW	0.00	0.05	0.01	0.03	0.14	0.16	0.21	0.21	0.16	0.01	0.01	0.98
NNW	0.00	0.00	0.03	0.10	0.41	0.53	0.51	0.50	0.25	0.00	0.00	2.34
Total	0.00	0.18	0.53	0.82	2.17	2.99	2.17	1.43	1.11	0.08	0.03	11.51

Percent of Calms 0.00
Percent of Invalid Hours 0.00
Percent of Valid Hours 11.51

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
MODERATELY UNSTABLE (-1.9 < delta T/ delta z <= -1.7)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL B
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.00	0.02	0.02	0.05	0.15	0.06	0.02	0.03	0.01	0.00	0.00	0.37
NNE	0.00	0.02	0.02	0.03	0.07	0.00	0.03	0.00	0.00	0.00	0.00	0.18
NE	0.00	0.00	0.02	0.03	0.02	0.03	0.01	0.00	0.00	0.00	0.00	0.13
ENE	0.00	0.01	0.01	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.14
E	0.00	0.00	0.01	0.05	0.08	0.02	0.01	0.00	0.00	0.00	0.00	0.17
ESE	0.00	0.00	0.01	0.01	0.11	0.07	0.03	0.01	0.00	0.00	0.00	0.25
SE	0.00	0.00	0.00	0.00	0.03	0.06	0.11	0.07	0.01	0.01	0.00	0.30
SSE	0.00	0.01	0.00	0.00	0.02	0.13	0.18	0.05	0.09	0.00	0.00	0.48
S	0.00	0.00	0.01	0.00	0.13	0.14	0.17	0.10	0.07	0.05	0.00	0.66
SSW	0.00	0.01	0.01	0.02	0.03	0.07	0.08	0.06	0.09	0.02	0.00	0.40
SW	0.00	0.00	0.01	0.02	0.08	0.06	0.03	0.01	0.03	0.00	0.00	0.25
WSW	0.00	0.00	0.02	0.03	0.08	0.02	0.00	0.00	0.00	0.01	0.00	0.17
W	0.00	0.00	0.01	0.06	0.03	0.01	0.02	0.00	0.02	0.00	0.00	0.16
WNW	0.00	0.01	0.01	0.02	0.10	0.05	0.02	0.00	0.00	0.00	0.00	0.22
NW	0.00	0.01	0.02	0.00	0.07	0.08	0.10	0.01	0.06	0.00	0.00	0.38
NNW	0.00	0.00	0.08	0.06	0.31	0.29	0.10	0.09	0.06	0.02	0.00	1.00
Total	0.00	0.10	0.29	0.42	1.36	1.10	0.96	0.45	0.45	0.11	0.00	5.23

Percent of Calms 0.02
Percent of Invalid Hours 0.00
Percent of Valid Hours 5.25

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
SLIGHTLY UNSTABLE (-1.7 < delta T/ delta z <= -1.5)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL C
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5- 1.0	1.1- 1.5	1.6- 2.0	2.1- 3.0	3.1- 4.0	4.1- 5.0	5.1- 6.0	6.1- 8.0	8.1- 10.0	> 10.0	Total
N	0.00	0.01	0.03	0.15	0.19	0.13	0.08	0.02	0.01	0.00	0.00	0.63
NNE	0.00	0.01	0.10	0.06	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.25
NE	0.00	0.01	0.05	0.02	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.15
ENE	0.00	0.00	0.05	0.02	0.05	0.01	0.01	0.00	0.00	0.00	0.00	0.14
E	0.00	0.00	0.01	0.01	0.07	0.00	0.03	0.00	0.01	0.00	0.00	0.14
ESE	0.00	0.00	0.00	0.02	0.07	0.09	0.07	0.02	0.02	0.00	0.00	0.30
SE	0.00	0.00	0.03	0.05	0.10	0.13	0.09	0.05	0.00	0.00	0.00	0.45
SSE	0.00	0.00	0.01	0.00	0.08	0.17	0.09	0.10	0.05	0.00	0.00	0.50
S	0.00	0.00	0.01	0.05	0.08	0.15	0.09	0.03	0.02	0.01	0.01	0.46
SSW	0.00	0.00	0.00	0.07	0.08	0.08	0.06	0.07	0.09	0.01	0.01	0.47
SW	0.00	0.01	0.02	0.02	0.07	0.08	0.06	0.01	0.05	0.03	0.01	0.37
WSW	0.00	0.00	0.00	0.02	0.05	0.05	0.02	0.01	0.00	0.00	0.00	0.15
W	0.00	0.00	0.00	0.01	0.05	0.01	0.00	0.00	0.03	0.00	0.00	0.10
WNW	0.00	0.00	0.01	0.01	0.08	0.02	0.05	0.02	0.00	0.00	0.00	0.19
NW	0.00	0.01	0.02	0.02	0.11	0.09	0.08	0.07	0.03	0.01	0.00	0.47
NNW	0.00	0.00	0.03	0.11	0.27	0.38	0.14	0.13	0.07	0.00	0.00	1.13
Total	0.00	0.06	0.39	0.65	1.45	1.40	0.89	0.54	0.39	0.07	0.03	5.87

Percent of Calms 0.01
Percent of Invalid Hours 0.00
Percent of Valid Hours 5.88

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
NEUTRAL (-1.5 < delta T/ delta z <= -0.5)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL D
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.01	0.22	0.33	0.47	0.94	0.37	0.15	0.08	0.02	0.00	0.00	2.58
NNE	0.00	0.18	0.30	0.15	0.14	0.11	0.02	0.00	0.01	0.00	0.00	0.91
NE	0.01	0.09	0.32	0.17	0.17	0.14	0.03	0.00	0.00	0.00	0.00	0.94
ENE	0.00	0.05	0.39	0.18	0.34	0.09	0.01	0.00	0.00	0.00	0.00	1.06
E	0.00	0.06	0.22	0.23	0.56	0.23	0.07	0.00	0.00	0.00	0.00	1.36
ESE	0.00	0.06	0.15	0.33	0.57	0.35	0.18	0.09	0.09	0.01	0.00	1.84
SE	0.00	0.03	0.18	0.30	0.71	0.65	0.56	0.22	0.09	0.01	0.00	2.75
SSE	0.02	0.08	0.09	0.22	0.79	0.81	0.81	0.63	0.55	0.06	0.01	4.06
S	0.00	0.06	0.07	0.14	0.34	0.41	0.64	0.54	0.51	0.16	0.00	2.87
SSW	0.00	0.05	0.10	0.15	0.25	0.22	0.29	0.26	0.16	0.07	0.02	1.56
SW	0.00	0.03	0.08	0.07	0.23	0.17	0.22	0.11	0.17	0.01	0.02	1.12
WSW	0.00	0.05	0.06	0.14	0.21	0.14	0.13	0.05	0.02	0.00	0.00	0.78
W	0.00	0.06	0.10	0.11	0.22	0.15	0.13	0.06	0.11	0.06	0.00	0.99
WNW	0.00	0.09	0.19	0.13	0.17	0.26	0.25	0.11	0.03	0.01	0.00	1.26
NW	0.01	0.11	0.14	0.18	0.24	0.48	0.59	0.35	0.34	0.15	0.02	2.63
NNW	0.01	0.10	0.40	0.49	1.53	1.38	0.86	0.50	0.30	0.03	0.01	5.62
Total	0.07	1.31	3.12	3.45	7.40	5.96	4.93	3.00	2.42	0.57	0.09	32.32

Percent of Calms 0.00
Percent of Invalid Hours 0.00
Percent of Valid Hours 32.32

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
SLIGHTLY STABLE (-0.5 < delta T/ delta z <= 1.5)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL E
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.02	0.21	0.18	0.21	0.10	0.05	0.00	0.02	0.00	0.00	0.00	0.79
NNE	0.03	0.24	0.09	0.06	0.05	0.01	0.01	0.00	0.01	0.00	0.00	0.50
NE	0.03	0.22	0.15	0.13	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.63
ENE	0.02	0.22	0.22	0.09	0.13	0.00	0.01	0.00	0.00	0.00	0.00	0.68
E	0.03	0.14	0.27	0.17	0.30	0.06	0.00	0.00	0.01	0.00	0.00	0.98
ESE	0.05	0.21	0.53	0.42	0.50	0.21	0.03	0.03	0.00	0.00	0.00	1.97
SE	0.03	0.22	0.53	0.73	1.22	0.84	0.45	0.10	0.05	0.00	0.00	4.17
SSE	0.06	0.17	0.22	0.31	1.08	1.31	1.12	0.50	0.43	0.03	0.00	5.24
S	0.06	0.10	0.13	0.15	0.50	0.58	0.75	0.46	0.33	0.03	0.00	3.09
SSW	0.03	0.18	0.05	0.05	0.22	0.21	0.38	0.22	0.47	0.09	0.02	1.91
SW	0.17	0.15	0.03	0.05	0.10	0.14	0.11	0.15	0.29	0.07	0.01	1.27
WSW	0.06	0.14	0.09	0.03	0.16	0.22	0.10	0.03	0.06	0.01	0.00	0.90
W	0.03	0.16	0.17	0.22	0.45	0.33	0.09	0.06	0.02	0.00	0.00	1.53
WNW	0.09	0.40	0.27	0.33	0.81	0.40	0.10	0.02	0.01	0.00	0.00	2.44
NW	0.06	0.37	0.29	0.40	0.56	0.32	0.07	0.00	0.03	0.00	0.00	2.09
NNW	0.07	0.32	0.49	0.48	0.78	0.39	0.03	0.07	0.00	0.00	0.00	2.63
Total	0.86	3.42	3.70	3.81	7.05	5.06	3.26	1.67	1.71	0.24	0.03	30.82

Percent of Calms 0.00
Percent of Invalid Hours 0.00
Percent of Valid Hours 30.82

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
MODERATELY STABLE (1.5 < delta T/ delta z <= 4.0)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL F
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.02	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.08
NNE	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
NE	0.07	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
ENE	0.05	0.09	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
E	0.07	0.26	0.08	0.08	0.13	0.01	0.00	0.00	0.00	0.00	0.00	0.63
ESE	0.01	0.13	0.23	0.14	0.10	0.08	0.00	0.00	0.00	0.00	0.00	0.68
SE	0.03	0.22	0.33	0.29	0.48	0.19	0.03	0.00	0.00	0.00	0.00	1.58
SSE	0.13	0.24	0.11	0.13	0.31	0.09	0.02	0.00	0.00	0.00	0.00	1.03
S	0.13	0.17	0.05	0.08	0.22	0.23	0.10	0.02	0.01	0.00	0.00	1.00
SSW	0.13	0.26	0.11	0.03	0.13	0.19	0.16	0.01	0.01	0.00	0.00	1.04
SW	0.16	0.27	0.02	0.02	0.10	0.08	0.10	0.05	0.02	0.00	0.00	0.83
WSW	0.15	0.34	0.03	0.02	0.02	0.07	0.05	0.00	0.00	0.00	0.00	0.68
W	0.18	0.40	0.15	0.03	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.87
WNW	0.13	0.31	0.23	0.15	0.14	0.05	0.01	0.00	0.00	0.00	0.00	1.00
NW	0.03	0.15	0.11	0.03	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.41
NNW	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Total	1.31	2.98	1.54	1.05	1.76	1.04	0.49	0.08	0.05	0.00	0.00	10.30

Percent of Calms 0.00
Percent of Invalid Hours 0.00
Percent of Valid Hours 10.30

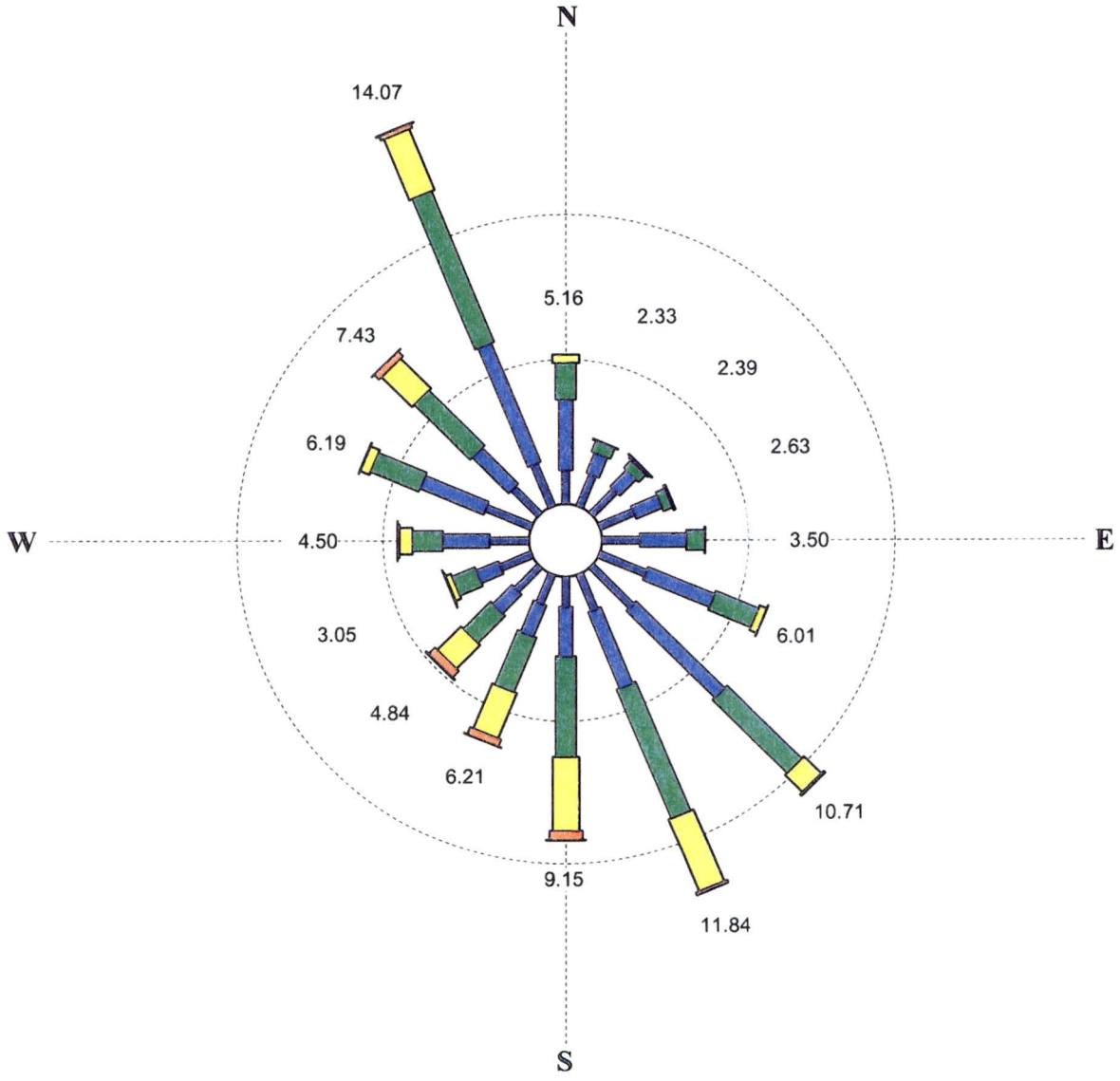
Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
EXTREMELY STABLE (delta T/ delta z > 4.0)
PERIOD OF RECORD: JAN 2015 - DEC 2015
PASQUILL G
WIND SPEED (m/s) AT 10-m LEVEL

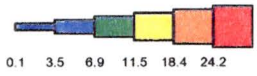
Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
NNE	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
NE	0.02	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
ENE	0.03	0.14	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
E	0.03	0.13	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.21
ESE	0.03	0.21	0.13	0.05	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.49
SE	0.09	0.26	0.07	0.09	0.10	0.01	0.01	0.00	0.00	0.00	0.00	0.64
SSE	0.03	0.16	0.07	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.29
S	0.03	0.21	0.06	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.37
SSW	0.05	0.19	0.02	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.30
SW	0.07	0.23	0.03	0.01	0.03	0.00	0.01	0.01	0.00	0.00	0.00	0.40
WSW	0.08	0.19	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.30
W	0.06	0.11	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
WNW	0.05	0.09	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23
NW	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
NNW	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02
Total	0.62	2.10	0.56	0.27	0.26	0.08	0.02	0.01	0.00	0.00	0.00	3.93

Percent of Calms 0.00
Percent of Invalid Hours 0.00
Percent of Valid Hours 3.93

Percent of Hours Accounted For: 100.00

Joint Frequency Distribution
2015 FCS Meterologiccal Tower





Wind Speed (Miles Per Hour)

Calms excluded.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

Omaha Public Power District
Fort Calhoun Station Unit No. 1

Radiological Environmental
Operating Report
For
Technical Specification
Section 5.9.4.b

January 1, 2015 to December 31, 2015

DOCKET NO. 50-285

OPERATING LICENSE DPR-40

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN STATION

RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

TECHNICAL SPECIFICATION 5.9.4.b

January 01, 2015 – December 31, 2015

Annual Radiological Environmental Operating Report

This report is submitted in accordance with Section 5.9.4.b of the Technical Specifications of Fort Calhoun Station Unit No. 1, Facility Operating License DPR-40 for the period January 01, 2015 through December 31, 2015.

In addition, this report provides any observations and anomalies that occurred during the monitoring period.

Reviewed by:

Supervisor-RadWaste/Environmental

Approved by:

Manager-Chemistry

FCS Plant Manager

Site Vice President

Annual Radiological Environmental Operating Report

In accordance with Technical Specification 5.9.4.b, herein is the Fort Calhoun Station (FCS) Annual Radiological Environmental Operating Report for year 2015. The data provided is consistent with the objectives as specified in Section 5.2.2 of the Offsite Dose Calculation Manual (ODCM), "Annual Radiological Environmental Operating Report." The report is presented as follows:

1) An introductory discussion of the implementation of the Radiological Environmental Monitoring Program (REMP), including program observations and environmental impact relevant to the operation of FCS.

2) The sample class, sample collection frequency, number of sample locations, and the number of samples collected this reporting period for each parameter is delineated in Table 1.0.

3) A statistical evaluation of REMP data is summarized in Table 2.0, in accordance with Regulatory Guide 4.8, Table 1. For each type of sample media and analysis, Table 2.0 presents data separately for all **indicator** locations, all **control** (background) locations, and the location having the highest annual mean result. For each of these classes, Table 2.0 specifies the following:

   a. The total number of analyses

   b. The fraction of analyses yielding detectable results (i.e., results above the highest Lower Limit of Detection (LLD) for this period

   c. The maximum, minimum, and average results

   d. Locations with the highest annual mean are specified by code, name, and by distance and direction from the center of plant reactor containment building.

4) Table 3.0 is a listing of missed samples and explanations

5) Table 4.0 is the 2014 Land Use Survey

6) Review of Environmental Inc. Quality Assurance Program

7) Appendix A describes the Interlaboratory Comparison Program

8) Appendix B describes the vendor Data Reporting Conventions utilized

9) Appendix C reports the information required when primary coolant specific activity has exceeded the limits of Technical Specification 2.1.3

10) Appendix D is the Sample Location Maps

INTRODUCTION

Radiological Environmental Monitoring Program (REMP) – 2015

This report gives the results of the Radiological Environmental Monitoring Program (REMP) for the year 2015. The REMP is a requirement of the Fort Calhoun Station (FCS) operating license. It was initiated prior to plant operation in 1973.

The main purpose of the REMP is to ensure public safety by monitoring plant discharges and assessing the effect, if any, of plant operations, on the environment. Samples are collected that would account for various exposure pathways such as ingestion, inhalation, adsorption and direct exposure. Samples collected on a regular basis include: air, surface water, ground water, milk, vegetation, fish, sediment, and food crops. Direct radiation is measured by thermoluminescent dosimeters (TLDs). These samples and TLDs are sent to an independent vendor laboratory for analysis. The vendor uses analytical methods that are sensitive enough to detect a level of activity far below that which would be considered harmful. Locations for sample collection are based on radiological and meteorological data from the Annual Effluent Release Report and information obtained from the Environmental Land Use Survey.

Most samples, particularly indicator samples, are collected in a circular area within a five-mile radius of plant containment. (However, control locations are usually outside of five miles.) This circle is divided into sixteen equal sectors, each assigned an identification letter "A" through "R" (note: letters "I" and "O" are not used, as they may be mistaken for the numbers "1" and "0"). Sector "A" is centered on North or zero degrees. Sectors are also given directional labels such as "West-Southwest" ("WSW"). Sample locations are listed by number along with their respective distances and direction from plant containment, in the Offsite Dose Calculation Manual (ODCM).

When assessing sample results, data from indicator locations (those most likely to be effected by plant operations) are compared to those from control locations (those least or not likely to be effected). Results from an indicator location which were significantly higher than those from a control location, could indicate a plant-attributable effect, and could require additional investigation.

The results of the sample analyses, as required by the FCS Offsite Dose Calculation Manual (ODCM), are presented in the attached statistical tables in accordance with Table 1 of Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants." Sample collection was conducted by plant chemistry/environmental staff. A contract vendor (Environmental Inc., Northbrook, Illinois) performed sample analyses, preparation of monthly reports and the statistical evaluation of sample results. All vendor analysis techniques met the sensitivity requirements as stated in the ODCM.

Results for 2015 were within expected ranges and compared closely with historical results. The result details and exceptions are listed in the following sections.

1) **Ambient Gamma Radiation**

Ambient gamma radiation is measured by thermoluminescent dosimeters (TLDs) provided by the vendor laboratory. These dosimeters contain calcium sulfate phosphors and are processed quarterly. Thirty-two new thermoluminescent dosimeters were added to the program during the fourth quarter of 2010.

The returned results were evaluated for their validity. The results appeared to be consistent with the results from previous quarters and to nearby TLDs, so the results were deemed to be valid.

All sample results are within the range of historical data and displayed less than 25% difference when compared to historical averages. All results were less than 3 sigma standard deviations from historical means. No discrepancy between released effluents and resultant radiation dose measured was observed. No changes in plant operation/procedures are required based upon observed impacts to the environment to date.

10-Year Trend Comparison of TLD Locations

Location	Avg. Dose (mr/week)	2015 Avg. Dose (mr/week)
A	1.35	1.11
B	1.43	1.28
C	1.40	1.05
D	1.25	1.00
F	1.38	1.08
G	1.32	1.13
H	1.42	1.15
I	1.50	1.40
J	1.55	1.35
K	1.47	1.30
N	1.42	1.43
O	1.41	1.33
P	1.46	1.38
S	1.48	1.53
L (Control)	1.28	1.13

2) **Milk/Pasture**

Milk samples or pasture grasses, if milk is temporarily unavailable, are collected every two weeks during the pasture season from the beginning of May through September, and monthly the rest of the calendar year. Indicator samples are collected from a herd of milk goats at a family farm located approximately 3.4 miles from the plant in Sector J (South). The control samples are collected from a commercial dairy cow herd located approximately 9.9 miles from the plant in Sector J (South). This indicator station was added in March of 2013, the control location is unchanged from last year. No indicator milk samples were available January and November due to the does drying up before birthing; pasture grass in lieu of milk was collected at the indicator location

All sample results for Cesium-134, Cesium-137 and other gammas were at the LLD for both indicator and control locations. No plant-related effects were observed.

3) **Fish**

Fish are collected on an annual basis. Control samples are collected at a location approximately twenty miles upstream of the plant (river miles 665 – 667). Indicator samples are collected in the immediate vicinity of the power plant (river miles 644 – 646). Several species of fish, important to commercial and recreational interest, representing all levels of the aquatic food chain are collected at both locations.

All sample results are within the range of historical data. Results from both control and indicator locations were less than LLD for all gamma emitters, indicating no plant-related effects.

4) **Food Crop**

Based on the results of the biennial Land Use Survey, the nearest high deposition pathway for food crops is the Alvin Pechnik Farm in Sector H (0.94 miles, 163°). Accordingly, vegetable samples were collected at Alvin Pechnik Farm for the purposes of the 2015 REMP.

Samples were comparable with historical results and within the range of results reported from the control location garden at Mohr Dairy. Additional special interest samples were obtained from on-site farm fields per plant Technical Specifications.

All results were at the LLD for all non-naturally occurring radionuclides. No plant-related effects were observed.

5) **Sediment**

River sediment samples are collected twice a year at an upstream control location and a downstream indicator location. All results were at the LLD for all non-naturally occurring radionuclides. No plant-related effects were observed.

6) **Air Monitoring**

Air sample results for 2015 were well within historical limits for all locations. Additionally, all indicator locations showed results very similar to the control locations.

Three incidents were documented in the Corrective Action Program in 2015 related to air sampling. Each is discussed below.

On 07/22/2015, the environmental air sampler as found flow value in the field at location OAP-I-(I) was found to be low and out of tolerance. The flow, as found in the field by the sampler, was 0.5 SCFM; the acceptance range is 1.8-2.2 SCFM. The unit was replaced and a bench test was performed to verify the as found flow. The bench test confirmed that the flow was low out of the tolerance. Since the air particulate pre-filter was very similar in color and particulate loading to the other filters, we felt that the failure was most likely during the middle to the end of the sampling period. Conservatively, the as left flow rate of 2.0 SCFM and the as found flow rate of 0.5 SCFM were averaged to get a flow rate of 1.25 SCFM. This flow rate was used to calculate the volume through the sampler because it was the conservative approach. The returned analytical results were reviewed for consistencies in gross beta and to verify the LLD I-131. The results were within the normal statistical limits and the LLD's were per the Offsite Dose Calculation Manual, so the sample was deemed to be acceptable.

There were two incidents of power failures affecting three air sampling locations during 2015. The power outages occurred, at OAP-J-(I) for 5 hours during the timeframe of 05/20/2015 to 05/27/2015, at OAP-K-(I) for 7 hours during the same time frame of 05/20/2015 to 05/27/2015, and at OAP-K-(I) for 33 hours during the time frame of 09/23/2015 to 09/30/2015. The returned analytical results were reviewed for consistencies in gross beta and to verify the LLD I-131. The results were within the normal statistical limits and the LLD's were per the Offsite Dose Calculation Manual, so the sample was deemed to be acceptable.

All sample results are within the range of historical data. All indicator locations displayed less than 20% difference when compared to historical average. All 2015 results when compared to historical averages are within the stated vendor error acceptance tolerance.

Results from both control and indicator locations were less than LLD for gamma emitters and iodine. No changes in plant operation/procedures are required based upon observed impacts to the environment to date.

10-Year Trend Comparison of Air Sampling Locations

Location	Avg. Beta (pCi/m^3)	2015 Avg. Beta (pCi/m^3)
Sector B	0.029	.026
Sector D	0.029	.027
Sector I	0.026	.021
Sector J	0.027	.025
Sector K*	0.028	.025
Sector F (Control)	0.030	.027

* At least a 5-Year comparison due to data availability

7) **Surface Water**

Water samples are collected upstream of the plant (control location) as well as half-mile downstream and at a municipal water treatment plant on the north edge of Omaha.

The January quality assurance North Omaha Station surface water sample results showed 322pCi/L of tritium in the sample. The reanalysis confirmed the presence of tritium with a result of 389pCi/L. The vendor lab was contacted and asked to analyze the other January samples for tritium. The nearest municipal drinking water inlet, Metropolitan Utilities District, sample showed 388pCi/L. Tritium was not detected in the upstream or downstream samples. None of the 1st quarter composite samples had tritium detected.

A dose estimate was also performed using the equations listed in the ODCM and the sample analysis result. For the determination, an adult was assumed to drink water at 389 pCi/L for one month at the rate listed in Table 6 of the ODCM. The dose from that calculation was $1.42E^{-3}$ mRem for a month (389 pCi/L * 730 L/yr *0.0833yr * $5.99E^{-8}$ mRem/ pCi) or $4.25E^{-3}$ mRem for one quarter. The dose estimated for a year at the January sample concentration ($1.42E^{-3}$ mRem/month * 12 months/year) equals $1.7E^{-2}$ mRem which represents 0.568% of the annual limit of 3 mRem. For a quarter at this concentration $4.25E^{-3}$ mRem, represents 0.283% of the quarter limit of 1.5 mRem. If we were to use the dose calculated from the genie dose software and taking the dilution factor at M.U.D. as 30.8, the dose of $8.63E^{-3}$ mRem for the quarter would represent 0.575% of the quarter limit of 1.5 mRem or 1.15% of the annual limit of 3 mRem.

The ($1.75E^{8}$ pCi/L * 50 gal/min flow from monitor tanks) / 360,000 gal/min dilution flow from 3 circulators running = $2.43E^{4}$ pCi/l at the discharge tunnel. To account for the river dilution from the discharge tunnel to the intake at Metropolitan Utilities District, the ($2.4305E^{4}$ pCi/L) / 30.8 the dilution factor from the ODCM = $7.8912E^{2}$ pCi/L. The dose calculation would be 789.12 pCi/L * 730 L/yr * 0.25yr * $5.99E^{-8}$ mRem/ pCi = $8.63E^{-3}$ mRem.

In conclusion, from the positive results and the postulated dose calculations, no effluent limits were challenged.

Results for Cs-134, Cs-137, and other gammas were all less than LLD. All other tritium results were less than LLD.

8) **Ground Water**

Quarterly residential well water samples are collected at the following four locations: Station No. 15: Smith Farm, Station No. 20: Mohr Dairy, Station No. 74: D. Miller Farm and Station No. 75: Lomp Acreage. All sample results to date have been at the LLD except gross beta due to naturally occurring radionuclides. Gross beta results have ranged from a low of 1.2 pCi/liter to a high of 6.2 pCi/liter, with an average gross beta for the year of 4.3 pCi/liter for indicator locations. Strontium-90 analysis is being conducted on wells as part of the station's groundwater protection program. No plant-related effects were detected.

Table 1.0

Sample Collection Program

Sample Class	Collection Frequency	Number of Sample Locations	Samples Collected this Period
Background Radiation (TLDs)	Quarterly	47	188
Air Particulates	Weekly	6	312
Airborne Iodine	Weekly	6	312
Milk	Biweekly May thru Sept	2	36[1]
Surface Water	Monthly	3	36
Ground Water	Quarterly	4	16
Fish	Annually	2	5[2]
Sediment	Semi-annually	2	4
Food Crops	Annually	3	9[3]
		TOTAL	918

Note 1: Milk sample collection total includes two vegetation samples performed for milk unavailability. Milk samples are collected every two weeks May-Sept. and monthly the rest of the year. Three milk samples were performed in September.
Note 2: Includes one background sample.
Note 3: Variety of samples collect during period

Table 2.0 Radiological Environmental Monitoring Program Summary — Reporting Period January-December, 2015

Name of Facility: Fort Calhoun Nuclear Power Station - Unit 1 — Docket No. 50-285

Location of Facility: Washington, Nebraska

(County, State)

Sample Type (Units)	Type and Number of Analyses[a]			LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean Location[d]	Location with Highest Annual Mean Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Background Radiation (TLD) (mR/week)	Gamma		188	0.5	1.2 (184/184) (0.8-1.8)	OTD-S-(I), 0.65 mi. @ 163°	1.5 (4/4) (1.4-1.6)	1.1 (4/4) (0.9-1.4)	0
Airborne Particulates (pCi/m^3)	GB		312	0.005	0.025 (260/260) (0.007-0.063)	OAP-D-(I) 3.0 mi. @ 303°	0.028 (52/52) (0.013-0.061)	0.027 (52/52) (0.013-0.055)	0
	GS		24						
		Cs-134		0.001	< LLD	-	-	< LLD	0
		Cs-137		0.001	< LLD	-	-	< LLD	0
		Other Gammas		0.001	< LLD	-	-	< LLD	0
Airborne Iodine (pCi/m3)		I-131	312	0.070	< LLD	-	-	< LLD	0
Milk (pCi/L)		I-131	34	0.5	< LLD	-	-	< LLD	0
	GS		34			OFM-G-(I)			
		K-40		150	1658 (16/16) (1415-1898)	Stangl Farm 3.4 mi @ 369°	1658 (16/16) (1415-1898)	1294 (18/18) (1222-1416)	0
		Cs-134		15	< LLD	-	-	< LLD	0
		Cs-137		15	< LLD	-	-	< LLD	0
		Other Gammas		15	< LLD	-	-	< LLD	0
Ground Water (pCi/L)	GB		16		4.3 (12/12) (1.2-6.2)	OGW-F-(I) Lomp Acreage	5.0 (4/4) (2.6-6.0)	4.3 (4/4) (2.3-6.5)	0
	H-3		16	300	< LLD	0.65 mi @ 163°	-	< LLD	0
	Sr-90		16	0.70	< LLD	-	-	< LLD	0
	GS		16						
(pCi/L)		Cs-134		15	< LLD	-	-	< LLD	0
		Cs-137		18	< LLD	-	-	< LLD	0
		Other Gammas		15	< LLD	-	-	< LLD	0
Surface Water (pCi/L)	GS		36						
		Cs-134		15	< LLD	-	-	< LLD	0
		Cs-137		18	< LLD	-	-	< LLD	0
		Other Gammas		15	< LLD	-	-	< LLD	0
									0
		H-3	12	300	< LLD	-	-	< LLD	

Name of Facility Fort Calhoun Nuclear Power Station - Unit 1 Docket No. 50-285
Location of Facility Washington, Nebraska
(County, State)

Sample Type (Units)	Type and Number of Analyses[a]		LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean Location[d]	Location with Highest Annual Mean Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Fish (pCi/g wet)	GS	5						
		Mn-54	0.067	< LLD	-	-	< LLD	0
		Co-58	0.060	< LLD	-	-	< LLD	0
		Co-60	0.048	< LLD	-	-	< LLD	0
		Fe-59	0.237	< LLD	-	-	< LLD	0
		Zn-65	0.115	< LLD	-	-	< LLD	0
		Ru-103	0.098	< LLD	-	-	< LLD	0
		Cs-134	0.061	< LLD	-	-	< LLD	0
		Cs-137	0.055	< LLD	-	-	< LLD	0
Sediment pCi/g dry	GS	4						
		Mn-54	0.024	< LLD	-	-	< LLD	0
		Co-58	0.022	< LLD	-	-	< LLD	0
		Co-60	0.015	< LLD	-	-	< LLD	0
		Fe-59	0.058	< LLD	-	-	< LLD	0
		Zn-65	0.041	< LLD	-	-	< LLD	0
		Cs-134	0.017	< LLD	-	-	< LLD	0
		Cs-137	0.018	< LLD	-	-	< LLD	0
Food Crops (pCi/g wet)	GS	9						
		Mn-54	0.019	< LLD	-	-	< LLD	0
		Co-58	0.016	< LLD	-	-	< LLD	0
		Co-60	0.020	< LLD	-	-	< LLD	0
		Fe-59	0.045	< LLD	-	-	< LLD	0
		Zn-65	0.030	< LLD	-	-	< LLD	0
		Zr-Nb-95	0.020	< LLD	-	-	< LLD	0
		Cs-134	0.019	< LLD	-	-	< LLD	0
		Cs-137	0.017	< LLD	-	-	< LLD	0
		Ba-La-140	0.015	< LLD	-	-	< LLD	0
Vegetation (MI) (pCi/g wet)	GS	2						
		Mn-54	0.017	< LLD	-	-	< LLD	0
		Co-58	0.019	< LLD	-	-	< LLD	0
		Co-60	0.016	< LLD	-	-	< LLD	0
		Fe-59	0.031	< LLD	-	-	< LLD	0
		Zn-65	0.040	< LLD	-	-	< LLD	0
		Zr-Nb-95	0.020	< LLD	-	-	< LLD	0
		I-131	0.025	< LLD			< LLD	0
		Cs-134	0.018	< LLD	-	-	< LLD	0
		Cs-137	0.022	< LLD	-	-	< LLD	0
		Ba-La-140	0.015	< LLD	-	-	< LLD	0

[a] GB = gross beta, GS = gamma scan.
[b] LLD = nominal lower limit of detection based on a 95% confidence level.
[c] Mean and range are based on detectable measurements only (i.e., >LLD) Fraction of detectable measurements at specified locations is indicated in parentheses (F).
[d] Locations are specified: (1) by code, (2) by name, and (3) by distance and direction relative to the Reactor Containment Building.
[e] Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds the typical pre-operational value for the medium or location.

Table 3.0 Listing of Missed Samples (samples scheduled but not collected)

Sample Type	Date	Location	Reason
			NONE

Table 4.0
FORT CALHOUN STATION
CHEMISTRY FORM

FC-801
REV 1

2014
Environmental Land Use Survey Report

Sector	Dir	Land Use	Owner	Miles	Meters	Deg	Survey Technique	Age Group				XOQ	DOQ	Remarks
								Adult	Teen	Child	Infant			
A	N	RESIDENCE	WRIGHT	4.36	7016.74	351	INTERVIEW	X		X		9.50E-08	4.10E-10	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION												
		GROUNDWATER	WRIGHT	4.36	7016.74	351	INTERVIEW	X		X		9.50E-08	4.10E-10	
B	NNE	RESIDENCE	RAND,J	1.93	3106.03	12	MAIL SURVEY	X				5.40E-07	2.50E-09	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION	SHEPARD	2.23	3588.84	16	INTERVIEW	X		X		3.60E-07	1.60E-09	
		GROUNDWATER	RAND,J	1.93	3106.03	12	MAIL SURVEY	X				5.40E-07	2.50E-09	
C	NE	RESIDENCE	HANSEN,M	1.52	2446.20	42	MAIL SURVEY	X		X		7.60E-07	2.50E-09	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION	THIELE	1.59	2558.86	52	MAIL SURVEY	X				7.10E-07	2.30E-09	
		GROUNDWATER	HANSEN,M	1.52	2446.20	42	MAIL SURVEY	X		X		7.60E-07	2.50E-09	
D	ENE	RESIDENCE	MEADE,G	4.79	7708.76	63	INTERVIEW	X				8.40E-08	1.20E-10	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION	MEADE,G	4.79	7708.76	63	INTERVIEW	X				8.40E-08	1.20E-10	
		GROUNDWATER	MEADE,G	4.79	7708.76	63	INTERVIEW	X				8.40E-08	1.20E-10	
E	E	RESIDENCE	LOVE	4.67	7515.64	89	MAIL SURVEY	X				9.80E-08	1.50E-10	
		MILK ANIMAL												
		MEAT ANIMAL	BROTHERS,D	4.91	7901.88	90	INTERVIEW	X				9.10E-08	1.40E-10	
		VEGETATION												
		GROUNDWATER	LOVE	4.67	7515.64	89	MAIL SURVEY	X				9.80E-08	1.50E-10	
F	ESE	RESIDENCE	WILSON ISLAND	4.22	6791.43	121	INTERVIEW	X	X	X		1.40E-07	2.90E-10	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION	WILSON ISLAND	4.22	6791.43	121	INTERVIEW	X	X	X		1.40E-07	2.90E-10	
		GROUNDWATER	WILSON ISLAND	4.22	6791.43	121	INTERVIEW	X	X	X		1.40E-07	2.90E-10	

2014
Environmental Land Use Survey Report

Sector	Dir	Land Use	Owner	Miles	Meters	Deg	Survey Technique	Age Group				XOQ	DOQ	Remarks
								Adult	Teen	Child	Infant			
G	SE	RESIDENCE	CARTER,T	1.67	2687.60	145	MAIL SURVEY	X				8.00E-07	5.00E-09	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION	KALIN,W	1.74	2800.26	145	INTERVIEW	X				7.50E-07	4.60E-09	
		GROUNDWATER	KALIN,W	1.74	2800.26	145	MAIL SURVEY	X				7.50E-07	4.60E-09	OGW-A-(I) SMITH FARM RETAINED TO MAINTAIN HISTORICAL DATA FROM PRE-OP TO PRESENT
H	SSE	RESIDENCE	LOMP	.65	1046.07	163	MAIL SURVEY	X				6.20E-06	6.60E-08	
		MILK ANIMAL												
		MEAT ANIMAL	HINELINE,R	1.82	2929.01	148	INTERVIEW	X				5.80E-07	5.80E-09	
		VEGETATION	PECHNIK,A	.94	1512.78	163	INTERVIEW	X				2.70E-06	2.90E-08	
		GROUNDWATER	LOMP	.65	1046.07	163	MAIL SURVEY	X				6.20E-06	6.60E-08	
J	S	RESIDENCE	DOWLER	.73	1174.82	175	INTERVIEW	X				2.60E-06	2.10E-08	
		MILK ANIMAL	STANGL	3.44	5536.14	169	INTERVIEW	X	X	X		6.20E-08	4.10E-10	
		MEAT ANIMAL	PRATT	2.48	3991.17	170	INTERVIEW	X		X		1.30E-07	9.10E-10	
		VEGETATION	DOWLER	.73	1174.82	175	INTERVIEW	X				2.60E-06	2.10E-08	
		GROUNDWATER	DOWLER	.73	1174.82	175	INTERVIEW	X				2.60E-06	2.10E-08	
K	SSW	RESIDENCE	D.MILLER	.65	1046.07	203	INTERVIEW	X				3.10E-06	1.50E-08	
		MILK ANIMAL												
		MEAT ANIMAL	D.MILLER	.65	1046.07	203	INTERVIEW	X				3.10E-06	1.50E-08	COWS ARE ONLY ON THE PROPERTY DURING GRAZING SEASON. PASTURE ON LEASE.
		VEGETATION	T. DEIN	2.00	3218.69	193	INTERVIEW	X			X	2.20E-07	9.50E-10	
		GROUNDWATER	D.MILLER	.65	1046.07	203	INTERVIEW	X				3.10E-06	1.50E-08	
L	SW	RESIDENCE	ROBERTSON,D	.73	1174.82	224	MAIL SURVEY	X				1.90E-06	8.20E-09	
		MILK ANIMAL												
		MEAT ANIMAL	RYDER	.76	1223.10	227	INTERVIEW	X				1.70E-06	7.50E-09	
		VEGETATION	KAZAKERICIUS	1.36	2188.71	233	INTERVIEW	X				3.90E-07	1.60E-09	
		GROUNDWATER	ROBERTSON,D	.73	1174.82	224	MAIL SURVEY	X				1.90E-06	8.20E-09	
M	WSW	RESIDENCE	BENSEN,M	1.06	1705.90	257	INTERVIEW	X				1.10E-06	3.40E-09	
		MILK ANIMAL												
		MEAT ANIMAL	WRICH,B	2.42	3894.61	250	INTERVIEW	X				1.40E-07	3.70E-10	
		VEGETATION	THOMAS	1.13	1818.56	259	MAIL SURVEY	X				8.90E-07	2.80E-09	
		GROUNDWATER	BENSEN,M	1.06	1705.90	257	INTERVIEW	X				1.10E-06	3.40E-09	

2014
Environmental Land Use Survey Report

Sector	Dir	Land Use	Owner	Miles	Meters	Deg	Survey Technique	Age Group				XOQ	DOQ	Remarks
								Adult	Teen	Child	Infant			
N	W	RESIDENCE	NIELSEN,D	1.20	1931.21	263	MAIL SURVEY	X				8.70E-07	2.90E-09	
		MILK ANIMAL												
		MEAT ANIMAL	ANDERSON,J	3.25	5230.37	281	INTERVIEW	X				8.10E-08	2.20E-10	
		VEGETATION	ASMUSSEN,G	1.30	2092.15	270	MAIL SURVEY	X				6.90E-07	2.30E-09	
		GROUNDWATER	ASMUSSEN,G	1.30	2092.15	270	MAIL SURVEY	X				6.90E-07	2.30E-09	
P	WNW	RESIDENCE	STONE	2.60	4184.29	283	MAIL SURVEY	X				2.40E-07	7.80E-10	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION	TABOR	2.65	4264.76	285	INTERVIEW	X		X		2.30E-07	7.40E-10	
		GROUNDWATER	STONE	2.60	4184.29	283	MAIL SURVEY	X				2.40E-07	7.80E-10	
Q	NW	RESIDENCE	HANSEN,R	2.40	3862.43	318	INTERVIEW	X				4.50E-07	1.90E-09	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION	HANSEN,R	2.40	3862.43	318	INTERVIEW	X				4.50E-07	1.90E-09	
		GROUNDWATER	HANSEN,R	2.40	3862.43	318	INTERVIEW	X				4.50E-07	1.90E-09	
R	NNW	RESIDENCE	SHUBERT,B	2.08	3347.44	330	INTERVIEW	X		X		4.90E-07	2.90E-09	
		MILK ANIMAL												
		MEAT ANIMAL												
		VEGETATION	SONDERUP	3.73	6002.85	328	MAIL SURVEY	X				1.30E-07	6.60E-10	
		GROUNDWATER	SONDERUP	3.73	6002.85	328	MAIL SURVEY	X				1.30E-07	6.60E-10	

Performed by_____ Reviewed by_____

Review of Environmental Inc., Quality Assurance Program

Fort Calhoun Station contracts with Environmental Inc., Midwest Laboratory (vendor lab) to perform radioanalysis of environmental samples. Environmental Inc. participates in interlaboratory comparison (cross-check) programs as part of its quality control program. These programs are operated by such agencies as the Department of Energy, which supply blind-spike samples such as milk or water containing concentrations of radionuclides unknown to the testing laboratory. This type of program provides an independent check of the analytical laboratory's procedures and processes, and provides indication of possible weaknesses. In addition, Environmental Inc. has its own in-house QA program of blind-spike and duplicate analyses.

Vendor in-house spike sampling was performed without a failure and in-house blank analyses were performed within acceptable ranges.

ERA vegetation sample, ERVE-1100, failed low for Co-60, Cs-134, Cs-137, K-40, & Zn-65. These 5 failures (low) were traced backed to a technician error weighing the sample, which caused the submitted gamma results to be understated and outside of the control limits. The reanalysis with the corrected sample volume produced acceptable results for all 5 of the failed analyses.

ERA water sample, ERW-1103, failed for Pu-239/240. The investigation into ERW-1103 failure for Pu-239 led to no known reason as to why the unacceptable results occurred. The sample ERW-3742 was ordered from ERA to determine why ERW-1103 results for Pu-239 were outside the acceptable range. The results for ERW-3742 were acceptable. So the new sample and analysis created acceptable results. The FCS REMP program does not perform Pu-239/240 analyses on water samples.

The 2 DOE sample failures, MAW-969 and MAAP-978, were both for Co-57 in water and air particulate. An investigation showed that a data entry error resulted in the unacceptable results. The actual lab results were acceptable.

ERA water sample, ERW-5540, dated 10/5/2015, failed for Ra-228. The investigation into ERW-5540 failure for Ra-228 is believed to be caused by the interference from short-lived Rn-222 daughters. Ra-228 spike was at a level close to the detection level. The reanalysis created acceptable results. The FCS REMP program does not perform Ra-228 analyses on water samples. OPPD results were not negatively impacted by this vendor identified and corrected issue.

ERW-5007 water sample, dated 8/1/2015, failed low on Fe-55. The known activity was below the routine laboratory detection limits for the available aliquot fraction. Since Fe-55 is not part of the FCS REMP program, OPPD results were not negatively impacted by this issue, and the environmental vendor does not receive a Fe-55 analytics cross check. Since Fe-55 is performed within the RETS program, the RETS and Rad Waste vendor, Teledyne and Brown Engineering (TBE), receives the FCS contracted crosscheck. TBE passed its vendor crosscheck sample, and no Fe-55 was identified in RETS release composites of station effluent reporting.

Two failures occurred on analysis of a DOE MAPEP soil sample dated 8/1/2015. MASO-4903 failed low on Sr-90. For Sr-90, the low result was due to the incomplete separation of calcium from strontium causing a failed low result. The sample was reanalyzed and produced acceptable results. Sr-90 analysis in soil is not part of the FCS REMP program. OPPD gamma scan results on soil were not negatively impacted by this vendor identified issue.

MASO-4903 also failed low on Tc-99. For Tc-99, the low result was due to the complex sample matrix interfering with the yield calculations causing a failed low result. An investigation is in process to determine a more reliable yield determination. Tc-99 analysis in soil is not part of the FCS REMP program. OPPD soil results were not negatively impacted by this vendor identified issue.

No test results failed both the ERA and DOE methodologies for a given sample type. Reanalysis produced acceptable results. The ordering of additional tests and successful testing after corrections were applied, visibly demonstrates the vendor's commitment to reporting and resolving deficiencies.

These results indicate the vendor's ability to self-identify and correct any deviations from acceptable or expected results. The test results had no impact on Fort Calhoun samples and were documented as such by the vendor.

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APPENDIX A

INTERLABORATORY COMPARISON PROGRAM RESULTS

NOTE: Environmental Inc., Midwest Laboratory participates in intercomparison studies administered by Environmental Resources Associates, and serves as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. Results are reported in Appendix A. TLD Intercomparison results, in-house spikes, blanks, duplicates and mixed analyte performance evaluation program results are also reported. Appendix A is updated four times a year; the complete Appendix is included in March, June, September and December monthly progress reports only.

January, 2015 through December, 2015

Appendix A

Interlaboratory Comparison Program Results

Environmental, Inc., Midwest Laboratory has participated in interlaboratory comparison (crosscheck) programs since the formulation of it's quality control program in December 1971. These programs are operated by agencies which supply environmental type samples containing concentrations of radionuclides known to the issuing agency but not to participant laboratories. The purpose of such a program is to provide an independent check on a laboratory's analytical procedures and to alert it of any possible problems.

Participant laboratories measure the concentration of specified radionuclides and report them to the issuing agency. Several months later, the agency reports the known values to the participant laboratories and specifies control limits. Results consistently higher or lower than the known values or outside the control limits indicate a need to check the instruments or procedures used.

Results in Table A-1 were obtained through participation in the environmental sample crosscheck program administered by Environmental Resources Associates, serving as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

Table A-2 lists results for thermoluminescent dosimeters (TLDs), via internal laboratory testing and by irradiation and evaluation by the University of Wisconsin-Madison Radiation Calibration Laboratory at the University of Wisconsin Medical Radiation Research Center.

Table A-3 lists results of the analyses on in-house "spiked" samples for the past twelve months. All samples are prepared using NIST traceable sources. Data for previous years available upon request.

Table A-4 lists results of the analyses on in-house "blank" samples for the past twelve months. Data for previous years available upon request.

Table A-5 lists REMP specific analytical results from the in-house "duplicate" program for the past twelve months. Acceptance is based on the difference of the results being less than the sum of the errors. Complete analytical data for duplicate analyses is available upon request.

The results in Table A-6 were obtained through participation in the Mixed Analyte Performance Evaluation Program.

Results in Table A-7 were obtained through participation in the environmental sample crosscheck program administered by Environmental Resources Associates, serving as a replacement for studies conducted previously by the Environmental Measurement Laboratory Quality Assessment Program (EML).

Attachment A lists the laboratory precision at the 1 sigma level for various analyses. The acceptance criteria in Table A-3 is set at $\pm$ 2 sigma.

Out-of-limit results are explained directly below the result.

Attachment A

ACCEPTANCE CRITERIA FOR "SPIKED" SAMPLES

LABORATORY PRECISION: ONE STANDARD DEVIATION VALUES FOR VARIOUS ANALYSES[a]

Analysis	Level	One standard deviation for single determination
Gamma Emitters	5 to 100 pCi/liter or kg	5.0 pCi/liter
	> 100 pCi/liter or kg	5% of known value
Strontium-89[b]	5 to 50 pCi/liter or kg	5.0 pCi/liter
	> 50 pCi/liter or kg	10% of known value
Strontium-90[b]	2 to 30 pCi/liter or kg	5.0 pCi/liter
	> 30 pCi/liter or kg	10% of known value
Potassium-40	≥ 0.1 g/liter or kg	5% of known value
Gross alpha	≤ 20 pCi/liter	5.0 pCi/liter
	> 20 pCi/liter	25% of known value
Gross beta	≤ 100 pCi/liter	5.0 pCi/liter
	> 100 pCi/liter	5% of known value
Tritium	≤ 4,000 pCi/liter	$\pm 1\sigma = 169.85 \times (\text{known})^{0.0933}$
	> 4,000 pCi/liter	10% of known value
Radium-226,-228	≥ 0.1 pCi/liter	15% of known value
Plutonium	≥ 0.1 pCi/liter, gram, or sample	10% of known value
Iodine-131, Iodine-129[b]	≤ 55 pCi/liter	6 pCi/liter
	> 55 pCi/liter	10% of known value
Uranium-238, Nickel-63[b] Technetium-99[b]	≤ 35 pCi/liter	6 pCi/liter
	> 35 pCi/liter	15% of known value
Iron-55[b]	50 to 100 pCi/liter	10 pCi/liter
	> 100 pCi/liter	10% of known value
Other Analyses [b]	---	20% of known value

[a] From EPA publication, "Environmental Radioactivity Laboratory Intercomparison Studies Program, Fiscal Year, 1981-1982, EPA-600/4-81-004.

[b] Laboratory limit.

TABLE A-1. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

Lab Code	Date	Analysis	Concentration (pCi/L) Laboratory Result[b]	ERA Result[c]	Control Limits	Acceptance
ERW-1444	4/6/2015	Sr-89	59.71 ± 5.44	63.20	51.10 - 71.20	Pass
ERW-1444	4/6/2015	Sr-90	43.41 ± 2.43	41.90	30.80 - 48.10	Pass
ERW-1448	4/6/2015	Ba-133	77.75 ± 4.69	82.50	69.30 - 90.80	Pass
ERW-1448	4/6/2015	Cs-134	68.82 ± 3.08	75.70	61.80 - 83.30	Pass
ERW-1448	4/6/2015	Cs-137	191.9 ± 5.9	189.0	170.0 - 210.0	Pass
ERW-1448	4/6/2015	Co-60	85.05 ± 4.59	84.50	76.00 - 95.30	Pass
ERW-1448	4/6/2015	Zn-65	196.0 ± 12.0	203.0	183.0 - 238.0	Pass
ERW-1450	4/6/2015	Gr. Alpha	34.05 ± 1.90	42.60	22.10 - 54.00	Pass
ERW-1450	4/6/2015	G. Beta	26.93 ± 1.12	32.90	21.30 - 40.60	Pass
ERW-1453	4/6/2015	I-131	22.47 ± 0.83	23.80	19.70 - 28.30	Pass
ERW-1456	4/6/2015	Ra-226	8.20 ± 0.56	8.43	6.33 - 9.90	Pass
ERW-1456	4/6/2015	Ra-228	5.00 ± 0.67	4.39	2.56 - 6.01	Pass
ERW-1456	4/6/2015	Uranium	5.98 ± 0.31	6.59	4.99 - 7.83	Pass
ERW-1461	4/6/2015	H-3	3,254 ± 180	3280	2,770 - 3,620	Pass
ERW-5528	10/5/2015	Sr-89	34.76 ± 0.06	35.70	26.70 - 42.50	Pass
ERW-5528	10/5/2015	Sr-90	29.23 ± 0.06	31.10	22.70 - 36.10	Pass
ERW-5531	10/5/2015	Ba-133	30.91 ± 0.53	32.50	25.90 - 36.70	Pass
ERW-5531	10/5/2015	Cs-134	57.40 ± 2.57	62.30	50.69 - 68.50	Pass
ERW-5531	10/5/2015	Cs-137	163.1 ± 4.8	157.0	141.0 - 175.0	Pass
ERW-5531	10/5/2015	Co-60	73.41 ± 1.72	71.10	64.00 - 80.70	Pass
ERW-5531	10/5/2015	Zn-65	138.9 ± 5.7	126.0	113.0 - 149.0	Pass
ERW-5534	10/5/2015	Gr. Alpha	29.99 ± 0.08	51.60	26.90 - 64.70	Pass
ERW-5534	10/5/2015	G. Beta	27.52 ± 0.04	36.60	24.10 - 44.20	Pass
ERW-5537	10/5/2015	I-131	25.54 ± 0.60	26.30	21.90 - 31.00	Pass
ERW-5540	10/5/2015	Ra-226	7.32 ± 0.37	7.29	5.49 - 8.63	Pass
ERW-5540[d]	10/5/2015	Ra-228	7.80 ± 0.02	4.25	2.46 - 5.85	Fail
ERW-5540[e]	10/5/2015	Ra-228	4.45 ± 0.96	4.25	2.46 - 5.85	Pass
ERW-5540	10/5/2015	Uranium	53.30 ± 0.55	56.20	45.70 - 62.40	Pass
ERW-5543	10/5/2015	H-3	21,260 ± 351	21,300	18,700 - 23,400	Pass

[a] Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the crosscheck program for proficiency testing in drinking water conducted by Environmental Resources Associates (ERA).

[b] Unless otherwise indicated, the laboratory result is given as the mean ± standard deviation for three determinations.

[c] Results are presented as the known values, expected laboratory precision (1 sigma, 1 determination) and control limits as provided by ERA.

[d] Ra-228 spike was at a level close to the detection level. The high result was likely caused by interference from short-lived Rn-222 daughters.

[e] The result of reanalysis (Compare to original result, footnoted "e" above).

TABLE A-2.1. Thermoluminescent Dosimetry, (TLD, $CaSO_4$: Dy Cards). [a]

Lab Code	Irradiation Date	Description	Known Value (mR)	Lab Result (mR)	Control Limits (mR)	Acceptance
Environmental, Inc.						
2015-1	6/24/2015	30 cm.	98.81	103.67 ± 6.05	69.20 - 128.50	Pass
2015-1	6/24/2015	30 cm.	98.81	111.32 ± 15.97	69.20 - 128.50	Pass
2015-1	6/24/2015	60 cm.	24.70	27.23 ± 1.33	17.30 - 32.10	Pass
2015-1	6/24/2015	60 cm.	24.70	26.98 ± 4.98	17.30 - 32.10	Pass
2015-1	6/24/2015	120 cm.	6.18	6.71 ± 1.77	4.30 - 8.00	Pass
2015-1	6/24/2015	120 cm.	6.18	6.78 ± 0.38	4.30 - 8.00	Pass
2015-1	6/24/2015	120 cm.	6.18	6.43 ± 2.00	4.30 - 8.00	Pass
2015-1	6/24/2015	150 cm.	3.95	4.13 ± 0.72	2.80 - 5.10	Pass
2015-1	6/24/2015	150 cm.	3.95	4.12 ± 1.36	2.80 - 5.10	Pass
2015-1	6/24/2015	150 cm.	3.95	4.50 ± 1.51	2.80 - 5.10	Pass
2015-1	6/24/2015	180 cm.	2.74	3.27 ± 0.28	1.90 - 3.60	Pass
2015-1	6/24/2015	180 cm.	2.74	3.05 ± 1.11	1.90 - 3.60	Pass
2015-1	6/24/2015	180 cm.	2.74	3.14 ± 0.18	1.90 - 3.60	Pass

TABLE A-2.2 Thermoluminescent Dosimetry, (TLD, $CaSO_4$: Dy Cards). [b]

Lab Code	Irradiation Date	Description	Delivered Dose (mrem)	Reported Dose (mrem)	Performance Quotient (P) [c]	Acceptance [d]
Environmental, Inc.						
2015-2	12/15/2015	Spike 1	138.0	118.5 ± 2.1	-0.14	Pass
2015-2	12/15/2015	Spike 2	138.0	120.0 ± 1.6	-0.13	Pass
2015-2	12/15/2015	Spike 3	138.0	121.9 ± 1.9	-0.12	Pass
2015-2	12/15/2015	Spike 4	138.0	124.5 ± 3.3	-0.10	Pass
2015-2	12/15/2015	Spike 5	138.0	126.5 ± 3.2	-0.08	Pass
2015-2	12/15/2015	Spike 6	138.0	140.0 ± 4.2	0.01	Pass
2015-2	12/15/2015	Spike 7	138.0	128.2 ± 1.2	-0.07	Pass
2015-2	12/15/2015	Spike 8	138.0	128.0 ± 4.0	-0.07	Pass
2015-2	12/15/2015	Spike 9	138.0	124.9 ± 5.1	-0.09	Pass
2015-2	12/15/2015	Spike 10	138.0	122.9 ± 3.0	-0.11	Pass
2015-2	12/15/2015	Spike 11	138.0	123.3 ± 3.0	-0.11	Pass
2015-2	12/15/2015	Spike 12	138.0	119.0 ± 3.4	-0.14	Pass
2015-2	12/15/2015	Spike 13	138.0	123.0 ± 2.7	-0.11	Pass
2015-2	12/15/2015	Spike 14	138.0	125.4 ± 2.0	-0.09	Pass
2015-2	12/15/2015	Spike 15	138.0	122.0 ± 3.1	-0.12	Pass
2015-2	12/15/2015	Spike 16	138.0	120.8 ± 2.0	-0.12	Pass
2015-2	12/15/2015	Spike 17	138.0	118.8 ± 1.1	-0.14	Pass
2015-2	12/15/2015	Spike 18	138.0	117.0 ± 2.3	-0.15	Pass
2015-2	12/15/2015	Spike 19	138.0	120.8 ± 2.6	-0.12	Pass
2015-2	12/15/2015	Spike 20	138.0	122.6 ± 3.0	-0.11	Pass
Mean (Spike 1-20)				123.4	0.11	Pass
Standard Deviation (Spike 1-20)				5.0	0.04	Pass

[a] TLD's were irradiated at Environmental Inc. Midwest Laboratory. (Table A-2.1)

[b] TLD's were irradiated by the University of Wisconsin-Madison Radiation Calibration Laboratory following ANSI N13.37 protocol from a known air kerma rate. TLD's were read and the results were submitted by Environmental Inc. to the University of Wisconsin-Madison Radiation Calibration Laboratory for comparison to the delivered dose.(Table A-2.2)

[c] Performance Quotient (P) is calculated as ((reported dose - conventially true value) ÷ conventially true value) where the conventially true value is the delivered dose.

[d] Acceptance is achieved when neither the absolute value of mean of the P values, nor the standard deviation of the P values exceed 0.15.

e Tables A2.1 and A2.2 assume 1 roentgen = 1 rem (per NRC -Health Physics Positions Based on 10 CFR Part 20 - Question 96 - Page Last Reviewed/Updated Thursday, October 01, 2015).

TABLE A-3. In-House "Spiked" Samples

Lab Code [b]	Date	Analysis	Concentration (pCi/L)[a] Laboratory results 2s, n=1 [c]	Known Activity	Control Limits [d]	Acceptance
W-020315	2/3/2015	Ra-226	16.19 ± 0.42	16.70	13.36 - 20.04	Pass
W-021215	2/12/2015	Gr. Alpha	18.38 ± 0.39	20.10	16.08 - 24.12	Pass
W-021215	2/12/2015	Gr. Beta	27.98 ± 0.32	30.90	24.72 - 37.08	Pass
SPW-687	2/27/2015	Ni-63	239.6 ± 3.5	202.4	161.9 - 242.9	Pass
SPAP-689	3/2/2015	Gr. Beta	42.37 ± 3.50	43.61	34.89 - 52.33	Pass
SPAP-691	3/2/2015	Cs-134	1.77 ± 0.61	1.90	1.52 - 2.28	Pass
SPAP-691	3/2/2015	Cs-137	83.02 ± 2.60	97.20	77.76 - 116.64	Pass
SPW-693	3/2/2015	Cs-134	44.30 ± 2.53	53.40	42.72 - 64.08	Pass
SPW-693	3/2/2015	Cs-137	74.82 ± 3.50	73.80	59.04 - 88.56	Pass
SPW-693	3/2/2015	Sr-89	87.45 ± 3.62	87.48	69.98 - 104.98	Pass
SPW-693	3/25/2015	Sr-90	37.22 ± 1.55	38.10	30.48 - 45.72	Pass
SPMI-697	3/2/2015	Cs-134	96.67 ± 7.74	107.00	85.60 - 128.40	Pass
SPMI-697	3/2/2015	Cs-137	78.51 ± 7.02	73.84	59.07 - 88.61	Pass
SPMI-697	3/2/2015	Sr-89	72.98 ± 4.86	87.48	69.98 - 104.98	Pass
SPMI-697	3/2/2015	Sr-90	39.17 ± 1.51	38.10	30.48 - 45.72	Pass
SPW-699	3/2/2015	H-3	59,592 ± 703	58,445	46,756 - 70,134	Pass
W-031115	3/11/2015	Ra-226	13.73 ± 0.35	16.70	13.36 - 20.04	Pass
W-030215	3/2/2015	Ra-228	32.79 ± 2.31	31.44	25.15 - 37.73	Pass
SPF-1040	3/16/2015	Cs-134	787.5 ± 9.2	840.0	672.0 - 1,008.0	Pass
SPF-1040	3/16/2015	Cs-137	2,599 ± 24	2,360	1,888 - 2,832	Pass
SPW-1036	3/25/2015	Fe-55	1,792 ± 63	1961	1,569 - 2,353	Pass
SPW-1374	4/6/2015	U-238	46.03 ± 2.25	41.70	25.02 - 58.38	Pass
W-040815	4/8/2015	Gr. Alpha	20.18 ± 0.42	20.10	16.08 - 24.12	Pass
W-040815	4/8/2015	Gr. Beta	29.70 ± 0.33	30.90	24.72 - 37.08	Pass
SPW-1038	4/13/2015	C-14	3,497 ± 9	4,734	2,840 - 6,628	Pass
W-2165	4/20/2015	H-3	5550 ± 226	5,780	3,468 - 8,092	Pass
W-2165	4/20/2015	Sr-89	90.70 ± 8.20	108.70	65.22 - 152.18	Pass
W-2165	4/20/2015	Sr-90	76.80 ± 2.00	75.90	45.54 - 106.26	Pass
W-2165	4/20/2015	Cs-134	62.40 ± 6.40	57.30	34.38 - 80.22	Pass
W-2165	4/20/2015	Cs-137	91.30 ± 7.70	84.00	50.40 - 117.60	Pass
W-2392	4/13/2015	H-3	5032 ± 214	5780	3468 - 8092	Pass
W-2392	4/13/2015	Ni-63	222.4 ± 3.8	202.0	121.2 - 282.8	Pass
W-2392	4/13/2015	Cs-134	53.26 ± 5.01	57.30	34.38 - 80.22	Pass
W-2392	4/13/2015	Cs-137	91.90 ± 7.76	84.20	50.52 - 117.88	Pass
W-042415	4/24/2015	Ra-226	12.52 ± 0.39	16.70	10.02 - 23.38	Pass
W-050715	5/7/2015	Gr. Alpha	19.05 ± 0.41	20.10	12.06 - 28.14	Pass
W-050715	5/7/2015	Gr. Beta	27.30 ± 0.32	30.90	18.54 - 43.26	Pass
W-061215	6/12/2015	Gr. Alpha	20.72 ± 0.44	20.10	12.06 - 28.14	Pass
W-061215	6/12/2015	Gr. Beta	28.51 ± 0.33	30.90	18.54 - 43.26	Pass
U-2982	6/9/2015	Gr. Beta	500.1 ± 5.1	604.0	362.4 - 845.6	Pass
U-3200	6/9/2015	H-3	2229 ± 424	2346	1408 - 3284	Pass
W-70915	7/9/2015	Gr. Alpha	18.76 ± 0.40	20.10	12.1 - 28.1	Pass
W-70915	7/9/2015	Gr. Beta	29.71 ± 0.33	30.90	18.5 - 43.3	Pass
SPAP-3859	7/21/2015	Gr. Beta	41.59 ± 0.12	43.61	26.17 - 61.05	Pass
SPAP-3861	7/21/2015	Cs-134	1.69 ± 0.60	1.69	1.0 - 2.4	Pass

TABLE A-3. In-House "Spiked" Samples

Lab Code [b]	Date	Concentration (pCi/L)[a] Analysis	Laboratory results 2s, n=1 [c]	Known Activity	Control Limits [d]	Acceptance
SPAP-3861	7/21/2015	Cs-137	93.71 ± 2.64	96.45	57.87 - 135.03	Pass
SPMI-3863	7/21/2015	Cs-134	38.21 ± 5.12	47.02	28.21 - 65.83	Pass
SPMI-3863	7/21/2015	Cs-137	78.65 ± 7.94	73.18	43.91 - 102.45	Pass
SPMI-3863	7/21/2015	Sr-90	41.05 ± 1.62	37.78	22.67 - 52.89	Pass
SPW-3871	7/21/2015	Cs-134	45.59 ± 6.39	47.02	28.21 - 65.83	Pass
SPW-3871	7/21/2015	Cs-137	78.73 ± 7.03	73.18	43.91 - 102.45	Pass
SPW-3871	7/21/2015	Sr-90	38.36 ± 1.58	37.78	22.67 - 52.89	Pass
SPW-3873	7/21/2015	H-3	60,034 ± 671	57,199	34,319 - 80,079	Pass
SPW-3875	7/21/2015	Ni-63	451.3 ± 3.3	403.7	242.2 - 565.2	Pass
SPW-3877	7/21/2015	Tc-99	483.0 ± 8.3	539.1	323.5 - 754.7	Pass
SPMI-3879	7/21/2015	C-14	4,921 ± 19	4,736	2,842 - 6,630	Pass
SPSO-4037	7/21/2015	Ni-63	42,458 ± 309	40,370	24,222 - 56,518	Pass
SPW-072515	7/17/2015	Ra-228	35.48 ± 3	31.44	18.86 - 44.02	Pass
SPF-4104	7/29/2015	Cs-134	661.5 ± 115.9	740.0	444.0 - 1036.0	Pass
SPF-4104	7/29/2015	Cs-137	2,469 ± 59	2,340	1,404 - 3,276	Pass
SPW-81015	8/10/2015	Gr. Alpha	21.59 ± 0.46	20.10	12.06 - 28.14	Pass
SPW-81015	8/10/2015	Gr. Beta	27.58 ± 0.32	30.90	18.54 - 43.26	Pass
SPW-81315	8/13/2015	Ra-226	15.05 ± 0.36	16.70	10.02 - 23.38	Pass
SPW-90615	9/6/2015	Gr. Alpha	18.32 ± 0.40	20.10	12.06 - 28.14	Pass
SPW-90615	9/6/2015	Gr. Beta	29.43 ± 0.33	30.90	18.54 - 43.26	Pass
W-091415	9/14/2016	Gr. Alpha	19.35 ± 0.51	20.10	12.06 - 28.14	Pass
W-091415	9/14/2016	Gr. Beta	31.53 ± 0.35	30.90	18.54 - 43.26	Pass
W-100815	10/8/2015	Ra-228	12.27 ± 0.33	16.70	10.02 - 23.38	Pass
W-100615	10/6/2016	Gr. Alpha	20.62 ± 0.43	20.10	12.06 - 28.14	Pass
W-100615	10/6/2016	Gr. Beta	29.35 ± 0.33	30.90	18.54 - 43.26	Pass
W-5277	10/16/2015	H-3	5,224 ± 218	5,466	3,280 - 7,652	Pass
W-5277	10/16/2015	Cs-134	99.40 ± 6.64	99.20	59.52 - 138.88	Pass
W-5277	10/16/2015	Cs-137	89.60 ± 6.64	83.20	49.92 - 116.48	Pass
W-110415	11/4/2015	Ra-226	12.27 ± 0.33	16.70	10.02 - 23.38	Pass
W-111115	11/11/2015	Ra-228	31.78 ± 2.48	31.44	18.86 - 44.02	Pass
W-6086,6087	11/18/2015	H-3	10,882 ± 309	11,231	6,738 - 15,723	Pass
W-6086,6087	11/18/2015	Cs-134	92.98 ± 7.29	96.25	57.75 - 134.75	Pass
W-6086,6087	11/18/2015	Cs-137	76.65 ± 7.81	82.94	49.76 - 116.12	Pass
W-112515	11/25/2015	Gr. Alpha	20.91 ± 0.52	20.10	12.06 - 28.14	Pass
W-112515	11/25/2015	Gr. Beta	31.59 ± 0.35	30.90	18.54 - 43.26	Pass
W-120715	12/7/2015	Fe-55	2,431 ± 97	2,319	1,391 - 3,247	Pass
W-120815	12/8/2015	Gr. Alpha	20.72 ± 0.43	20.10	12.06 - 28.14	Pass
W-120815	12/8/2015	Gr. Beta	29.50 ± 0.33	30.90	18.54 - 43.26	Pass
W-121515	12/15/2015	Ra-226	14.77 ± 0.42	16.70	10.02 - 23.38	Pass

[a] Liquid sample results are reported in pCi/Liter, air filters(pCi/m3), charcoal (pCi/charcoal canister), and solid samples (pCi/kg).

[b] Laboratory codes : W (Water), MI (milk), AP (air filter), SO (soil), VE (vegetation), CH (charcoal canister), F (fish), U (urine).

[c] Results are based on single determinations.

[d] Control limits are established from the precision values listed in Attachment A of this report, adjusted to ± 2s.

NOTE: For fish, Jello is used for the spike matrix. For vegetation, cabbage is used for the spike matrix.

TABLE A-4. In-House "Blank" Samples

Lab Code	Sample Type	Date	Analysis[b]	Concentration (pCi/L)[a]		
				Laboratory results (4.66σ)		Acceptance
				LLD	Activity[c]	Criteria (4.66 σ)
W-020315	Water	2/3/2015	Ra-226	0.03	0.03 ± 0.02	1
W-021215	Water	2/12/2015	Gr. Alpha	0.47	-0.37 ± 0.30	2
W-021215	Water	2/12/2015	Gr. Beta	0.76	-0.62 ± 0.51	4
SPW-686	Water	2/27/2015	Ni-63	2.36	-0.74 ± 1.42	20
SPAP-688	Air Particulate	3/2/2015	Gr. Beta	0.003	-0.001 ± 0.002	0.01
SPAP-690	Air Particulate	3/2/2015	Cs-134	0.006	0.428 ± 0.927	0.05
SPAP-690	Air Particulate	3/2/2015	Cs-137	0.006	-0.785 ± 1.146	0.05
W-030215	Water	3/2/2015	Ra-228	0.76	0.22 ± 0.38	2
SPW-692	Water	3/2/2015	Cs-134	6.70	-1.57 ± 3.55	10
SPW-692	Water	3/2/2015	Cs-137	6.18	-0.15 ± 3.20	10
SPW-692	Water	3/2/2015	Sr-89	0.61	-0.51 ± 0.51	5
SPW-692	Water	3/2/2015	Sr-90	0.60	0.38 ± 0.33	1
SPMI-696	Milk	3/2/2015	Cs-134	3.75	-0.25 ± 2.24	10
SPMI-696	Milk	3/2/2015	Cs-137	4.36	-0.25 ± 2.24	10
SPMI-696	Milk	3/2/2015	Sr-89	0.80	-0.40 ± 0.84	5
SPMI-696	Milk	3/2/2015	Sr-90	0.49	0.98 ± 0.32	1
SPW-698	Water	3/2/2015	H-3	144.0	28.6 ± 88.9	200
SPW-1035	Water	3/16/2015	Fe-55	599.7	72.6 ± 368.1	1000
SPW-1037	Water	3/16/2015	C-14	8.94	2.16 ± 5.47	200
SPF-1039	Fish	3/16/2015	Cs-134	13.54	-1.00 ± 6.80	100
SPF-1039	Fish	3/16/2015	Cs-137	9.80	4.87 ± 7.00	100
W-040615	Water	4/6/2015	Ra-226	0.04	0.01 ± 0.03	2
W-1373	Water	4/6/2015	U-238	0.08	0.01 ± 0.01	1
W-1375	Water	4/6/2015	Pu-238	0.03	0.00 ± 0.01	1
W-050715	Water	5/7/2015	Gr. Alpha	0.38	-0.10 ± 0.25	2
W-050715	Water	5/7/2015	Gr. Beta	0.74	-0.14 ± 0.51	4
W-061215	Water	6/12/2015	Gr. Alpha	0.42	-0.10 ± 0.29	2
W-061215	Water	6/12/2015	Gr. Beta	0.75	-0.04 ± 0.53	4
SPW-3858	Water	7/21/2015	Gr. Beta	0.003	0.004 ± 0.002	2
SPAP-3860	Air Particulate	7/21/2015	Cs-134	0.011	0.010 ± 0.005	0.05
SPAP-3860	Air Particulate	7/21/2015	Cs-137	0.009	0.000 ± 0.005	0.05
SPMI-3862	Milk	7/21/2015	Cs-134	3.13	1.56 ± 1.74	10
SPMI-3862	Milk	7/21/2015	Cs-137	3.20	1.69 ± 1.89	10
SPMI-3862	Milk	7/21/2015	Sr-89	2.17	-1.30 ± 2.05	5
SPMI-3862	Milk	7/21/2015	Sr-90	0.90	0.74 ± 0.50	1
SPW-3870	Water	7/21/2015	Cs-134	3.01	0.71 ± 1.66	10
SPW-3870	Water	7/21/2015	Cs-137	3.94	0.81 ± 1.86	10
SPW-3870	Water	7/21/2015	Sr-89	2.28	-0.42 ± 1.80	5
SPW-3870	Water	7/21/2015	Sr-90	0.84	0.25 ± 0.42	1

TABLE A-4. In-House "Blank" Samples

Lab Code	Sample Type	Date	Analysis[b]	Concentration (pCi/L)[a]		
				Laboratory results (4.66σ)		Acceptance
				LLD	Activity[c]	Criteria (4.66 σ)
SPW-3872	Water	7/21/2015	H-3	142.6	82.7 ± 79.4	200
SPW-3874	Water	7/21/2015	Ni-63	2.98	0.77 ± 1.82	20
SPW-3876	Water	7/21/2015	Tc-99	5.49	-3.81 ± 3.26	10
SPW-3878	Water	7/21/2015	C-14	17.06	8.52 ± 10.54	200
SPSO-4036	Soil	7/21/2015	Ni-63	135.7	51.3 ± 83.0	1000
SPF-4103	Fish	7/29/2015	Cs-134	14.17	-37.70 ± 9.67	100
SPF-4103	Fish	7/29/2015	Cs-137	12.39	1.13 ± 8.06	100
W-081015	Water	8/10/2015	Gr. Alpha	0.48	-0.10 ± 0.33	2
W-081015	Water	8/10/2015	Gr. Beta	0.78	-0.18 ± 0.54	4
W-081815	Water	8/18/2015	Ra-226	0.03	0.03 ± 0.02	2
W-090615	Water	9/6/2015	Gr. Alpha	0.40	0.00 ± 0.28	2
W-090615	Water	9/6/2015	Gr. Beta	0.77	0.22 ± 0.54	4
W-091415	Water	9/14/2015	Gr. Alpha	0.41	0.10 ± 0.30	2
W-091415	Water	9/14/2015	Gr. Beta	0.77	0.04 ± 0.54	4
W-100615	Water	10/6/2015	Gr. Alpha	0.41	-0.15 ± 0.27	2
W-100615	Water	10/6/2015	Gr. Beta	0.75	-0.12 ± 0.52	4
W-112515	Water	11/25/2015	Gr. Alpha	0.42	0.05 ± 0.30	2
W-112515	Water	11/25/2015	Gr. Beta	0.78	-0.31 ± 0.54	4
W-120815	Water	12/8/2015	Gr. Alpha	0.42	-0.08 ± 0.29	2
W-120815	Water	12/8/2015	Gr. Beta	0.76	0.17 ± 0.54	4
W-121515	Water	12/15/2015	Ra-226	0.01	0.01 ± 0.01	2

[a] Liquid sample results are reported in pCi/Liter, air filters(pCi/m^3), charcoal (pCi/charcoal canister), and solid samples (pCi/kg).

[b] I-131(G); iodine-131 as analyzed by gamma spectroscopy.

[c] Activity reported is a net activity result.

TABLE A-5. In-House "Duplicate" Samples

			Concentration (pCi/L)[a]			
Lab Code	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
CF-62,63	1/7/2015	Gr. Beta	5.72 ± 0.12	5.78 ± 0.12	5.75 ± 0.42	Pass
CF-62,63	1/7/2015	Be-7	0.915 ± 0.135	0.919 ± 0.102	0.917 ± 0.15	Pass
CF-62,63	1/7/2015	K-40	3.97 ± 0.28	3.88 ± 0.23	3.92 ± 0.33	Pass
CF-62,63	1/7/2015	Sr-90	0.017 ± 0.006	0.011 ± 0.006	0.014 ± 0.004	Pass
SG-83,84	1/12/2015	K-40	10.11 ± 1.42	9.69 ± 1.20	9.90 ± 1.16	Pass
SG-83,84	1/12/2015	Tl-208	0.57 ± 0.07	0.56 ± 0.06	0.57 ± 0.05	Pass
SG-83,84	1/12/2015	Pb-212	1.73 ± 0.10	1.58 ± 0.09	1.65 ± 0.13	Pass
SG-83,84	1/12/2015	Pb-214	13.33 ± 0.33	13.88 ± 0.28	13.61 ± 0.22	Pass
SG-83,84	1/12/2015	Bi-214	13.48 ± 0.39	13.45 ± 0.29	13.47 ± 0.24	Pass
SG-83,84	1/12/2015	Ra-226	25.68 ± 2.19	26.22 ± 1.53	25.95 ± 1.34	Pass
SG-83,84	1/12/2015	Ac-228	13.33 ± 0.59	12.86 ± 0.43	13.09 ± 0.36	Pass
AP-011215A/B	1/12/2015	Gr. Beta	0.025 ± 0.004	0.023 ± 0.004	0.024 ± 0.003	Pass
WW-315,316	1/27/2015	H-3	1,961 ± 178	1,868 ± 174	1,915 ± 124	Pass
DW-60010,60011	1/28/2015	Ra-226	1.25 ± 0.14	1.40 ± 0.15	1.33 ± 0.10	Pass
DW-60010,60011	1/28/2015	Ra-228	2.00 ± 0.66	1.39 ± 0.60	1.70 ± 0.45	Pass
SG-336,337	1/30/2015	Bi-214	6.63 ± 0.20	6.45 ± 0.45	6.54 ± 0.21	Pass
SG-336,337	1/30/2015	Pb-214	6.45 ± 0.19	6.45 ± 0.37	6.45 ± 0.21	Pass
SG-336,337	1/30/2015	Ac-228	4.43 ± 0.24	4.20 ± 0.58	4.32 ± 0.31	Pass
AP-020415A/B	2/4/2015	Gr. Beta	0.021 ± 0.004	0.019 ± 0.035	0.035 ± 0.020	Pass
AP-021115A/B	2/11/2015	Gr. Beta	0.034 ± 0.004	0.040 ± 0.047	0.037 ± 0.003	Pass
DW-60023,60024	2/26/2015	Ra-226	1.52 ± 0.15	1.51 ± 0.15	1.52 ± 0.11	Pass
DW-60023,60024	2/26/2015	Ra-228	0.97 ± 0.48	1.66 ± 0.58	1.32 ± 0.38	Pass
S-799,800	2/26/2015	K-40	11.96 ± 0.98	11.49 ± 0.82	11.72 ± 0.64	Pass
S-799,800	2/26/2015	Tl-208	0.36 ± 0.04	0.31 ± 0.04	0.34 ± 0.03	Pass
S-799,800	2/26/2015	Pb-212	0.92 ± 0.06	0.91 ± 0.06	0.91 ± 0.05	Pass
S-799,800	2/26/2015	Bi-212	1.26 ± 0.45	1.50 ± 0.40	1.38 ± 0.30	Pass
S-799,800	2/26/2015	Ac-228	1.35 ± 0.22	1.23 ± 0.17	1.29 ± 0.14	Pass
SG-834,835	2/2/2015	Gr. Alpha	113.3 ± 6.3	117.2 ± 2.8	115.2 ± 3.4	Pass
SG-834,835	2/2/2015	Gr. Beta	82.27 ± 2.79	84.33 ± 2.74	83.30 ± 1.96	Pass
DW-60031,60032	3/4/2015	Gr. Alpha	185.4 ± 7.4	177.0 ± 7.2	181.2 ± 5.2	Pass
DW-60036,60037	3/4/2015	Ra-226	6.89 ± 0.34	6.88 ± 0.32	6.89 ± 0.23	Pass
DW-60036,60037	3/4/2015	Ra-228	4.43 ± 0.73	4.41 ± 0.72	4.42 ± 0.51	Pass
DW-60048,60049	3/4/2015	Ra-226	0.84 ± 0.10	0.94 ± 0.11	0.89 ± 0.07	Pass
DW-60048,60049	3/4/2015	Ra-228	0.68 ± 0.41	1.42 ± 0.58	1.05 ± 0.36	Pass
AP-1169,1170	3/19/2015	Be-7	0.20 ± 0.02	0.24 ± 0.10	0.22 ± 0.07	Pass
DW-60069,60070	4/8/2015	Gr. Alpha	3.58 ± 0.88	3.92 ± 0.88	3.75 ± 0.62	Pass
AP-040915	4/9/2015	Gr. Beta	0.027 ± 0.005	0.023 ± 0.005	0.025 ± 0.003	Pass
WW-2394,2395	4/13/2015	H-3	1,628 ± 139	1,695 ± 141	1,662 ± 99	Pass
SG-1847,1848	4/20/2015	K-40	3.24 ± 1.18	1.99 ± 0.76	2.62 ± 0.70	Pass
SG-1847,1848	4/20/2015	Pb-214	5.80 ± 0.22	6.23 ± 0.76	6.02 ± 0.40	Pass
SG-1847,1848	4/20/2015	Ac-228	5.26 ± 0.51	5.00 ± 0.42	5.13 ± 0.33	Pass
XWW-2267,2268	4/23/2015	H-3	6,584 ± 244	6,164 ± 237	6,374 ± 170	Pass
XWW-2078,2079	4/27/2015	H-3	359.0 ± 89.6	418.7 ± 92.3	388.9 ± 64.3	Pass

TABLE A-5. In-House "Duplicate" Samples

			Concentration (pCi/L)[a]			
Lab Code	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
XWW-2162,2163	4/28/2015	H-3	4,408 ± 201	4,242 ± 198	4,325 ± 141	Pass
SG-1868,1869	4/28/2015	Gr. Alpha	47.57 ± 3.63	43.61 ± 3.58	45.59 ± 2.55	Pass
SG-1868,1869	4/28/2015	Gr. Beta	50.90 ± 1.94	51.90 ± 2.02	51.40 ± 1.40	Pass
SG-1868,1869	4/28/2015	Pb-214	13.80 ± 0.52	13.54 ± 0.62	13.67 ± 0.40	Pass
SG-1868,1869	4/28/2015	Ra-228	20.10 ± 0.92	22.10 ± 1.29	21.10 ± 0.79	Pass
AP-042915	4/29/2015	Gr. Beta	0.014 ± 0.003	0.014 ± 0.003	0.014 ± 0.002	Pass
DW-60076,60077	5/4/2015	Ra-228	2.89 ± 0.61	2.45 ± 0.57	2.67 ± 0.42	Pass
AP-050515	5/5/2015	Gr. Beta	0.026 ± 0.004	0.025 ± 0.004	0.026 ± 0.003	Pass
AP-051115	5/11/2015	Gr. Beta	0.006 ± 0.005	0.010 ± 0.005	0.008 ± 0.004	Pass
DW-60087,60088	5/14/2015	Ra-226	1.58 ± 0.17	1.52 ± 0.17	1.55 ± 0.12	Pass
DW-60087,60088	5/14/2015	Ra-228	0.94 ± 0.50	0.94 ± 0.50	0.94 ± 0.35	Pass
SG-2436,2437	5/15/2015	Pb-214	22.90 ± 2.31	24.10 ± 2.43	23.50 ± 1.68	Pass
SG-2436,2437	5/15/2015	Ra-228	47.95 ± 0.61	47.80 ± 0.71	47.88 ± 0.47	Pass
SG-2436,2437	5/15/2015	Gr. Alpha	267.8 ± 7.9	254.6 ± 7.6	261.2 ± 5.5	Pass
SG-2458,2459	5/19/2015	Pb-214	75.00 ± 1.66	77.70 ± 1.75	76.35 ± 1.21	Pass
SG-2458,2459	5/19/2015	Ra-228	41.10 ± 0.92	40.80 ± 0.83	40.95 ± 0.62	Pass
DW-60095,60096	5/26/2015	Gr. Alpha	1.34 ± 0.69	0.91 ± 0.62	1.13 ± 0.46	Pass
AP-052715	5/27/2015	Gr. Beta	0.010 ± 0.003	0.010 ± 0.003	0.010 ± 0.002	Pass
S-2627,2628	5/29/2015	Pb-214	0.85 ± 0.07	0.85 ± 0.07	0.85 ± 0.05	Pass
S-2627,2628	5/29/2015	Ac-228	0.85 ± 0.14	1.08 ± 0.12	0.97 ± 0.09	Pass
S-2627,2628	5/29/2015	Cs-137	0.07 ± 0.02	0.07 ± 0.02	0.07 ± 0.01	Pass
S-2605,2606	6/1/2015	Ac-228	0.42 ± 0.06	0.38 ± 0.07	0.40 ± 0.05	Pass
S-2605,2606	6/1/2015	Ra-226	0.44 ± 0.03	0.49 ± 0.03	0.47 ± 0.02	Pass
S-2605,2606	6/1/2015	K-40	10.89 ± 0.51	11.40 ± 0.48	11.15 ± 0.35	Pass
S-2605,2606	6/1/2015	Cs-137	0.05 ± 0.01	0.05 ± 0.01	0.05 ± 0.01	Pass
S-2858,2859	6/2/2015	Cs-137	34.30 ± 16.05	40.66 ± 17.79	37.48 ± 11.98	Pass
S-2858,2859	6/2/2015	Be-7	1501 ± 264	1171 ± 214	1336 ± 170	Pass
S-2858,2859	6/2/2015	K-40	22,122 ± 658	20,987 ± 600	21,555 ± 445	Pass
AP-060315	6/3/2015	Gr. Beta	0.022 ± 0.004	0.021 ± 0.004	0.022 ± 0.003	Pass
DW-30107,30108	6/8/2015	Gr. Alpha	1.34 ± 0.82	1.47 ± 0.85	1.41 ± 0.59	Pass
SG-2900,2901	6/9/2015	Ac-228	10.22 ± 1.36	8.32 ± 1.07	9.27 ± 0.87	Pass
SG-2900,2901	6/9/2015	Pb-214	7.55 ± 0.43	7.27 ± 0.41	7.41 ± 0.30	Pass
AP-061515	6/15/2015	Gr. Beta	0.022 ± 0.004	0.021 ± 0.004	0.022 ± 0.003	Pass
XWW-3173,3174	6/18/2015	H-3	841.9 ± 123.6	799.3 ± 122.4	820.6 ± 87.0	Pass
AP-062215	6/22/2015	Gr. Beta	0.023 ± 0.004	0.018 ± 0.004	0.020 ± 0.003	Pass
S-3216,3217	6/24/2015	K-40	10.38 ± 0.51	10.51 ± 0.53	10.45 ± 0.37	Pass
S-3216,3217	6/24/2015	Be-7	3.65 ± 0.24	3.38 ± 0.27	3.52 ± 0.18	Pass
VE-3300,3301	6/24/2015	Be-7	0.78 ± 0.15	0.83 ± 0.23	0.81 ± 0.14	Pass
VE-3300,3301	6/24/2015	K-40	29.12 ± 0.62	29.36 ± 0.64	29.24 ± 0.45	Pass
AP-062915	6/29/2015	Gr. Beta	0.023 ± 0.005	0.023 ± 0.005	0.023 ± 0.003	Pass
WW-3632,3633	6/30/2015	H-3	5,169 ± 225	5,058 ± 223	5,114 ± 158	Pass

TABLE A-5. In-House "Duplicate" Samples

Lab Code	Date	Analysis	Concentration (pCi/L)[a] First Result	Second Result	Averaged Result	Acceptance
AP-3822, 3823	7/1/2015	Be-7	0.075 ± 0.011	0.068 ± 0.012	0.072 ± 0.008	Pass
AP-3969, 3970	7/1/2015	Be-7	0.063 ± 0.008	0.064 ± 0.010	0.063 ± 0.006	Pass
WW-3632, 3633	7/6/2015	H-3	5,169 ± 225	5,058 ± 223	5,114 ± 159	Pass
W-4368, 4369	7/6/2015	Gr. Alpha	26.70 ± 4.00	24.10 ± 3.90	25.40 ± 2.79	Pass
W-4368, 4369	7/6/2015	Gr. Beta	34.62 ± 2.10	33.30 ± 2.02	33.96 ± 1.46	Pass
DW-60138, 60139	7/7/2015	Ra-226	0.07 ± 0.04	0.11 ± 0.05	0.09 ± 0.03	Pass
DW-60138, 60139	7/7/2015	Ra-228	1.04 ± 0.41	1.15 ± 0.47	1.10 ± 0.31	Pass
WW-4158, 4159	7/9/2015	H-3	138.8 ± 82.4	174.0 ± 84.1	156.4 ± 58.9	Pass
MI-2902, 2903	7/10/2015	K-40	1271 ± 118	1308 ± 115	1289 ± 82	Pass
SG-3533, 3534	7/10/2015	Gr. Alpha	238.0 ± 8.2	249.5 ± 8.5	243.8 ± 5.9	Pass
DW-60150, 60151	7/10/2015	Ra-226	1.53 ± 0.16	1.49 ± 0.12	1.51 ± 0.10	Pass
DW-60150, 60151	7/10/2015	Ra-228	2.68 ± 0.68	1.89 ± 0.62	2.29 ± 0.46	Pass
VE-3716, 3717	7/14/2015	K-40	3.85 ± 0.33	3.71 ± 0.31	3.78 ± 0.23	Pass
MI-3759, 3760	7/15/2015	K-40	1819 ± 127	1764 ± 140	1791 ± 94	Pass
MI-3759, 3760	7/15/2015	Sr-90	1.00 ± 0.36	0.61 ± 0.32	0.80 ± 0.24	Pass
AP-072115	7/21/2015	Gr. Beta	0.022 ± 0.004	0.027 ± 0.004	0.024 ± 0.003	Pass
VE-4053, 4054	7/21/2015	Be-7	0.52 ± 0.15	0.49 ± 0.11	0.50 ± 0.09	Pass
VE-4053, 4054	7/21/2015	K-40	8.00 ± 0.42	7.61 ± 0.31	7.81 ± 0.26	Pass
AP-4200, 4201	7/29/2015	Be-7	1.06 ± 0.12	0.96 ± 0.11	1.01 ± 0.08	Pass
AP-4200, 4201	7/29/2015	K-40	5.03 ± 0.24	4.96 ± 0.23	4.99 ± 0.16	Pass
W-4137, 4138	7/31/2015	Ra-226	0.58 ± 0.13	0.45 ± 0.14	0.52 ± 0.10	Pass
XWW-4431, 4432	8/5/2015	H-3	4,773 ± 213	4,915 ± 216	4,844 ± 152	Pass
SG-4305, 4306	8/6/2015	Ra-228	10.34 ± 0.58	11.46 ± 0.62	10.90 ± 0.42	Pass
AP-081015	8/10/2015	Gr. Beta	0.038 ± 0.005	0.039 ± 0.005	0.039 0.004	Pass
AP-081115	8/11/2015	Gr. Beta	0.024 ± 0.004	0.020 ± 0.004	0.022 0.003	Pass
VE-4452, 4453	8/11/2015	K-40	3.77 ± 0.29	3.78 ± 0.26	3.77 ± 0.20	Pass
AP-081715	8/17/2015	Gr. Beta	0.030 ± 0.005	0.030 ± 0.005	0.030 ± 0.003	Pass
DW-60195, 60196	8/17/2015	Ra-226	0.39 ± 0.10	0.37 ± 0.10	0.38 ± 0.07	Pass
DW-60195, 60196	8/17/2015	Ra-228	1.43 ± 0.51	1.97 ± 0.61	1.70 ± 0.40	Pass
DW-60198, 60199	8/17/2015	Gr. Alpha	2.93 ± 0.94	2.11 ± 0.96	2.52 ± 0.67	Pass
VE-4578, 4579	8/18/2015	K-40	4.14 ± 0.25	4.32 ± 0.24	4.23 ± 0.17	Pass
SW-4662, 4663	8/25/2015	H-3	351.3 ± 89.8	415.6 ± 92.8	383.4 ± 64.6	Pass
DW-60212, 60213	8/25/2015	Ra-226	0.09 ± 0.07	0.10 ± 0.08	0.10 ± 0.05	Pass
LW-4788, 4789	8/27/2015	Gr. Beta	0.97 ± 0.51	1.68 ± 0.59	1.32 ± 0.39	Pass
AP-083115	8/31/2015	Gr. Beta	0.032 ± 0.005	0.031 ± 0.005	0.031 ± 0.003	Pass
AP-4875, 4876	9/3/2015	Be-7	0.294 ± 0.125	0.202 ± 0.109	0.248 ± 0.083	Pass
VE-5083, 5084	9/14/2015	Be-7	0.47 ± 0.23	0.56 ± 0.19	0.52 ± 0.15	Pass
VE-5083, 5084	9/14/2015	K-40	6.20 ± 0.51	6.36 ± 0.50	6.28 ± 0.36	Pass
VE-5167, 5168	9/16/2015	Be-7	0.40 ± 0.11	0.41 ± 0.10	0.41 ± 0.07	Pass
VE-5167, 5168	9/16/2015	K-40	3.56 ± 0.27	3.91 ± 0.24	3.74 ± 0.18	Pass
BS-5188, 5189	9/16/2015	K-40	9.69 ± 0.51	10.51 ± 0.52	10.10 ± 0.36	Pass
F-5419, 5420	9/17/2015	K-40	3.48 ± 0.47	3.49 ± 0.56	3.49 ± 0.36	Pass
DW-60238, 60239	9/18/2015	Ra-226	1.93 ± 0.23	2.31 ± 0.26	2.12 ± 0.17	Pass
DW-60238, 60239	9/18/2015	Ra-228	4.44 ± 0.78	5.61 ± 0.84	5.03 ± 0.57	Pass
AP-092215A/B	9/22/2015	Gr. Beta	0.021 ± 0.004	0.025 ± 0.004	0.023 ± 0.00	Pass
WW-5398, 5399	9/22/2015	H-3	1,857 ± 145	1,846 ± 144	1,852 ± 102	Pass
AP-6007, 6008	9/28/2015	Be-7	0.08 ± 0.01	0.08 ± 0.01	0.08 ± 0.01	Pass

TABLE A-5. In-House "Duplicate" Samples

Lab Code	Date	Analysis	Concentration (pCi/L)[a] First Result	Second Result	Averaged Result	Acceptance
XW-7490, 7491	9/29/2015	Ni-63	2,332 ± 233	2,108 ± 211	2,220 ± 157	Pass
WW-5377, 5378	9/30/2015	H-3	220.0 ± 84.6	197.0 ± 83.5	208.5 ± 59.4	Pass
AP-6028, 6029	9/30/2015	Be-7	0.073 ± 0.009	0.083 ± 0.012	0.078 ± 0.007	Pass
G-5461,2	10/1/2015	Be-7	2.02 ± 0.32	1.98 ± 0.25	2.00 ± 0.20	Pass
G-5461,2	10/1/2015	K-40	8.77 ± 0.66	9.31 ± 0.59	9.04 ± 0.44	Pass
SO-5482, 5483	10/1/2015	Ac-228	0.76 ± 0.12	0.74 ± 0.30	0.75 ± 0.16	Pass
SO-5482, 5483	10/1/2015	Bi-214	0.53 ± 0.04	0.52 ± 0.04	0.52 ± 0.03	Pass
SO-5482, 5483	10/1/2015	Cs-137	0.12 ± 0.03	0.12 ± 0.03	0.12 ± 0.02	Pass
SO-5482, 5483	10/1/2015	K-40	2.17 ± 0.73	2.10 ± 0.72	2.13 ± 0.51	Pass
SO-5482, 5483	10/1/2015	Pb-214	0.57 ± 0.04	0.55 ± 0.04	0.56 ± 0.03	Pass
SO-5482, 5483	10/1/2015	Ra-226	1.45 ± 0.27	1.46 ± 0.30	1.45 ± 0.20	Pass
SO-5482, 5483	10/1/2015	Tl-208	0.24 ± 0.03	0.25 ± 0.03	0.24 ± 0.02	Pass
WW-5524, 5525	10/5/2015	H-3	1,192 ± 123	1,318 ± 127	1,255 ± 89	Pass
AP-5881, 5882	10/5/2015	Be-7	0.078 ± 0.008	0.085 ± 0.011	0.082 ± 0.007	Pass
AP-5881, 5882	10/5/2015	K-40	0.009 ± 0.004	0.010 ± 0.006	0.010 ± 0.004	Pass
SG-6400,1	10/5/2015	Gr. Alpha	19.09 ± 3.14	19.45 ± 3.25	19.27 ± 2.26	Pass
SG-6400,1	10/5/2015	Gr. Beta	31.36 ± 2.08	29.80 ± 2.13	30.58 ± 1.49	Pass
VE-5923, 5924	10/12/2015	K-40	4.29 ± 0.29	4.13 ± 0.33	4.21 ± 0.22	Pass
SS-5818, 5819	10/14/2015	Ac-228	0.20 ± 0.06	0.24 ± 0.06	0.22 ± 0.04	Pass
SS-5818, 5819	10/14/2015	Cs-137	0.03 ± 0.02	0.02 ± 0.01	0.03 ± 0.01	Pass
SS-5818, 5819	10/14/2015	Gr. Beta	8.10 ± 0.87	8.08 ± 0.96	8.09 ± 0.65	Pass
SS-5818, 5819	10/14/2015	Pb-212	0.19 ± 0.03	0.17 ± 0.02	0.18 ± 0.02	Pass
SS-5818, 5819	10/14/2015	Ra-226	0.47 ± 0.24	0.45 ± 0.19	0.46 ± 0.15	Pass
SS-5818, 5819	10/14/2015	Tl-208	0.06 ± 0.02	0.06 ± 0.02	0.06 ± 0.01	Pass
DW-60251, 60252	10/15/2015	Ra-226	0.56 ± 0.12	0.50 ± 0.08	0.53 ± 0.07	Pass
DW-60251, 60252	10/15/2015	Ra-228	0.79 ± 0.48	1.16 ± 0.59	0.98 ± 0.38	Pass
SO-5944, 5945	10/21/2015	Ac-228	1.08 ± 0.15	1.14 ± 0.15	1.11 ± 0.10	Pass
SO-5944, 5945	10/21/2015	Bi-214	0.89 ± 0.08	0.82 ± 0.06	0.85 ± 0.05	Pass
SO-5944, 5945	10/21/2015	Cs-137	0.06 ± 0.02	0.08 ± 0.03	0.07 ± 0.02	Pass
SO-5944, 5945	10/21/2015	Pb-212	1.06 ± 0.06	0.99 ± 0.05	1.03 ± 0.04	Pass
SO-5944, 5945	10/21/2015	Pb-214	1.00 ± 0.09	0.89 ± 0.06	0.95 ± 0.05	Pass
SO-5944, 5945	10/21/2015	Ra-226	2.13 ± 0.43	2.16 ± 0.37	2.14 ± 0.28	Pass
SO-5944, 5945	10/21/2015	Tl-208	0.36 ± 0.04	0.34 ± 0.04	0.35 ± 0.03	Pass
S-6175, 6176	10/23/2015	K-40	16.86 ± 1.92	14.28 ± 1.66	15.57 ± 1.27	Pass
XWW-6196, 6197	10/26/2015	H-3	2,856 ± 170	2,815 ± 169	2,836 ± 120	Pass
SO-6259, 6260	10/28/2015	Ac-228	0.60 ± 0.10	0.53 ± 0.08	0.57 ± 0.07	Pass
SO-6259, 6260	10/28/2015	Bi-214	0.40 ± 0.06	0.50 ± 0.05	0.45 ± 0.04	Pass
SO-6259, 6260	10/28/2015	Cs-137	0.17 ± 0.03	0.19 ± 0.03	0.18 ± 0.02	Pass
SO-6259, 6260	10/28/2015	Gr. Beta	21.6 ± 1.1	23.36 ± 1.21	22.48 ± 0.82	Pass
SO-6259, 6260	10/28/2015	Pb-212	0.53 ± 0.04	0.49 ± 0.04	0.51 ± 0.03	Pass
SO-6259, 6260	10/28/2015	Tl-208	0.16 ± 0.03	0.19 ± 0.04	0.18 ± 0.02	Pass

TABLE A-5. In-House "Duplicate" Samples

			Concentration (pCi/L)[a]			
Lab Code	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
LW-6280, 6281	10/29/2015	Gr. Beta	2.03 ± 0.91	1.97 ± 0.97	2.00 ± 0.67	Pass
MI-6484, 6485	11/11/2015	K-40	1,384 ± 82	1,432 ± 89	1,408 ± 60	Pass
SO-6841, 6842	11/24/2015	Cs-137	0.18 ± 0.03	0.16 ± 0.03	0.17 ± 0.02	Pass
SO-6841, 6842	11/24/2015	K-40	13.62 ± 0.76	13.67 ± 0.69	13.64 ± 0.51	Pass
WW-6978, 6979	11/30/2015	H-3	569.0 ± 97.7	480.3 ± 93.9	524.7 ± 67.8	Pass
SW-6936, 6937	12/10/2015	H-3	151.9 ± 80.0	176.2 ± 81.2	164.0 ± 57.0	Pass
SW-7017, 7018	12/10/2015	H-3	584.3 ± 98.7	451.6 ± 93.9	518.0 ± 68.1	Pass
LW-7020, 7021	12/10/2015	H-3	236.9 ± 84.2	285.6 ± 86.5	261.2 ± 60.3	Pass
AP-7351, 7352	12/29/2015	Be-7	0.099 ± 0.020	0.084 ± 0.018	0.091 ± 0.014	Pass
AP-7414, 7415	12/30/2015	Be-7	0.049 ± 0.013	0.048 ± 0.011	0.048 ± 0.008	Pass

Note: Duplicate analyses are performed on every twentieth sample received in-house. Results are not listed for those analyses with activities that measure below the LLD.

[a] Results are reported in units of pCi/L, except for air filters (pCi/Filter or pCi/m3), food products, vegetation, soil, sediment (pCi/g).

TABLE A-6. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

			Concentration [a]			
Lab Code [b]	Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MASO-975	2/1/2015	Ni-63	341 ± 18	448	314 - 582	Pass
MASO-975	2/1/2015	Sr-90	523 ± 12	653	457 - 849	Pass
MASO-975	2/1/2015	Tc-99	614 ± 12	867	607 - 1,127	Pass
MASO-975	2/1/2015	Cs-134	533 ± 6	678	475 - 881	Pass
MASO-975	2/1/2015	Cs-137	0.8 ± 2.5	0.0	NA [c]	Pass
MASO-975	2/1/2015	Co-57	0.5 ± 1.0	0.0	NA [c]	Pass
MASO-975	2/1/2015	Co-60	741 ± 8	817	572 - 1,062	Pass
MASO-975	2/1/2015	Mn-54	1,153 ± 9	1,198	839 - 1,557	Pass
MASO-975	2/1/2015	Zn-65	892 ± 18	1064	745 - 1,383	Pass
MAW-969	2/1/2015	Am-241	0.650 ± 0.078	0.654	0.458 - 0.850	Pass
MAW-969	2/1/2015	Cs-134	21.1 ± 0.3	23.5	16.5 - 30.6	Pass
MAW-969	2/1/2015	Cs-137	19.6 ± 0.3	19.1	13.4 - 24.8	Pass
MAW-969 [d]	2/1/2015	Co-57	10.2 ± 0.4	29.9	20.9 - 38.9	Fail
MAW-969	2/1/2015	Co-60	0.02 ± 0.05	0.00	NA [c]	Pass
MAW-969	2/1/2015	H-3	569 ± 13	563	394 - 732	Pass
MAW-969	2/1/2015	Fe-55	6.00 ± 6.60	6.88	4.82 - 8.94	Pass
MAW-969	2/1/2015	Mn-54	0.02 ± 0.07	0.00	NA [c]	Pass
MAW-969	2/1/2015	Ni-63	2.9 ± 3.0	0.00	NA [c]	Pass
MAW-969	2/1/2015	Zn-65	16.5 ± 0.9	18.3	12.8 - 23.8	Pass
MAW-969	2/1/2015	Tc-99	3.40 ± 0.60	3.18	2.23 - 4.13	Pass
MAW-969	2/1/2015	Pu-238	0.02 ± 0.03	0.01	NA [e]	Pass
MAW-969	2/1/2015	Pu-239/240	0.81 ± 0.10	0.83	0.58 - 1.08	Pass
MAW-969	2/1/2015	U-233/234	0.150 ± 0.040	0.148	0.104 - 0.192	Pass
MAW-969	2/1/2015	U-238	0.84 ± 0.09	0.97	0.68 - 1.26	Pass
MAW-969	2/1/2015	Sr-90	9.40 ± 1.30	9.48	6.64 - 12.32	Pass
MAW-950	2/1/2015	Gr. Alpha	0.66 ± 0.05	1.07	0.32 - 1.81	Pass
MAW-950	2/1/2015	Gr. Beta	2.72 ± 0.06	2.79	1.40 - 4.19	Pass
MAW-947	2/1/2015	I-129	1.26 ± 0.12	1.49	1.04 - 1.94	Pass
MAAP-978	2/1/2015	Am-241	0.069 ± 0.200	0.068	0.048 - 0.089	Pass
MAAP-978	2/1/2015	Cs-134	1.00 ± 0.04	1.15	0.81 - 1.50	Pass
MAAP-978	2/1/2015	Cs-137	0.004 ± 0.023	0.00	NA [c]	Pass
MAAP-978 [f]	2/1/2015	Co-57	0.04 ± 0.04	1.51	1.06 - 1.96	Fail
MAAP-978	2/1/2015	Co-60	0.01 ± 0.02	0.00	NA [c]	Pass
MAAP-978	2/1/2015	Mn-54	1.11 ± 0.08	1.02	0.71 - 1.33	Pass
MAAP-978	2/1/2015	Zn-65	0.83 ± 0.10	0.83	0.58 - 1.08	Pass
MAAP-978	2/1/2015	Pu-238	-0.003 ± 0.010	0.000	NA [c]	Pass
MAAP-978	2/1/2015	Pu-239/240	0.090 ± 0.022	0.085	0.059 - 0.110	Pass
MAAP-978	2/1/2015	U-233/234	0.020 ± 0.010	0.016	0.011 - 0.020	Pass
MAAP-978	2/1/2015	U-238	0.073 ± 0.018	0.099	0.069 - 0.129	Pass

TABLE A-6. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

			Concentration [a]			
Lab Code [b]	Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MAAP-981	2/1/2015	Sr-89	38.1 ± 1.0	47.5	33.3 - 61.8	Pass
MAAP-981	2/1/2015	Sr-90	1.22 ± 0.13	1.06	0.74 - 1.38	Pass
MAAP-984	2/1/2015	Gr. Alpha	0.59 ± 0.06	1.77	0.53 - 3.01	Pass
MAAP-984	2/1/2015	Gr. Beta	0.95 ± 0.07	0.75	0.38 - 1.13	Pass
MAVE-972	2/1/2015	Cs-134	6.98 ± 0.13	7.32	5.12 - 9.52	Pass
MAVE-972	2/1/2015	Cs-137	9.73 ± 0.21	9.18	6.43 - 11.93	Pass
MAVE-972	2/1/2015	Co-57	0.01 ± 0.04	0.00	NA [c]	Pass
MAVE-972	2/1/2015	Co-60	3.89 ± 0.20	5.55	3.89 - 7.22	Pass
MAVE-972	2/1/2015	Mn-54	0.04 ± 0.07	0.00	NA [c]	Pass
MAVE-972	2/1/2015	Zn-65	0.09 ± 0.12	0.00	NA [c]	Pass
MAAP-978	2/1/2015	Pu-238	-0.003 ± 0.010	0.000	NA [c]	Pass
MAAP-978	2/1/2015	Pu-239/240	0.090 ± 0.022	0.085	0.059 - 0.110	Pass
MAAP-978	2/1/2015	U-233/234	0.020 ± 0.010	0.016	0.011 - 0.020	Pass
MAAP-978	2/1/2015	U-238	0.073 ± 0.018	0.099	0.069 - 0.129	Pass
MAAP-981	2/1/2015	Sr-89	38.1 ± 1.0	47.5	33.3 - 61.8	Pass
MAAP-981	2/1/2015	Sr-90	1.22 ± 0.13	1.06	0.74 - 1.38	Pass
MAAP-984	2/1/2015	Gr. Alpha	0.59 ± 0.06	1.77	0.53 - 3.01	Pass
MAAP-984	2/1/2015	Gr. Beta	0.95 ± 0.07	0.75	0.38 - 1.13	Pass
MAVE-972	2/1/2015	Cs-134	6.98 ± 0.13	7.32	5.12 - 9.52	Pass
MAVE-972	2/1/2015	Cs-137	9.73 ± 0.21	9.18	6.43 - 11.93	Pass
MAVE-972	2/1/2015	Co-57	0.01 ± 0.04	0.00	NA [c]	Pass
MAVE-972	2/1/2015	Co-60	3.89 ± 0.20	5.55	3.89 - 7.22	Pass
MAVE-972	2/1/2015	Mn-54	0.04 ± 0.07	0.00	NA [c]	Pass
MAVE-972	2/1/2015	Zn-65	0.09 ± 0.12	0.00	NA [c]	Pass
MASO-4903	8/1/2015	Ni-63	556 ± 18	682	477 - 887	Pass
MASO-4903 [g]	8/1/2015	Sr-90	231 ± 7	425	298 - 553	Fail
MASO-4903 [g]	8/1/2015	Sr-90	352 ± 10	425	298 - 553	Pass
MASO-4903 [h]	8/1/2015	Tc-99	411 ± 11	631	442 - 820	Fail
MASO-4903	8/1/2015	Cs-134	833 ± 10	1,010	707 - 1,313	Pass
MASO-4903	8/1/2015	Cs-137	808 ± 11	809.00	566 - 1,052	Pass
MASO-4903	8/1/2015	Co-57	1,052 ± 10	1,180	826 - 1,534	Pass
MASO-4903	8/1/2015	Co-60	2 ± 2	1.3	NA [e]	Pass
MASO-4903	8/1/2015	Mn-54	1,331 ± 13	1,340	938 - 1,742	Pass
MASO-4903	8/1/2015	Zn-65	686 ± 15	662	463 - 861	Pass

TABLE A-6. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

			Concentration [a]			
Lab Code [b]	Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MAW-5007	8/1/2015	Cs-134	16.7 ± 0.4	23.1	16.2 - 30.0	Pass
MAW-5007	8/1/2015	Cs-137	-0.4 ± 0.1	0.0	NA [c]	Pass
MAW-5007	8/1/2015	Co-57	21.8 ± 0.4	20.8	14.6 - 27.0	Pass
MAW-5007	8/1/2015	Co-60	17.3 ± 0.3	17.1	12.0 - 22.2	Pass
MAW-5007	8/1/2015	H-3	227.5 ± 8.9	216.0	151.0 - 281.0	Pass
MAW-5007 [l]	8/1/2015	Fe-55	4.2 ± 14.1	13.1	9.2 - 17.0	Fail
MAW-5007	8/1/2015	Mn-54	16.6 ± 0.5	15.6	10.9 - 20.3	Pass
MAW-5007	8/1/2015	Ni-63	9.1 ± 2.6	8.6	6.0 - 11.1	Pass
MAW-5007	8/1/2015	Zn-65	15.5 ± 0.9	13.9	9.7 - 18.1	Pass
MAW-5007	8/1/2015	Tc-99	6.80 ± 0.60	7.19	5.03 - 9.35	Pass
MAW-5007	8/1/2015	Sr-90	4.80 ± 0.50	4.80	3.36 - 6.24	Pass
MAW-5007	8/1/2015	Gr. Alpha	0.41 ± 0.04	0.43	0.13 - 0.73	Pass
MAW-5007	8/1/2015	Gr. Beta	3.45 ± 0.07	3.52	1.76 - 5.28	Pass
MAW-5007	8/1/2015	I-129	1.42 ± 0.13	1.49	1.04 - 1.94	Pass
MAAP-4911	8/1/2015	Sr-89	3.55 ± 0.67	3.98	2.79 - 5.17	Pass
MAAP-4911	8/1/2015	Sr-90	0.94 ± 0.16	1.05	0.74 - 1.37	Pass
MAAP-4907	8/1/2015	Gr. Alpha	0.30 ± 0.04	0.90	0.27 - 1.53	Pass
MAAP-4907	8/1/2015	Gr. Beta	1.85 ± 0.09	1.56	0.78 - 2.34	Pass
MAVE-4901	8/1/2015	Cs-134	5.56 ± 0.16	5.80	4.06 - 7.54	Pass
MAVE-4901	8/1/2015	Cs-137	-0.02 ± 0.06	0.00	NA [c]	Pass
MAVE-4901	8/1/2015	Co-57	7.74 ± 0.18	6.62	4.63 - 8.61	Pass
MAVE-4901	8/1/2015	Co-60	4.84 ± 0.15	4.56	3.19 - 5.93	Pass
MAVE-4901	8/1/2015	Mn-54	8.25 ± 0.25	7.68	5.38 - 9.98	Pass
MAVE-4901	8/1/2015	Zn-65	5.78 ± 0.29	5.46	3.82 - 7.10	Pass

[a] Results are reported in units of Bq/kg (soil), Bq/L (water) or Bq/total sample (filters, vegetation).

[b] Laboratory codes as follows: MAW (water), MAAP (air filter), MASO (soil), MAVE (vegetation).

[c] MAPEP results are presented as the known values and expected laboratory precision (1 sigma, 1 determination) and control limits as defined by the MAPEP. A known value of "zero" indicates an analysis was included in the testing series as a "false positive". MAPEP does not provide control limits.

[d] Lab result was 27.84. Data entry error resulted in a non-acceptable result.

[e] Provided in the series for "sensitivity evaluation". MAPEP does not provide control limits.

[f] Lab result was 1.58. Data entry error resulted in a non-acceptable result.

[g] The incomplete separation of calcium from strontium caused a failed low result. The result of reanalysis acceptable.

[h] The complex sample matrix is interfering with yield calculations causing a failed low result. An investigation is in process to determine a more reliable yield determination.

[l] The known activity was below the routine laboratory detection limits for the available aliquot fraction.

TABLE A-7. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

Lab Code [b]	Date	Analysis	Concentration (pCi/L) [b] Laboratory Result [c]	ERA Result [d]	Control Limits	Acceptance
ERAP-1091	3/16/2015	Am-241	46.8 ± 2.2	49.8	30.7 - 67.4	Pass
ERAP-1091	3/16/2015	Co-60	85.1 ± 2.9	79.1	61.2 - 98.8	Pass
ERAP-1091	3/16/2015	Cs-134	825.6 ± 34.7	909.0	578.0 - 1,130.0	Pass
ERAP-1091	3/16/2015	Cs-137	1,312 ± 12	1,170	879 - 1,540	Pass
ERAP-1091	3/16/2015	Fe-55	760.6 ± 48.2	836.0	259.0 - 1630.0	Pass
ERAP-1091	3/16/2015	Mn-54	<2.7	<50	0.0 - 50.0	Pass
ERAP-1091	3/16/2015	Pu-238	51.0 ± 3.9	52.1	35.7 - 68.5	Pass
ERAP-1091	3/16/2015	Pu-239/240	38.3 ± 1.3	40.3	29.20 - 52.70	Pass
ERAP-1091	3/16/2015	Sr-90	95.3 ± 11.4	96.6	47.2 - 145.0	Pass
ERAP-1091	3/16/2015	U-233/234	29.0 ± 1.2	34.3	21.3 - 51.7	Pass
ERAP-1091	3/16/2015	U-238	31.0 ± 1.1	34.0	22.0 - 47.0	Pass
ERAP-1091	3/16/2015	Zn-65	1099.3 ± 146.5	986.0	706.0 - 1360.0	Pass
ERAP-1094	3/16/2015	Gr. Alpha	73.7 ± 0.7	62.2	20.8 - 96.6	Pass
ERAP-1094	3/16/2015	Gr. Beta	69.6 ± 0.8	58.4	36.9 - 85.1	Pass
ERSO-1098	3/16/2015	Am-241	1571.8 ± 209.6	1,500	878 - 1,950	Pass
ERSO-1098	3/16/2015	Ac-228	1198.8 ± 140.4	1,250	802 - 1,730	Pass
ERSO-1098	3/16/2015	Bi-212	1420.1 ± 455.7	1,780	474 - 2,620	Pass
ERSO-1098	3/16/2015	Bi-214	3466.9 ± 86.9	4,430	2,670 - 6,380	Pass
ERSO-1098	3/16/2015	Co-60	1779.8 ± 41.0	1,880	1,270 - 2,590	Pass
ERSO-1098	3/16/2015	Cs-134	5204.6 ± 64.5	6,390	4,180 - 7,680	Pass
ERSO-1098	3/16/2015	Cs-137	1417.1 ± 41.9	1,490	1,140 - 1,920	Pass
ERSO-1098	3/16/2015	K-40	10,597 ± 380	10,700	7,810 - 14,400	Pass
ERSO-1098	3/16/2015	Mn-54	<62.2	< 1000	0.0 - 1,000	Pass
ERSO-1098	3/16/2015	Pb-212	1,032 ± 41	1,230	806 - 1,710	Pass
ERSO-1098	3/16/2015	Pb-214	3,629 ± 93	4,530	2,640 - 6,760	Pass
ERSO-1098	3/16/2015	Pu-238	942.9 ± 128.8	998.0	600.0 - 1,380.0	Pass
ERSO-1098	3/16/2015	Pu-239/240	1,185 ± 140	1,210	791 - 1,670	Pass
ERSO-1098	3/16/2015	Sr-90	1,724 ± 125	1,940	740 - 3,060	Pass
ERSO-1098	3/16/2015	Th-234	3,666 ± 948	3,890	1,230 - 7,320	Pass
ERSO-1098	3/16/2015	U-233/234	3,474 ± 226	3,920	2,400 - 5,020	Pass
ERSO-1098	3/16/2015	U-238	3,620 ± 232	3,890	2,410 - 4,930	Pass
ERSO-1098	3/16/2015	Zn-65	7,362 ± 145	7,130	5,680 - 9,470	Pass
ERW-1095	3/16/2015	Gr. Alpha	93.4 ± 11.5	119.0	42.2 - 184.0	Pass
ERW-1095	3/16/2015	Gr. Beta	145.2 ± 4.8	158.0	90.5 - 234.0	Pass
ERW-1110	3/16/2015	H-3	10,573 ± 78	10,300	6,900 - 14,700	Pass
ERVE-1100	3/16/2015	Am-241	4,537 ± 266	4,340	2,650 - 5,770	Pass
ERVE-1100	3/16/2015	Cm-244	1,338 ± 146	1,360	666 - 2,120	Pass

TABLE A-7. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

Lab Code [b]	Date	Analysis	Concentration (pCi/L) [b] Laboratory Result [c]	ERA Result [d]	Control Limits	Acceptance
ERVE-1100 [e]	3/16/2015	Co-60	1,030 ± 29	1,540	1,060 - 2,150	Fail
ERVE-1100 [f]	3/16/2015	Co-60	1,684 ± 48	1,540	1,060 - 2,150	Pass
ERVE-1100 [e]	3/16/2015	Cs-134	1,615 ± 27	2,650	1,700 - 3,440	Fail
ERVE-1100 [f]	3/16/2015	Cs-134	2,554 ± 49	2,650	1,700 - 3,440	Pass
ERVE-1100 [e]	3/16/2015	Cs-137	1,248 ± 29	1,810	1,310 - 2,520	Fail
ERVE-1100 [f]	3/16/2015	Cs-137	2,078 ± 68	1,810	1,310 - 2,520	Pass
ERVE-1100 [e]	3/16/2015	K-40	22,037 ± 463	30,900	22,300 - 43,400	Fail
ERVE-1100 [f]	3/16/2015	K-40	34,895 ± 764	30,900	22,300 - 43,400	Pass
ERVE-1100 [e]	3/16/2015	Mn-54	<13.8	<300	0.0 - 300.0	Pass
ERVE-1100 [f]	3/16/2015	Mn-54	<24.4	<300	0.0 - 300.0	Pass
ERVE-1100	3/16/2015	Pu-238	3,232 ± 232	3,680	2,190 - 5,040	Pass
ERVE-1100	3/16/2015	Pu-239/240	3,606 ± 240	4,180	2,570 - 5,760	Pass
ERVE-1100	3/16/2015	Sr-90	6,023 ± 326	6,590	3,760 - 8,740	Pass
ERVE-1100	3/16/2015	U-233/234	2,653 ± 153	3,150	2,070 - 4,050	Pass
ERVE-1100	3/16/2015	U-238	2,717 ± 163	3,130	2,090 - 3,980	Pass
ERVE-1100 [e]	3/16/2015	Zn-65	<94.6	1,090	786 - 1,530	Fail
ERVE-1100 [f]	3/16/2015	Zn-65	1,306 ± 75	1,090	786 - 1,530	Pass
ERW-1103	3/16/2015	Am-241	47.1 ± 4.0	46.0	31.0 - 61.7	Pass
ERW-1103	3/16/2015	Co-60	1,217 ± 17	1,250	1,090 - 1,460	Pass
ERW-1103	3/16/2015	Cs-134	1,121 ± 18	1,260	925 - 1,450	Pass
ERW-1103	3/16/2015	Cs-137	1,332 ± 31	1,360	1,150 - 1,630	Pass
ERW-1103	3/16/2015	Mn-54	<3.7	<100	0.00 - 100.00	Pass
ERW-1103	3/16/2015	Pu-238	54.5 ± 1.6	72.4	53.6 - 90.1	Pass
ERW-1103 [g]	3/16/2015	Pu-239/240	140.2 ± 7.8	184.0	143.0 - 232.0	Fail
ERW-3742 [h]	9/27/2012	Pu-239/240	89.3 ± 4.9	97.7	66.6 - 108.0	Pass
ERW-1103	3/16/2015	U-233/234	56.5 ± 6.4	61.8	46.4 - 79.7	Pass
ERW-1103	3/16/2015	U-238	58.4 ± 5.8	61.3	46.7 - 75.2	Pass
ERW-1103	3/16/2015	Zn-65	1,191 ± 136	1,180	984 - 1,490	Pass
ERW-1103	3/16/2015	Fe-55	1,149 ± 144	1,070	638 - 1,450	Pass
ERW-1103	3/16/2015	Sr-90	860.0 ± 37.0	912.0	594.0 - 1,210.0	Pass

[a] Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the crosscheck program for proficiency testing administered by Environmental Resources Associates, serving as a replacement for studies conducted previously by the Environmental Measurements Laboratory Quality Assessment Program (EML).

[b] Laboratory codes as follows: ERW (water), ERAP (air filter), ERSO (soil), ERVE (vegetation). Results are reported in units of pCi/L, except for air filters (pCi/Filter), vegetation and soil (pCi/kg).

[c] Unless otherwise indicated, the laboratory result is given as the mean ± standard deviation for three determinations.

[d] Results are presented as the known values, expected laboratory precision (1 sigma, 1 determination) and control limits as provided by ERA. A known value of "zero" indicates an analysis was included in the testing series as a "false positive". Control limits are not provided.

[e] Technician error weighing sample caused submitted gamma results to be understated and outside the control limits.(low)

[f] The result of reanalysis with the correct sample volume (Compare to original result, footnoted "e" above).

[g] The results of reanalysis were outside the control limits (low).

[h] Sample ERW-3742 was ordered from ERA to determine why ERW-1103 results for Pu-239 were outside the acceptable range. The results for ERW-3742 were acceptable. No reason for the unacceptable results for ERW-3742 was determined.

APPENDIX B

DATA REPORTING CONVENTIONS

Data Reporting Conventions

1.0. All activities, except gross alpha and gross beta, are decay corrected to collection time or the end of the collection period.

2.0. Single Measurements

Each single measurement is reported as follows: $x \pm s$

where: x = value of the measurement;

s = 2s counting uncertainty (corresponding to the 95% confidence level).

In cases where the activity is less than the lower limit of detection L, it is reported as: <L,

where L = the lower limit of detection based on 4.66s uncertainty for a background sample.

3.0. Duplicate analyses

3.1 Individual results: For two analysis results; $x_1 \pm s_1$ and $x_2 \pm s_2$

Reported result: $x \pm s$; where $x = (1/2)(x_1 + x_2)$ and $s = (1/2)\sqrt{s_1^2 + s_2^2}$

3.2. Individual results: $<L_1$, $<L_2$ Reported result: <L, where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$, <L Reported result: $x \pm s$ if $x \geq L$; <L otherwise.

4.0. Computation of Averages and Standard Deviations

4.1 Averages and standard deviations listed in the tables are computed from all of the individual measurements over the period averaged; for example, an annual standard deviation would not be the average of quarterly standard deviations. The average $\bar{x}$ and standard deviation s of a set of n numbers $x_1, x_2 \ldots x_n$ are defined as follows:

$$\bar{x} = \frac{1}{n} \sum x \qquad s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

4.2 Values below the highest lower limit of detection are not included in the average.

4.3 If all values in the averaging group are less than the highest LLD, the highest LLD is reported.

4.4 If all but one of the values are less than the highest LLD, the single value x and associated two sigma error is reported.

4.5 In rounding off, the following rules are followed:

4.5.1. If the figure following those to be retained is less than 5, the figure is dropped, and the retained figures are kept unchanged. As an example, 11.443 is rounded off to 11.44.

4.5.2. If the figure following those to be retained is equal to or greater than 5, the figure is dropped and the last retained figure is raised by 1. As an example, 11.445 is rounded off to 11.45.

4.6 Composite samples which overlap the next month or year are reported for the month or year in which most of the sample is collected.

APPENDIX C

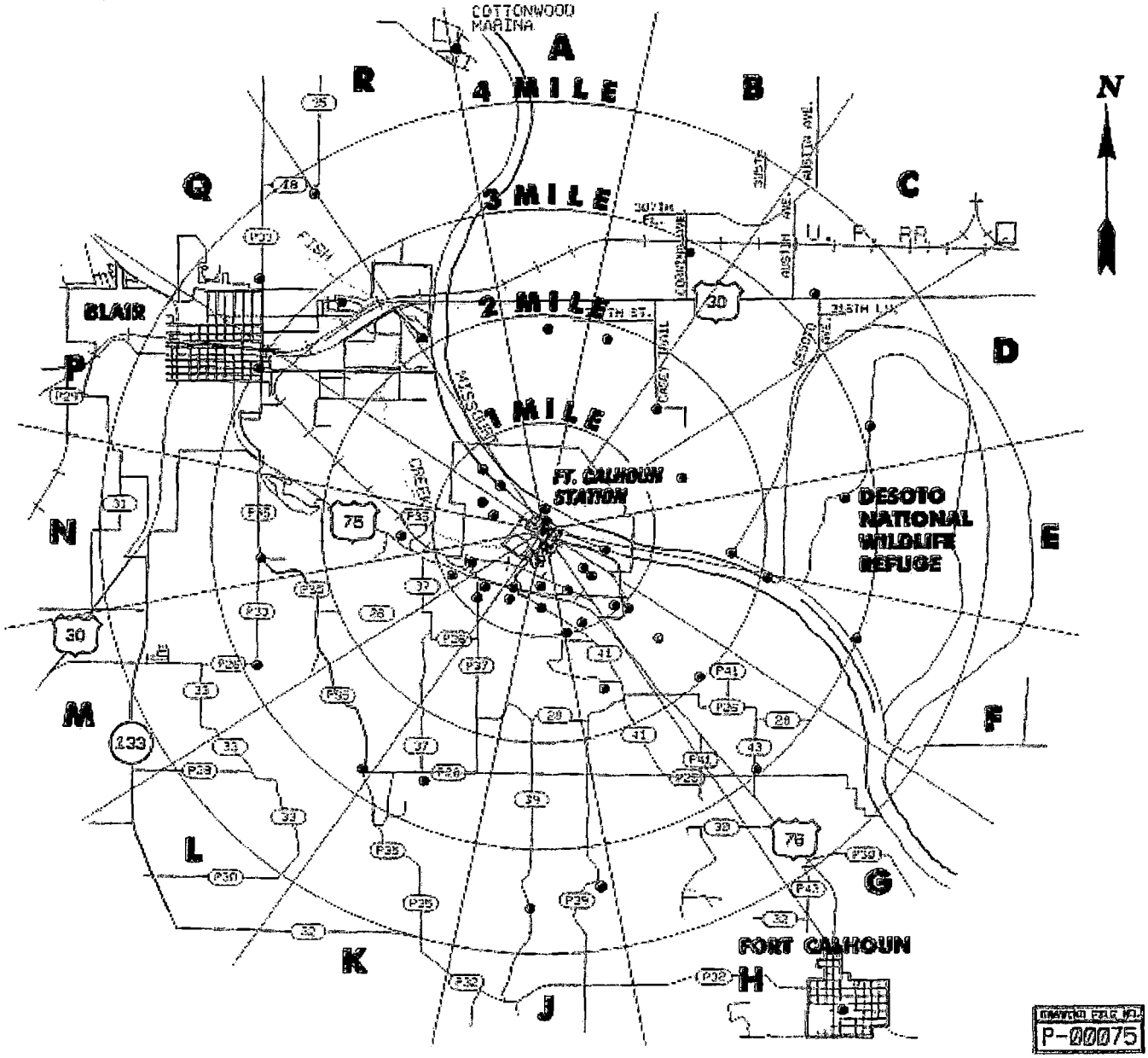
TECHNICAL SPECIFICATION 2.1.3

REACTOR COOLANT DOSE EQUIVALENT IODINE ABOVE TECHNICAL SPECIFICATION LIMIT

During the 2015 reporting period, radioactivity of primary coolant did not exceed the limits of Technical Specification 2.1.3.

APPENDIX D

SAMPLE LOCATION MAPS


COTTONWOOD MARINA
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
4 MILE
3 MILE
2 MILE
1 MILE
N
U. P. RR.
BLAIR
FT. CALHOUN STATION
DESOTO NATIONAL WILDLIFE REFUGE
FORT CALHOUN
30
75
78
133
P-00075

Radiological Environmental Sampling Locations and Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
1	Onsite Station, 110-meter weather tower	0.53	293°/WNW	P			X						
2[C,E]	Onsite Station, adjacent to old plant access road	0.59	207°/SSW	K	X	X	X						
3	Offsite Station, Intersection of Hwy. 75 and farm access road	0.94	145°/SE	G			X						
4	Blair OPPD office	2.86	305°/NW	Q	X	X	X						
5[A]													
6	Fort Calhoun, NE City Hall	5.18	150°/SSE	H			X						
7	Fence around intake gate, Desoto Wildlife Refuge	2.07	102°/ESE	F			X						
8	Onsite Station, entrance to Plant Site from Hwy. 75	0.55	191°/S	J			X						
9	Onsite Station, NW of Plant	0.68	305°/NW	Q			X						
10	Onsite Station, WSW of Plant	0.61	242°/WSW	M			X						

Radiological Environmental Sampling Locations and Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
11	Offsite Station, SE of Plant	1.07	39°/SE	G			X						
12	Metropolitan Utilities Dist., Florence Treatment Plant North Omaha, NE	14.3	154°/SSE	H				X					
13	West bank Missouri River, downstream from Plant discharge	0.45	108°/ESE	F				X		X			
14[D]	Upstream from Intake Bldg, west bank of river	0.09	4°/N	A				X		X			
15	Smith Farm	1.99	134°/SE	G									X
16[A]													
17[A]													
18[A]													
19[A]													
20[D]	Mohr Dairy	9.86	186°/S	J					[B]			X	X
21[A]													
22	Fish Sampling Area, Missouri River	0.08 (R.M. 645.0)	6°/N	A							X		
23[D]	Fish Sampling Area, Missouri River	17.9 (R.M. 666.0)	358°/N	A							X		

Radiological Environmental Sampling Locations and Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
24[A]													
25[A]													
26[A]													
27[A]													
28	Alvin Pechnik Farm	0.94	163°/SSE	H								X	
29[A]													
30[A]													
31[A]													
32[D]	Valley Substation #902	19.6	221°/SW	L	X	X	X						
33[A]													
34[A]													
35	Onsite Farm Field	0.52	118°/ESE	F								X	
36	Offsite Station Intersection Hwy 75/Co. Rd. P37	0.75	227°/SW	L			X						
37	Offsite Station Desoto Township	1.57	144°/SE	G	X	X	X						
38[A]													
39[A]													
40[A]													
41[C]	Dowler Acreage	0.73	175°/S	J	X	X	X		[B,C]				

Radiological Environmental Sampling Locations and Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
42	Sector A-1	1.94	0°/NORTH	A			X						
43	Sector B-1	1.97	16°/NNE	B			X						
44	Sector C-1	1.56	41°/NE	C			X						
45	Sector D-1	1.34	71°/ENE	D			X						
46	Sector E-1	1.54	90°/EAST	E			X						
47	Sector F-1	0.45	108°/ESE	F			X						
48	Sector G-1	1.99	134°/SE	G			X						
49	Sector H-1	1.04	159°/SSE	H			X						
50	Sector J-1	0.71	179°/SOUTH	J			X						
51	Sector K-1	0.61	205°/SSW	K			X						
52	Sector L-1	0.74	229°/SW	L			X						
53	Sector M-1	0.93	248°/WSW	M			X						
54	Sector N-1	1.31	266°/WEST	N			X						
55	Sector P-1	0.60	291°/WNW	P			X						
56	Sector Q-1	0.67	307°/NW	Q			X						
57	Sector R-1	2.32	328°/NNW	R			X						
58	Sector A-2	4.54	350°/NORTH	A			X						
59	Sector B-2	2.95	26°/NNE	B			X						
60	Sector C-2	3.32	50°/NE	C			X						
61	Sector D-2	3.11	75°/ENE	D			X						
62	Sector E-2	2.51	90°/EAST	E			X						
63	Sector F-2	2.91	110°/ESE	F			X						
64	Sector G-2	3.00	140°/SE	G			X						
65	Sector H-2	2.58	154°/SSE	H			X						

Radiological Environmental Sampling Locations and Media

Sample Station No.	Approximate Collection Sites	Approximate Distance from Center of Containment (miles)	Approximate Direction (degrees from true north)	Sector	Air Monitoring		TLD	Water	Milk	Sedi-ment	Fish	Vegetables and Food Products	Ground-water
					Airborne Particulate	Airborne Iodine							
66	Sector J-2	3.53	181°/SOUTH	J			X						
67	Sector K-2	2.52	205°/SSW	K			X						
68	Sector L-2	2.77	214°/SW	L			X						
69	Sector M-2	2.86	243°/WSW	M			X						
70	Sector N-2	2.54	263°/WEST	N			X						
71	Sector P-2	2.99	299°/WNW	P			X						
72	Sector Q-2	3.37	311°/NW	Q			X						
73	Sector R-2	3.81	328°/NNW	R			X						
74	D. Miller Farm	0.65	203°/SSW	K									X
75[C]	Lomp Acreage	0.65	163°/SSE	H	X	X	X		B, C				X
76	Stangl Farm	3.40	169°/S	J					X				

NOTES:

A. Location is either not in use or currently discontinued and is documented in the table for reference only.

B. If milk samples are temporarily not available at a sampling site due to mitigating circumstances, then vegetation (broadleaf, pasture grass, etc.) shall be collected as an alternate sample at the site. If there are no milk producers within the entire 5-mile radius of the plant, then vegetation shall be collected monthly, when available, at two offsite locations having the highest calculated annual average ground level D/Q and a background locale. (Reference Off-Site Dose Calculation Manual, Part II, Table 4 "Highest Potential Exposure Pathways for Estimating Dose")

C. Locations represent highest potential exposure pathways as determined by the biennial Land Use Survey

D. Background location (control). All other locations are indicators.

E. Location for monitoring Sector K High Exposure Pathway Resident Receptor for inhalation.

F. When broad leaf (pasture grasses) are being collected in lieu of milk, background broad leaf samples will be collected at a background locale.