Omaha Public Power District

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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 Permanently Defueled Technical Specifications (PDTS) Sections 5.9.4(a) and 5.9.4(b)

Pursuant to Fort Calhoun Station (FCS), Unit No. 1, Permanently Defueled Technical Specifications (PDTS), Sections 5.9.4(a), and 5.9.4(b), 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 PDTS 5.9.4(a) and encompasses the period of January 1, 2018 through December 31, 2018. 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 PDTS Section 5.17(d), Section VII of the Annual Radiological Effluent Release Report includes the revisions to the ODCM made during this period. Section VII of the Annual Radiological Effluent Release Report also includes Process Control Program (PCP) changes made during this period.

The Annual Radiological Environmental Operating Report is submitted in accordance with PDTS 5.9.4(b) and encompasses the period of January 1, 2018 through December 31, 2018.

No commitments to the NRC are contained in this letter.

Please contact Mr. Bradley H. Blome at (402) 533-6041 if you should have any questions.

Respectfully,

Bradley H. Blome
Director, Licensing and Regulatory Assurance

BHB/cac

Enclosures:

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

c: S. A. Morris, NRC Regional Administrator, Region IV
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Omaha Public Power District
Fort Calhoun Station Unit No. 1

Annual Report
For
Technical Specifications,
Section 5.9.4.a

January 1, 2018 to December 31, 2018

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, 2018 through December 31, 2018. 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, 2018 through December 31, 2018.

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 Decommissioning

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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, 2018 through December 31, 2018.

1.1 Executive Summary

The Radioactive Effluent Monitoring program for the year 2018 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 0.00 curies. This was a decrease from the 2017 activity of 1.88 E-4 curies. This decrease was due to decrease in RCS source from plant shutdown.

The total airborne activity from I-131, I-133, and particulates with half-lives > 8 days in 2018 was 0.00 curies. This is a continuation from the 2017 activity of 0.00 curies. This was due to decrease in RCS source from plant shutdown and zero particulate release from decommissioning activities.

The total airborne activity from Tritium was 0.672 curies. This was an increase from the 2017 activity of 0.393 curies. This increase was due to maintaining the Auxiliary Building at a higher temperature than in the past, which added to the evaporation of the tritium

The total airborne activity from C-14 was 0.00 curies. This is a continuation from the 2017 activity of 0.00 curies. Airborne activity from C-14 is included in the 2018 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. Since Fort Calhoun Station ceased power operations, C-14 is no longer being produced. Any C-14 released from gas tanks or decommissioning activities was previously accounted for in reports which had power history.

Dose contributions from airborne effluents at the unrestricted area boundary were; 0.00 mRad gamma air dose, 0.00 mRad beta air dose, 7.74E-04 mRem total body dose, and 7.74E-04 mRem critical organ dose. Gamma and beta dose showed a decrease from 2017 levels of 1.13 E-09 mRad gamma air dose and 1.28-07 mRad beta

air dose, from not releasing iodines and a reduction in gas source term plant shutdown. Whole body and critical organ doses increased from 2017 levels of 5.47E-04 mRem total body dose and 5.47E-04 mRem critical organ dose. This increase is due to the increase in the tritium released.

Total water activity (excluding tritium, dissolved gases, and alpha) released in 2018 in liquid effluents was 1.38E-04 curies. This was a decrease from the 2017 activity of 2.23E-03 curies. This decrease was due to a substantial decrease in liquid waste generated and reduced source term from cessation of operations.

The total water tritium activity released in 2018 in liquid effluents was 7.83E-02 curies. This was a decrease from the 2017 activity of 2.2 curies. This decrease was due to a substantial decrease in liquid waste generated and reduced source term from cessation of operations.

The calculated whole body dose due to liquid effluents at the site discharge from all sources in 2018 was 2.72E-02 mRem which was 0.91% of the annual dose limit. This was a decrease from the 2017 dose of 2.80-01 mRem, which was 9.33% of the annual dose limit. Dose decreased due to a decrease in volume and activity released.

The calculated critical organ dose due to liquid effluents at the site discharge from all sources in 2018 was 4.31E-02 mRem. This was a decrease from the 2017 dose of 4.39E-01 mRem. This decrease was previously described.

The Fort Calhoun Station meteorological system had a cumulative recovery rate of 95.17% from the station meteorological tower with the remaining 4.83% 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 2018.

During 2018 there were one change to the Off-site Dose Calculations Manual (ODCM), CH-ODCM-0001 and two changes to the Process Control Program, RP-5101.

For 2018, the total volume of solid radwaste released from the unit was 149.39 cubic meters. This was a decrease from the 260.24 cubic meters of solid waste released from the unit in 2017. The decrease was attributed to the four filter shipments were small waste volumes and a reduction in disposal of resin and dry compressible waste.

The total activity released from the unit for 2018 was 202.39 curies, 187.7 curies from spent resin, 9.84 curies from dry compressible, 4.85 curies from irradiated components and 5.76E-06 curies from other. This was an increase from the 2017 value of 212.18 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, Chemistry supervision 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, Chemistry supervision 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. 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.

2.3.2 Gaseous Radioactive Effluents

Each gaseous batch release was sampled and analyzed for radioactivity prior to release. 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 = $(E_1^2 + E_2^2 + E_3^2 + ... + E_n^2)^{0.5}$
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 was 1 instrument used to monitor radioactive effluent releases that failed to meet the minimum reportable instrument operability requirements listed in the ODCM during the reporting period.

RM-063, Post Accident Radiation Monitor, was inoperable for 98 days (1/1/2018-4/9/2018) due to a failure of a circuit board. Multiple attempts to obtain new and modified boards did not address the issue. NRC was notified after 7 days of the monitor being unavailable as required by station Emergency Planning procedures. The ability to perform grab sampling per CH-SMP-PA-0005 in the event of an emergency was the required compensatory action during the monitor's unavailability.

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

During 2018, one revision was made to the ODCM on March 19, 2018 and two changes were made to the PCP on May 30, 2018 and June 27, 2018.

- The following change was made to the ODCM:
  - To align with a Technical Specification change.
    - Changed Operable-Operability to Functional-Functionality.
    - Removed Steam Generator Blowdown, Containment, Waste Gas Decay Tanks and Condenser Off Gas as release points.
    - Removed I-131 sampling and analysis requirements.
    - Removed section related to primary coolant exceeding the limits of Technical Specification 2.1.3.
    - Removed RM-063.
    - Changed Updated Safety Analysis Report to Defueled Safety Analysis Report.

        - Removed correction factor associated with VIAS and increased the correction factor associated with detector sensitivity.
        - Replaced "Plant" with "Facility" to align with the current terminology.
    - Revised Supervisor-System Chemistry to Chemistry supervision.
    - Added Distance and direction to Sample location.
    - Revised title of reportability manual from SO-R-1 to LS-FC-1010.
    - Removed circulating water and warm water recirc as release options.
    - Revised the normal and maximum flow for monitor tank discharges.
    - Added parameter definitions for multiple equations.

- The following changes were made to the PCP:
    - Revision 1:
        - Added note to the definition section to clarify applicability and scope.
    - Revision 2:
        - Added revision bars indicating all changes made in Revision 0 and 1.

6.3 New Locations or Modifications for Dose Calculations or Environmental Monitoring

None

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 2018.

6.4.2 Failure to Meet Specified Sampling Requirements

During 2018, 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 2018, 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 and a special report 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 2018 were any of these limits exceeded; therefore, no special report per Tech Specification 5.16 was required.

The external Total Body Dose is comprised of:

1) Total Body Dose due to noble gas radionuclides in gaseous effluents
2) Dose due to radioactive waste and the ISFSI
3) Total Body Dose due to radioactivity deposited on the ground (this dose is accounted for in the determination of the non-noble gas dose and is not considered here)

The Total Body Dose, external is given by:
Dext = Dtb + Dosf

Where Dext is the external dose
Dtb is the total body dose
Dosf is the dose from on-site storage

The Total Dose is then given by:
Dtot = Dext + Dliq + Dnng

Where Dtot is the total dose
Dext is the external dose
Dliq is the dose from liquid effluents
Dnng is the dose from non-noble gases

Dose Limits

Total Body, annual	25 mrem
Thyroid, annual	75 mrem
Other Organs, annual	25 mrem

Calculation using REMP TLD Comparison

Indicating TLD station {OTD-1K-(I)}, closest to on site storage, in mrem/week minus REMP environmental control {OTD-L-(C)}, in mrem/week

	OTD-1K-(I) mrem/wk	OTD-L-(C) mrem/wk	Net mrem/wk	Weeks/qtr	Qtr Dose mrem/qtr
Quarter 1	1.9	1.3	0.6	13	7.8
Quarter 2	1.5	1.3	0.2	13	2.6
Quarter 3	1.9	1.3	0.6	13	7.8
Quarter 4	1.6	1.4	0.2	13	2.6
Dext					**20.8**

Dext = 20.8 mrem

Maximum offsite doses from report

Dtbwb = 7.74E-04 mrem, Dtbco = 7.74E-04 mrem

Dliqwb = 2.72E-02 mrem Dliqco = 4.31E-02 mrem

Dtot wholebody = 20.8 + 7.74E-04 + 2.72E-02 = 20.83 mrem

Dtot critical organ = 20.8 + 7.74E-04 + 4.31E-02 = 20.84 mrem

These reported doses are bounding cases demonstrating compliance. Actual REMP TLD readings do not show any deviation from historical averages for this location, both pre and post construction of the SG storage mausoleum and ISFSI. On-site TLD's used for dose monitoring at onsite rad storage facilities do not have identical counterparts at the site boundary or actual offsite receptors. Additionally the liquid dose pathway, since it is downstream of the indicator location and is not hydro-geologically connected, would produce very conservative results compared to calculating actual dose.

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 2018. Additional radiological surveys were performed during decommissioning characterization, no plant related nuclides were discovered in soil. 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 rain sampling events were conducted. No tritium activity in excess of the vendor's Minimum Detectable Activity (MDA) was reported. No tritium activity in excess of the vendor's Minimum Detectable Activity (MDA) was reported in collected storm water or rain sampling.

- One monitoring well (MW-6) had tritium in excess of the vendor's Minimum Detectable Activity (MDA) (285 pCi/L) reported in Table III.9 at values between 323 pCi/L +/- 200 pCi/L. MW-6 detection was below any reporting thresholds. This well is sampled quarterly for the entire HTD suite of analyses. No other analyses had detected activity. MW-6 had tritium identified with activity <MDA (275 pCi/L) during 2 quarterly samples, at 241 pCi/L +/- 197 and 225 pCi/L +/- 186. These results were not reduced due to station trends for this location. This well is hydrogeology connected to the Missouri River downstream of the plant discharge and is influenced by high river levels and station discharge. The third quarter result for the East Sewage Lagoon had tritium in excess of the vendor's Minimum Detectable Activity (MDA) (284 pCi/L) reported in Table III.9 at values between 328 pCi/L +/- 199 pCi/L. There is well documented industry OE of false positives in sewage samples. Since the 4th quarter sample had been drawn with the irrigation end of season sample when the vendor result had returned, that sample was analyzed vice reanalysis of a potentially bad matrix. The fourth quarter sample had no detection aligning with established trends. One Sr-90 result identified < MDA (0.555 pCi/L) was retained during statistical data review based on historical station shallow well trends (MW-5A 0.375 pCi/L). 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. During the 3rd quarter wells MW-12A & 12B, station background wells, were not sampled due to localized flooding which covered these wells.

- The Fort Calhoun REMP sampling did not detect tritium in samples within the Missouri River downstream at the site boundary or at the nearest municipal drinking water facility. No groundwater drinking pathway exists on site. Groundwater monitoring of neighboring drinking wells is performed to have data, if a plume were identified 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, 2018 - December 31, 2018

Quarterly Dose Calculation Results

January 1, 2018 through December 31, 2018

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 2018 calculated doses.

This section presents the results of the quarterly dose calculations performed during the period January 1, 2018 through December 31, 2018. 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 2018 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	2.16E-02	3.43E-02
Continuous:	0.00E+00	0.00E+00
Totals:	2.16E-02	3.43E-02
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj.	1.44 %	0.69 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.72 %	0.34 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	0.00E+00	0.00E+00
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.00 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.00 %	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:	2.13E-05	2.13E-05
Ground and Food:	9.86E-05	9.86E-05
Totals:	1.20E-04	1.20E-04
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.00 %	0.00 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.00 %	0.00 %

Reviewed by:

QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN SECOND QUARTER 2018 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	0.00E+00	0.00E+00
Continuous:	0.00E+00	0.00E+00
Totals:	0.00E+00	0.00E+00
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj.	0.00 %	0.00 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.72 %	0.34 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	0.00E+00	0.00E+00
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.00 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.00 %	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:	4.47E-05	4.47E-05
Ground and Food:	2.07E-04	2.07E-04
Totals:	2.52E-04	2.52E-04
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.00 %	0.00 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.00 %	0.00 %

Reviewed by:

QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN THIRD QUARTER 2018 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	0.00E+00	0.00E+00
Continuous:	0.00E+00	0.00E+00
Totals:	0.00E+00	0.00E+00
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.00 %	0.00 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.72 %	0.34 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	0.00E+00	0.00E+00
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.00 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.00 %	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:	6.98E-05	6.98E-05
Ground and Food:	3.23E-04	3.23E-04
Totals:	3.93E-04	3.93E-04
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.01 %	0.01 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.03 %	0.01 %

Reviewed by:

QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN FOURTH QUARTER 2018 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	5.78E-03	9.11E-03
Continuous:	0.00E+00	0.00E+00
Totals:	5.78E-03	9.11E-03
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.39 %	0.18 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.91 %	0.42 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	0.00E+00	0.00E+00
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj	0.00 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj.	0.00 %	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:	8.51E-05	8.51E-05
Ground and Food:	3.93E-04	3.93E-04
Totals:	4.78E-04	4.78E-04
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.01 %	0.01 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.01 %	0.01 %

Reviewed by:

RADIOLOGICAL EFFLUENT RELEASES

Technical Specification (5.9.4.a)

January 1, 2018 - December 31, 2018

TABLE III.1

BATCH LIQUID AND GASEOUS RELEASE SUMMARY

JANUARY THROUGH DECEMBER 2018

A. Liquid Releases All Sources	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. Number of Batch Releases:	3			2	5
2. Total Time Period for Batch Releases(min):	1,422			295	1,717
3. Maximum Time Period for Batch Releases(min):	763			163	763
4. Average Time Period for Batch Releases(min):	474			148	343
5. Minimum Time Period for Batch Releases(min):	178			132	132
6. Average Dilution Stream Flow During Periods of Release into the Missouri River(mls/min):	2.731E+07			2.739E+07	2.734E+07

B. Gaseous Releases All Sources	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. Number of Batch Releases:				1	1
2. Total Time Period for Batch Releases(min):				8,795	8,795
3. Maximum Time Period for Batch Releases(min):				8,795	8,795
4. Average Time Period for Batch Releases(min):				8,795	8,795
5. Minimum Time Period for Batch Releases(min):				8,795	8,795

TABLE III.2

ABNORMAL BATCH LIQUID AND GASEOUS RELEASE SUMMARY

JANUARY THROUGH DECEMBER 2018

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 2018

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
A.	Fission & Activation Gases					
	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 (%): 21.2					
B.	Iodines					
	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 (%): 21.2					
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	1.31E-06	1.58E-06	1.50E-06	9.55E-07	5.35E-06
D.	Tritium					
	Total Release (Ci):	6.49E-02	1.36E-01	2.13E-01	2.59E-01	6.72E-01
	Average Release Rate (uCi/sec):	6.49E-04	1.35E-03	2.08E-03	2.35E-03	1.61E-03
	Total Error (%): 25.08					
E.	Carbon-14					
	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					

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 2018

Batch 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					
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	0.00E+00	0.00E+00	0.00E+00	9.11E-07	9.11E-07

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 2018

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					
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					
ALPHA	1.31E-06	1.58E-06	1.50E-06	9.55E-07	5.35E-06
H-3	6.49E-02	1.36E-01	2.13E-01	2.59E-01	6.72E-01

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 2018

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
A. Fission & Activiation Products					
Total Release (No H-3,Gas,Alpha) (Ci):	1.06E-04	0.00E+00	0.00E+00	3.21E-05	1.38E-04
Average Diluted Concentration (uCi/mL):	8.21E-09	0.00E+00	0.00E+00	7.96E-09	1.48E-08
10 CFR 20, App. B Limit 1.00E-06 (uCi/mL) Percent of Limit (%):	8.21E-01	0.00E+00	0.00E+00	7.96E-01	1.48E+00
Total Error (%): 19.48					
B. Tritium					
Total Release (Ci):	4.41E-02	0.00E+00	0.00E+00	3.43E-02	7.83E-02
Average Diluted Concentration (uCi/mL):	3.41E-06	0.00E+00	0.00E+00	8.49E-06	8.35E-06
10 CFR 20, App. B Limit 1.00E-03(uCi/mL) Percent of Limit (%):	3.41E-01	0.00E+00	0.00E+00	8.49E-01	8.35E-01
Total Error (%): 25.08					
C. Dissolved & Entrained Gases					
Total Release (Ci):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Average Diluted Concentration (uCi/mL):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ODCM Limit 2.00E-04 (uCi/mL): Percent of Limit (%):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Error (%): 18.34					
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):	5.95E+04			3.89E+04	9.85E+04
F. Volume of Dilution Water During Releases (Liters):	3.88E+07	0.00E+00	0.00E+00	8.04E+06	4.68E+07

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

TABLE III.7

LIQUID EFFLUENTS

JANUARY THROUGH DECEMBER 2018

Batch Mode

Nuclides(Ci)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
Fission & Activation Gases					
CS-137	1.00E-04	0.00E+00	0.00E+00	2.65E-05	1.27E-04
CS-134	2.33E-07	0.00E+00	0.00E+00	0.00E+00	2.33E-07
CO-60	5.93E-06	0.00E+00	0.00E+00	5.64E-06	1.16E-05
Totals for Period:	1.06E-04	.00E+00	.00E+00	3.21E-05	1.38E-04
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	4.41E-02	0.00E+00	0.00E+00	3.43E-02	7.83E-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.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2018

		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		0.00E+00		
	Ni-63		0.00E+00		
	Sr-90		0.00E+00		
	Total Gamma		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		
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		
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		
	Total Gamma		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		
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		
MW-3A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Sr-90	0.00E+00	0.00E+00	5.88E-01	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-3B					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55	0.00E-00	0.00E+00	0.00E+00	0.00E+00
	Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Sr-90	0.00E+00	0.00E+00	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		
	Total Gamma		0.00E+00		

TABLE III.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2018

		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		
	NI-63		0.00E+00		
	Sr-90		0.00E+00		
	Total Gamma		0.00E+00		
MW-5A					
	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		3.75E-01		
	Total Gamma		0.00E+00		
MW-6					
	Tritium	0.00E+00	2.41E+02	2.25E+02	3.23E-02
	FE-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NI-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total Gamma	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		
MW-7					
	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		
MW-9					
	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		
MW-10					
	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		
MW-11					
	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		
MW-12A					
	Tritium	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		

TABLE III.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2018

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
MW-12P				
Tritium	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		
EAST LAGOON				
Tritium	0.00E+00	0.00E+00	3.28E+02	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-8 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, 2018 - December 31, 2018

Radioactive Effluent Releases - First, Second, Third and Fourth Quarters 2018

GASEOUS EFFLUENTS

No radioactive inert gas releases were released during the reporting period from gaseous effluent discharges.

No radioactive halogens releases were released during the reporting period 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 6.72E-01 curies.

Carbon-14 released for the reporting period totaled 0.00 curies, this is a calculated value based on reactor power and days of operation. The Fort Calhoun estimate of 0.00 curies Carbon-14 with 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-40. 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, 2018 through December 31, 2018 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 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 1 RES
AT 4.36 MILES N

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	1.68E-06	1.68E-06	0.00E+00	1.68E-06	1.68E-06	1.68E-06	1.68E-06	1.68E-06
TEEN	1.70E-06	1.70E-06	0.00E+00	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
CHILD	1.50E-06	1.50E-06	0.00E+00	1.50E-06	1.50E-06	1.50E-06	1.50E-06	1.50E-06
INFANT	8.63E-07	8.63E-07	0.00E+00	8.63E-07	8.63E-07	8.63E-07	8.63E-07	8.63E-07

TABLE IV-A- 2

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 2 RES
AT 1.93 MILES NNE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	8.73E-06	8.73E-06	0.00E+00	8.73E-06	8.73E-06	8.73E-06	8.73E-06	8.73E-06
TEEN	8.81E-06	8.81E-06	0.00E+00	8.81E-06	8.81E-06	8.81E-06	8.81E-06	8.81E-06
CHILD	7.78E-06	7.78E-06	0.00E+00	7.78E-06	7.78E-06	7.78E-06	7.78E-06	7.78E-06
INFANT	4.47E-06	4.47E-06	0.00E+00	4.47E-06	4.47E-06	4.47E-06	4.47E-06	4.47E-06

TABLE IV-A- 3

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 3 RES
AT 1.52 MILES NE

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	1.03E-05	1.03E-05	0.00E+00	1.03E-05	1.03E-05	1.03E-05	1.03E-05	1.03E-05
TEEN	1.04E-05	1.04E-05	0.00E+00	1.04E-05	1.04E-05	1.04E-05	1.04E-05	1.04E-05
CHILD	9.14E-06	9.14E-06	0.00E+00	9.14E-06	9.14E-06	9.14E-06	9.14E-06	9.14E-06
INFANT	5.26E-06	5.26E-06	0.00E+00	5.26E-06	5.26E-06	5.26E-06	5.26E-06	5.26E-06

TABLE IV-A- 4

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 4 RES
AT 4.79 MILES ENE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	8.12E-07	8.12E-07	0.00E+00	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
TEEN	8.19E-07	8.19E-07	0.00E+00	8.19E-07	8.19E-07	8.19E-07	8.19E-07	8.19E-07
CHILD	7.23E-07	7.23E-07	0.00E+00	7.23E-07	7.23E-07	7.23E-07	7.23E-07	7.23E-07
INFANT	4.16E-07	4.16E-07	0.00E+00	4.16E-07	4.16E-07	4.16E-07	4.16E-07	4.16E-07

TABLE IV-A- 5

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 5 RES
AT 4.67 MILES E

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	1.01E-06	1.01E-06	0.00E+00	1.01E-06	1.01E-06	1.01E-06	1.01E-06	1.01E-06
TEEN	1.02E-06	1.02E-06	0.00E+00	1.02E-06	1.02E-06	1.02E-06	1.02E-06	1.02E-06
CHILD	9.00E-07	9.00E-07	0.00E+00	9.00E-07	9.00E-07	9.00E-07	9.00E-07	9.00E-07
INFANT	5.18E-07	5.18E-07	0.00E+00	5.18E-07	5.18E-07	5.18E-07	5.18E-07	5.18E-07

TABLE IV-A- 6

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 6 RES
AT 4.22 MILES ESE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	1.68E-06	1.68E-06	0.00E+00	1.68E-06	1.68E-06	1.68E-06	1.68E-06	1.68E-06
TEEN	1.70E-06	1.70E-06	0.00E+00	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
CHILD	1.50E-06	1.50E-06	0.00E+00	1.50E-06	1.50E-06	1.50E-06	1.50E-06	1.50E-06
INFANT	8.63E-07	8.63E-07	0.00E+00	8.63E-07	8.63E-07	8.63E-07	8.63E-07	8.63E-07

TABLE IV-A- 7

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 7 RES
AT 1.67 MILES SE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	1.13E-05	1.13E-05	0.00E+00	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05
TEEN	1.14E-05	1.14E-05	0.00E+00	1.14E-05	1.14E-05	1.14E-05	1.14E-05	1.14E-05
CHILD	1.01E-05	1.01E-05	0.00E+00	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
INFANT	5.81E-06	5.81E-06	0.00E+00	5.81E-06	5.81E-06	5.81E-06	5.81E-06	5.81E-06

TABLE IV-A- 8

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 8 RES
AT 0.65 MILES SSE

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	1.16E-04	1.16E-04	0.00E+00	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04
TEEN	1.17E-04	1.17E-04	0.00E+00	1.17E-04	1.17E-04	1.17E-04	1.17E-04	1.17E-04
CHILD	1.04E-04	1.04E-04	0.00E+00	1.04E-04	1.04E-04	1.04E-04	1.04E-04	1.04E-04
INFANT	5.96E-05	5.96E-05	0.00E+00	5.96E-05	5.96E-05	5.96E-05	5.96E-05	5.96E-05

TABLE IV-A- 9

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 9 RES
AT 0.73 MILES S

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	5.51E-05	5.51E-05	0.00E+00	5.51E-05	5.51E-05	5.51E-05	5.51E-05	5.51E-05
TEEN	5.56E-05	5.56E-05	0.00E+00	5.56E-05	5.56E-05	5.56E-05	5.56E-05	5.56E-05
CHILD	4.91E-05	4.91E-05	0.00E+00	4.91E-05	4.91E-05	4.91E-05	4.91E-05	4.91E-05
INFANT	2.83E-05	2.83E-05	0.00E+00	2.83E-05	2.83E-05	2.83E-05	2.83E-05	2.83E-05

TABLE IV-A-10

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 10 RES
AT 0.65 MILES SSW

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	7.35E-05	7.35E-05	0.00E+00	7.35E-05	7.35E-05	7.35E-05	7.35E-05	7.35E-05
TEEN	7.42E-05	7.42E-05	0.00E+00	7.42E-05	7.42E-05	7.42E-05	7.42E-05	7.42E-05
CHILD	6.55E-05	6.55E-05	0.00E+00	6.55E-05	6.55E-05	6.55E-05	6.55E-05	6.55E-05
INFANT	3.77E-05	3.77E-05	0.00E+00	3.77E-05	3.77E-05	3.77E-05	3.77E-05	3.77E-05

TABLE IV-A-11

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 11 RES
AT 0.73 MILES SW

ANNUAL BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	3.98E-05	3.98E-05	0.00E+00	3.98E-05	3.98E-05	3.98E-05	3.98E-05	3.98E-05
TEEN	4.02E-05	4.02E-05	0.00E+00	4.02E-05	4.02E-05	4.02E-05	4.02E-05	4.02E-05
CHILD	3.55E-05	3.55E-05	0.00E+00	3.55E-05	3.55E-05	3.55E-05	3.55E-05	3.55E-05
INFANT	2.04E-05	2.04E-05	0.00E+00	2.04E-05	2.04E-05	2.04E-05	2.04E-05	2.04E-05

TABLE IV-A-12

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 12 RES
AT 1.06 MILES WSW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	2.30E-05	2.30E-05	0.00E+00	2.30E-05	2.30E-05	2.30E-05	2.30E-05	2.30E-05
TEEN	2.32E-05	2.32E-05	0.00E+00	2.32E-05	2.32E-05	2.32E-05	2.32E-05	2.32E-05
CHILD	2.05E-05	2.05E-05	0.00E+00	2.05E-05	2.05E-05	2.05E-05	2.05E-05	2.05E-05
INFANT	1.18E-05	1.18E-05	0.00E+00	1.18E-05	1.18E-05	1.18E-05	1.18E-05	1.18E-05

TABLE IV-A-13

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 13 RES
AT 1.20 MILES W

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	1.99E-05	1.99E-05	0.00E+00	1.99E-05	1.99E-05	1.99E-05	1.99E-05	1.99E-05
TEEN	2.01E-05	2.01E-05	0.00E+00	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05
CHILD	1.77E-05	1.77E-05	0.00E+00	1.77E-05	1.77E-05	1.77E-05	1.77E-05	1.77E-05
INFANT	1.02E-05	1.02E-05	0.00E+00	1.02E-05	1.02E-05	1.02E-05	1.02E-05	1.02E-05

TABLE IV-A-14

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 14 RES
AT 2.60 MILES WNW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	4.44E-06	4.44E-06	0.00E+00	4.44E-06	4.44E-06	4.44E-06	4.44E-06	4.44E-06
TEEN	4.48E-06	4.48E-06	0.00E+00	4.48E-06	4.48E-06	4.48E-06	4.48E-06	4.48E-06
CHILD	3.96E-06	3.96E-06	0.00E+00	3.96E-06	3.96E-06	3.96E-06	3.96E-06	3.96E-06
INFANT	2.28E-06	2.28E-06	0.00E+00	2.28E-06	2.28E-06	2.28E-06	2.28E-06	2.28E-06

TABLE IV-A-15

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 15 RES
AT 2.40 MILES NW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E-00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E-00
INHAL								
ADULT	7.20E-06	7.20E-06	0.00E+00	7.20E-06	7.20E-06	7.20E-06	7.20E-06	7.20E-06
TEEN	7.26E-06	7.26E-06	0.00E+00	7.26E-06	7.26E-06	7.26E-06	7.26E-06	7.26E-06
CHILD	6.41E-06	6.41E-06	0.00E+00	6.41E-06	6.41E-06	6.41E-06	6.41E-06	6.41E-06
INFANT	3.69E-06	3.69E-06	0.00E+00	3.69E-06	3.69E-06	3.69E-06	3.69E-06	3.69E-06

TABLE IV-A-16

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 16 RES
AT 2.08 MILES NNW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INHAL								
ADULT	9.03E-06	9.03E-06	0.00E+00	9.03E-06	9.03E-06	9.03E-06	9.03E-06	9.03E-06
TEEN	9.12E-06	9.12E-06	0.00E+00	9.12E-06	9.12E-06	9.12E-06	9.12E-06	9.12E-06
CHILD	8.05E-06	8.05E-06	0.00E+00	8.05E-06	8.05E-06	8.05E-06	8.05E-06	8.05E-06
INFANT	4.63E-06	4.63E-06	0.00E+00	4.63E-06	4.63E-06	4.63E-06	4.63E-06	4.63E-06

TABLE IV-A-17

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 17 VEG
AT 2.23 MILES NNE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	1.05E-05	1.05E-05	0.00E+00	1.05E-05	1.05E-05	1.05E-05	1.05E-05	1.05E-05
TEEN	1.21E-05	1.21E-05	0.00E+00	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05
CHILD	1.87E-05	1.87E-05	0.00E+00	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05

TABLE IV-A-18

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 18 VEG
AT 3.20 MILES NE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	3.05E-06	3.05E-06	0.00E+00	3.05E-06	3.05E-06	3.05E-06	3.05E-06	3.05E-06
TEEN	3.49E-06	3.49E-06	0.00E+00	3.49E-06	3.49E-06	3.49E-06	3.49E-06	3.49E-06
CHILD	5.42E-06	5.42E-06	0.00E+00	5.42E-06	5.42E-06	5.42E-06	5.42E-06	5.42E-06

TABLE IV-A-19

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 19 VEG
AT 4.79 MILES ENE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	1.47E-06	1.47E-06	0.00E+00	1.47E-06	1.47E-06	1.47E-06	1.47E-06	1.47E-06
TEEN	1.68E-06	1.68E-06	0.00E+00	1.68E-06	1.68E-06	1.68E-06	1.68E-06	1.68E-06
CHILD	2.61E-06	2.61E-06	0.00E+00	2.61E-06	2.61E-06	2.61E-06	2.61E-06	2.61E-06

TABLE IV-A-20

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 20 VEG
AT 4.22 MILES ESE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	3.05E-06	3.05E-06	0.00E+00	3.05E-06	3.05E-06	3.05E-06	3.05E-06	3.05E-06
TEEN	3.49E-06	3.49E-06	0.00E+00	3.49E-06	3.49E-06	3.49E-06	3.49E-06	3.49E-06
CHILD	5.42E-06	5.42E-06	0.00E+00	5.42E-06	5.42E-06	5.42E-06	5.42E-06	5.42E-06

TABLE IV-A-21

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 21 VEG
AT 2.15 MILES SE

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	1.05E-05	1.05E-05	0.00E+00	1.05E-05	1.05E-05	1.05E-05	1.05E-05	1.05E-05
TEEN	1.21E-05	1.21E-05	0.00E+00	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05
CHILD	1.87E-05	1.87E-05	0.00E+00	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05

TABLE IV-A-22

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 22 VEG
AT 0.94 MILES SSE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	9.16E-05	9.16E-05	0.00E+00	9.16E-05	9.16E-05	9.16E-05	9.16E-05	9.16E-05
TEEN	1.05E-04	1.05E-04	0.00E+00	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04
CHILD	1.63E-04	1.63E-04	0.00E+00	1.63E-04	1.63E-04	1.63E-04	1.63E-04	1.63E-04

TABLE IV-A-23

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 23 VEG
AT 0.73 MILES S

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	9.99E-05	9.99E-05	0.00E+00	9.99E-05	9.99E-05	9.99E-05	9.99E-05	9.99E-05
TEEN	1.14E-04	1.14E-04	0.00E+00	1.14E-04	1.14E-04	1.14E-04	1.14E-04	1.14E-04
CHILD	1.77E-04	1.77E-04	0.00E+00	1.77E-04	1.77E-04	1.77E-04	1.77E-04	1.77E-04

TABLE IV-A-24

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 24 VEG
AT 0.99 MILES SSW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E-00
VEGET								
ADULT	5.27E-05	5.27E-05	0.00E+00	5.27E-05	5.27E-05	5.27E-05	5.27E-05	5.27E-05
TEEN	6.03E-05	6.03E-05	0.00E+00	6.03E-05	6.03E-05	6.03E-05	6.03E-05	6.03E-05
CHILD	9.36E-05	9.36E-05	0.00E+00	9.36E-05	9.36E-05	9.36E-05	9.36E-05	9.36E-05

TABLE IV-A-25

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 25 VEG
AT 1.43 MILES SW

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	1.39E-05	1.39E-05	0.00E+00	1.39E-05	1.39E-05	1.39E-05	1.39E-05	1.39E-05
TEEN	1.59E-05	1.59E-05	0.00E+00	1.59E-05	1.59E-05	1.59E-05	1.59E-05	1.59E-05
CHILD	2.46E-05	2.46E-05	0.00E+00	2.46E-05	2.46E-05	2.46E-05	2.46E-05	2.46E-05

TABLE IV-A-26

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 26 VEG
AT 1.13 MILES WSW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	3.33E-05	3.33E-05	0.00E+00	3.33E-05	3.33E-05	3.33E-05	3.33E-05	3.33E-05
TEEN	3.81E-05	3.81E-05	0.00E+00	3.81E-05	3.81E-05	3.81E-05	3.81E-05	3.81E-05
CHILD	5.91E-05	5.91E-05	0.00E+00	5.91E-05	5.91E-05	5.91E-05	5.91E-05	5.91E-05

TABLE IV-A-27

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 27 VEG
AT 1.30 MILES W

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	2.75E-05	2.75E-05	0.00E+00	2.75E-05	2.75E-05	2.75E-05	2.75E-05	2.75E-05
TEEN	3.14E-05	3.14E-05	0.00E+00	3.14E-05	3.14E-05	3.14E-05	3.14E-05	3.14E-05
CHILD	4.88E-05	4.88E-05	0.00E+00	4.88E-05	4.88E-05	4.88E-05	4.88E-05	4.88E-05

TABLE IV-A-28

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 28 VEG
AT 2.65 MILES WNW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	7.77E-06	7.77E-06	0.00E+00	7.77E-06	7.77E-06	7.77E-06	7.77E-06	7.77E-06
TEEN	8.88E-06	8.88E-06	0.00E+00	8.88E-06	8.88E-06	8.88E-06	8.88E-06	8.88E-06
CHILD	1.38E-05	1.38E-05	0.00E+00	1.38E-05	1.38E-05	1.38E-05	1.38E-05	1.38E-05

TABLE IV-A-29

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 29 VEG
AT 2.40 MILES NW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	1.30E-05	1.30E-05	0.00E+00	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05
TEEN	1.49E-05	1.49E-05	0.00E+00	1.49E-05	1.49E-05	1.49E-05	1.49E-05	1.49E-05
CHILD	2.32E-05	2.32E-05	0.00E+00	2.32E-05	2.32E-05	2.32E-05	2.32E-05	2.32E-05

TABLE IV-A-30

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 30 VEG
AT 3.73 MILES NNW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
VEGET								
ADULT	4.44E-06	4.44E-06	0.00E+00	4.44E-06	4.44E-06	4.44E-06	4.44E-06	4.44E-06
TEEN	5.08E-06	5.08E-06	0.00E+00	5.08E-06	5.08E-06	5.08E-06	5.08E-06	5.08E-06
CHILD	7.88E-06	7.88E-06	0.00E+00	7.88E-06	7.88E-06	7.88E-06	7.88E-06	7.88E-06

TABLE IV-A-31

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 31 BEEF
AT 4.72 MILES NNE

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAT								
ADULT	3.63E-07	3.63E-07	0.00E+00	3.63E-07	3.63E-07	3.63E-07	3.63E-07	3.63E-07
TEEN	2.16E-07	2.16E-07	0.00E+00	2.16E-07	2.16E-07	2.16E-07	2.16E-07	2.16E-07
CHILD	2.62E-07	2.62E-07	0.00E+00	2.62E-07	2.62E-07	2.62E-07	2.62E-07	2.62E-07

TABLE IV-A-32

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 32 BEEF
AT 4.91 MILES E

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAT								
ADULT	2.47E-07	2.47E-07	0.00E+00	2.47E-07	2.47E-07	2.47E-07	2.47E-07	2.47E-07
TEEN	1.47E-07	1.47E-07	0.00E+00	1.47E-07	1.47E-07	1.47E-07	1.47E-07	1.47E-07
CHILD	1.78E-07	1.78E-07	0.00E+00	1.78E-07	1.78E-07	1.78E-07	1.78E-07	1.78E-07

TABLE IV-A-33

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 33 BEEF
AT 0.66 MILES S

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAT								
ADULT	1.83E-05	1.83E-05	0.00E+00	1.83E-05	1.83E-05	1.83E-05	1.83E-05	1.83E-05
TEEN	1.09E-05	1.09E-05	0.00E+00	1.09E-05	1.09E-05	1.09E-05	1.09E-05	1.09E-05
CHILD	1.32E-05	1.32E-05	0.00E+00	1.32E-05	1.32E-05	1.32E-05	1.32E-05	1.32E-05

TABLE IV-A-34

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 34 BEEF
AT 0.76 MILES SW

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAT								
ADULT	9.57E-06	9.57E-06	0.00E+00	9.57E-06	9.57E-06	9.57E-06	9.57E-06	9.57E-06
TEEN	5.70E-06	5.70E-06	0.00E+00	5.70E-06	5.70E-06	5.70E-06	5.70E-06	5.70E-06
CHILD	6.91E-06	6.91E-06	0.00E+00	6.91E-06	6.91E-06	6.91E-06	6.91E-06	6.91E-06

TABLE IV-A-35

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 35 BEEF
AT 3.25 MILES W

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAT								
ADULT	4.78E-07	4.78E-07	0.00E+00	4.78E-07	4.78E-07	4.78E-07	4.78E-07	4.78E-07
TEEN	2.85E-07	2.85E-07	0.00E+00	2.85E-07	2.85E-07	2.85E-07	2.85E-07	2.85E-07
CHILD	3.45E-07	3.45E-07	0.00E+00	3.45E-07	3.45E-07	3.45E-07	3.45E-07	3.45E-07

TABLE IV-A-36

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS

SPECIAL LOCATION NO. 36 BEEF
AT 4.59 MILES WNW

ANNUAL BETA AIR DOSE = 0.00E+00 MILLRADS
ANNUAL GAMMA AIR DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAT								
ADULT	4.39E-07	4.39E-07	0.00E+00	4.39E-07	4.39E-07	4.39E-07	4.39E-07	4.39E-07
TEEN	2.61E-07	2.61E-07	0.00E+00	2.61E-07	2.61E-07	2.61E-07	2.61E-07	2.61E-07
CHILD	3.17E-07	3.17E-07	0.00E+00	3.17E-07	3.17E-07	3.17E-07	3.17E-07	3.17E-07

TABLE IV-A-37

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
SPECIAL LOCATION NO. 37 GOAT
AT 3.44 MILES S

ANNUAL_BETA_AIR_DOSE = 0.00E+00 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 0.00E+00 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GROUND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GOATMILK								
ADULT	1.72E-06	1.72E-06	0.00E+00	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
TEEN	2.24E-06	2.24E-06	0.00E+00	2.24E-06	2.24E-06	2.24E-06	2.24E-06	2.24E-06
CHILD	3.54E-06	3.54E-06	0.00E+00	3.54E-06	3.54E-06	3.54E-06	3.54E-06	3.54E-06
INFANT	5.38E-06	5.38E-06	0.00E+00	5.38E-06	5.38E-06	5.38E-06	5.38E-06	5.38E-06

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, 2018 TO DECEMBER 31, 2018

MAXIMUM SITE BOUNDARY GAMMA AIR DOSE - 0.00E+00

MAXIMUM SITE BOUNDARY BETA AIR DOSE - 0.00E+00

TABLE IV-C-1

FORT CALHOUN ANNUAL 2018, DOSE PROJECTIONS
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
INHAL	1.92E-04	1.92E-04	0.00E+00	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04
	43.70%	43.70%	0.00%	43.70%	43.70%	43.70%	43.70%	43.70%
VEGET	1.74E-04	1.74E-04	0.00E+00	1.74E-04	1.74E-04	1.74E-04	1.74E-04	1.74E-04
	39.52%	39.52%	0.00%	39.52%	39.52%	39.52%	39.52%	39.52%
COW MILK	3.47E-05	3.47E-05	0.00E+00	3.47E-05	3.47E-05	3.47E-05	3.47E-05	3.47E-05
	7.87%	7.87%	0.00%	7.87%	7.87%	7.87%	7.87%	7.87%
MEAT	3.92E-05	3.92E-05	0.00E+00	3.92E-05	3.92E-05	3.92E-05	3.92E-05	3.92E-05
	8.91%	8.91%	0.00%	8.91%	8.91%	8.91%	8.91%	8.91%
TOTAL	4.40E-04	4.40E-04	0.00E+00	4.40E-04	4.40E-04	4.40E-04	4.40E-04	4.40E-04

SECTION V

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

January 1, 2018 - December 31, 2018

Radioactive Effluent Releases - First, Second, Third, and Fourth Quarters 2018

LIQUID EFFLUENTS

During the reporting period, a total of 1.38E-04 curies of radioactive liquid materials, less tritium, dissolved noble gases, and alpha, were released to the Missouri River at an average concentration of 1.48E-08 µCi/mL. This represents 1.48E+00 percent of the limits specified in Appendix B to 10 CFR 20 (1.0E-06 µCi/mL for unrestricted areas), 7.83E-02 curies of tritium were discharged at an average diluted concentration of 8.35E-06 µCi/mL or 8.35E-01 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.

Dilution water during the periods of release amounted to 4.68E+07 liters, while liquid waste discharges consisted of 9.85E+04 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, 2018 through December 31, 2018 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 16.04 cubic feet per second (CFS) for 2018. The average discharge rate during releases was 16.08 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 2018, DOSE PROJECTIONS

RADIOLOGICAL ASSESSMENT BRANCH

DIVISION OF SYSTEMS INTEGRATION

U. S. NUCLEAR REGULATORY COMMISSION

WASHINGTON, D. C.

DATE OF RUN: 201903041

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		4.04E-03	5.53E-03	3.63E-03	8.44E-07	1.88E-03	6.25E-04	1.13E-04
DRINKING		1.66E-05	3.06E-05	2.28E-05	7.73E-06	1.55E-05	1.03E-05	8.94E-06
SHORELINE	6.70E-06	5.73E-06	5.73E-06	5.73E-06	5.73E-06	5.73E-06	5.73E-06	5.73E-06
SWIMMING		2.06E-08	2.06E-08	2.06E-08	2.06E-08	2.06E-08	2.06E-08	2.06E-08
BOATING		1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08
TOTAL	6.70E-06	4.06E-03	5.57E-03	3.66E-03	1.43E-05	1.90E-03	6.41E-04	1.27E-04

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	SHOREWIDTH FACTOR=0.2
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	

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		4.33E-03	5.76E-03	2.01E-03	6.49E-07	1.96E-03	7.62E-04	8.58E-05
DRINKING		1.63E-05	2.72E-05	1.31E-05	5.45E-06	1.28E-05	8.32E-06	6.24E-06
SHORELINE	3.74E-05	3.20E-05	3.20E-05	3.20E-05	3.20E-05	3.20E-05	3.20E-05	3.20E-05
SWIMMING		1.15E-07	1.15E-07	1.15E-07	1.15E-07	1.15E-07	1.15E-07	1.15E-07
BOATING		5.76E-08	5.76E-08	5.76E-08	5.76E-08	5.76E-08	5.76E-08	5.76E-08
TOTAL	3.74E-05	4.37E-03	5.82E-03	2.05E-03	3.83E-05	2.01E-03	8.03E-04	1.24E-04

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	SHOREWIDTH FACTOR=0.2
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	

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		5.45E-03	5.22E-03	7.72E-04	5.37E-07	1.70E-03	6.12E-04	3.43E-05
DRINKING		4.77E-05	5.62E-05	1.74E-05	1.05E-05	2.54E-05	1.58E-05	1.11E-05
SHORELINE	7.81E-06	6.69E-06	6.69E-06	6.69E-06	6.69E-06	6.69E-06	6.69E-06	6.69E-06
SWIMMING		2.41E-08	2.41E-08	2.41E-08	2.41E-08	2.41E-08	2.41E-08	2.41E-08
BOATING		1.20E-08	1.20E-08	1.20E-08	1.20E-08	1.20E-08	1.20E-08	1.20E-08
TOTAL	7.81E-06	5.50E-03	5.28E-03	7.96E-04	1.77E-05	1.73E-03	6.35E-04	5.22E-05

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	SHOREWIDTH FACTOR=0.2
FISH	6.9	7.3	24.00	
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		4.93E-05	6.81E-05	1.46E-05	1.03E-05	2.58E-05	1.65E-05	1.07E-05
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	4.93E-05	6.81E-05	1.46E-05	1.03E-05	2.58E-05	1.65E-05	1.07E-05

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	SHOREWIDTH FACTOR=0.2
FISH	0.0	7.3	24.00	
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		2.95E-02	4.04E-02	2.65E-02	6.16E-06	1.37E-02	4.56E-03	8.22E-04
DRINKING		5.13E-04	9.41E-04	7.01E-04	2.38E-04	4.76E-04	3.17E-04	2.75E-04
SHORELINE	4.89E-05	4.19E-05	4.19E-05	4.19E-05	4.19E-05	4.19E-05	4.19E-05	4.19E-05
SWIMMING		1.51E-07	1.51E-07	1.51E-07	1.51E-07	1.51E-07	1.51E-07	1.51E-07
BOATING		7.53E-08	7.53E-08	7.53E-08	7.53E-08	7.53E-08	7.53E-08	7.53E-08
TOTAL	4.89E-05	3.00E-02	4.14E-02	2.72E-02	2.86E-04	1.42E-02	4.92E-03	1.14E-03

	USAGE (KG/YR, HR/YR)	DILUTION	TIME (HR)	SHOREWIDTH FACTOR=0.2
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	

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		3.16E-02	4.21E-02	1.47E-02	4.74E-06	1.43E-02	5.56E-03	6.26E-04
DRINKING		5.03E-04	8.39E-04	4.04E-04	1.68E-04	3.96E-04	2.56E-04	1.92E-04
SHORELINE	2.73E-04	2.34E-04	2.34E-04	2.34E-04	2.34E-04	2.34E-04	2.34E-04	2.34E-04
SWIMMING		8.41E-07	8.41E-07	8.41E-07	8.41E-07	8.41E-07	8.41E-07	8.41E-07
BOATING		4.20E-07	4.20E-07	4.20E-07	4.20E-07	4.20E-07	4.20E-07	4.20E-07
TOTAL	2.73E-04	3.23E-02	4.31E-02	1.53E-02	4.07E-04	1.49E-02	6.05E-03	1.05E-03

	USAGE (KG/YR, HR/YR)	DILUTION	TIME (HR)	SHOREWIDTH FACTOR=0.2
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	

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-02	3.81E-02	5.64E-03	3.92E-06	1.24E-02	4.47E-03	2.50E-04
DRINKING		1.47E-03	1.73E-03	5.37E-04	3.22E-04	7.81E-04	4.87E-04	3.43E-04
SHORELINE	5.70E-05	4.88E-05	4.88E-05	4.88E-05	4.88E-05	4.88E-05	4.88E-05	4.88E-05
SWIMMING		1.76E-07	1.76E-07	1.76E-07	1.76E-07	1.76E-07	1.76E-07	1.76E-07
BOATING		8.78E-08	8.78E-08	8.78E-08	8.78E-08	8.78E-08	8.78E-08	8.78E-08
TOTAL	5.70E-05	4.13E-02	3.99E-02	6.22E-03	3.75E-04	1.32E-02	5.01E-03	6.43E-04

	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	SHOREWIDTH FACTOR=0.2
FISH	6.9	1.0	24.00	
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		1.52E-03	2.10E-03	4.49E-04	3.16E-04	7.93E-04	5.09E-04	3.29E-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	1.52E-03	2.10E-03	4.49E-04	3.16E-04	7.93E-04	5.09E-04	3.29E-04

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

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

SPORT HARVEST

PATHWAY	AGE GROUP	USAGE	DOSE (PERSON-REM) BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH	ADULT	6.10E+04	1.17E-02	1.61E-02	1.05E-02	2.45E-06	5.45E-03	1.81E-03	3.27E-04
FISH	TEENAGER	7.12E+03	1.92E-03	2.56E-03	8.93E-04	2.88E-07	8.72E-04	3.39E-04	3.82E-05
FISH	CHILD	4.93E+03	3.89E-03	3.73E-03	5.51E-04	3.83E-07	1.21E-03	4.37E-04	2.45E-05
FISH	TOTAL	7.30E+04	1.75E-02	2.23E-02	1.20E-02	3.12E-06	7.54E-03	2.59E-03	3.89E-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

NEPA DOSES

NOTE--TOTAL NEPA DOSE INCLUDES SPORT CATCH

PATHWAY	AGE GROUP	USAGE	DOSE (PERSON-REM) BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH	ADULT	1.22E+05	2.34E-02	3.21E-02	2.10E-02	4.90E-06	1.09E-02	3.63E-03	6.53E-04
FISH	TEENAGER	1.42E+04	3.85E-03	5.12E-03	1.79E-03	5.76E-07	1.74E-03	6.78E-04	7.63E-05
FISH	CHILD	9.85E+03	7.77E-03	7.45E-03	1.10E-03	7.66E-07	2.43E-03	8.74E-04	4.90E-05
FISH	TOTAL	1.46E+05	3.51E-02	4.47E-02	2.39E-02	6.24E-06	1.51E-02	5.18E-03	7.78E-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	3.17E-03	5.82E-03	4.33E-03	1.47E-03	2.94E-03	1.96E-03	1.70E-03
DRINKING	TEENAGER	1.51E+07	4.85E-04	8.08E-04	3.89E-04	1.62E-04	3.81E-04	2.47E-04	1.85E-04
DRINKING	CHILD	2.48E+07	2.32E-03	2.73E-03	8.46E-04	5.08E-04	1.23E-03	7.68E-04	5.40E-04
DRINKING	TOTAL	1.79E+08	5.97E-03	9.35E-03	5.57E-03	2.14E-03	4.56E-03	2.98E-03	2.43E-03

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

-----CUMULATIVE TOTAL-----									
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
DRINKING	CUMUL TOTAL	2.08E+08	6.93E-03	1.09E-02	6.47E-03	2.49E-03	5.29E-03	3.46E-03	2.82E-03

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	5.97E-07	5.97E-07	5.97E-07	5.97E-07	5.97E-07	5.97E-07

* * * RECREATION POPULATION DOSES * * *

LOCATION- DOWN STREAM SWIMMING

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

			DOSE (PERSON-REM)		
PATHWAY	AGE GROUP	USAGE	SKIN	TOTAL BODY	THYROID
SHORELINE	TOTAL POPUL	4.10E+07	2.29E-02	1.96E-02	1.96E-02

LOCATION- DOWN STREAM SWIMMING

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

			DOSE (PERSON-REM)		
PATHWAY	AGE GROUP	USAGE	SKIN	TOTAL BODY	THYROID
SWIMMING	TOTAL POPUL	4.10E+07		7.05E-05	7.05E-05

LOCATION- DOWN STREAM BOATING

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

			DOSE (PERSON-REM)		
PATHWAY	AGE GROUP	USAGE	SKIN	TOTAL BODY	THYROID
BOATING	TOTAL POPUL	4.10E+07		3.52E-05	3.52E-05

* * * DOSE TO BIOTA * * *

MRADS PER YEAR

BIOTA	DILUTION= 1.00E+00		TRANSIT TIME= 0.00E+00 HR
	INTERNAL	EXTERNAL	TOTAL
FISH	8.86E-02	1.53E-01	2.41E-01
INVERTEBRATE	4.50E-02	3.06E-01	3.51E-01
ALGAE	2.29E-02	1.10E-04	2.30E-02
MUSKRAT	4.80E-01	1.02E-01	5.82E-01
RACCOON	1.79E-01	7.64E-02	2.56E-01
HERON	2.80E+00	1.02E-01	2.90E+00
DUCK	4.38E-01	1.53E-01	5.91E-01

SECTION VI

RADIOACTIVE EFFLUENT RELEASES - SOLID RADIOACTIVE WASTE

Technical Specifications 5.9.4.a

January 1, 2018 - December 31, 2018

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

January 1, 2018 through December 31, 2018

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, filters, sludges, evaporator bottoms, etc.	January	0	0	0	N/A
		February	1	3.4	26.7	20
		March	0	0	0	N/A
		April	1	3.4	61.1	20
		May	1	1.56	17.3	20
		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	2	0.57	73.0	20
		November	0	0	0	N/A
		December	1	0.56	9.6	20
Total		(Type a)	6	9.49	187.7	20
b.	Dry compressible, contaminated equipment, etc.	January	0	0	0	N/A
		February	0	0	0	N/A
		March	1	32.9	0.205	20
		April	0	0	0	N/A
		May	2	8.49	0.132	20
		June	2	9.37	4.342	20
		July	0	0	0	N/A
		August	2	9.43	2.823	20
		September	0	0	0	N/A
		October	0	0	0	N/A
		November	2	65.8	0.008	20
		December	2	12.33	2.33	20
Total		(Type b)	11	138.32	9.84	20

VI. 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	2	0.11	4.85	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 c)	2	0.11	4.85	20
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	1	1.47	5.76E-06	20
Total		(Type d)	1	1.47	5.76E-06	20

VI. RADIOACTIVE EFFLUENT RELEASE – SOLID RADIOACTIVE WASTE EFFLUENT AND WASTE DISPOSAL REPORT (Continued)

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

1. Percentage of Curies from Represented Isotopes

	Isotope	Percent	Curies
a.	Ni-63	43.5	8.16E+01
	Co-60	23.7	4.45E+01
	Cs-137 D	17.8	3.34E+01
	Fe-55	8.1	1.53E+01
	Ag-110m	2.6	4.94E+00
	Ni-59	1.4	2.57E+00
	All Other Nuclides Constitute Less than 1% Each for Type a		
b.	Cs-137	42.5	4.18E+03
	Co-60	28.9	2.84E+03
	Ni-63	20.7	2.04E+03
	Fe-55	5.0	4.93E+02
	All Other Nuclides Constitute Less than 1% Each for Type b		
c.	Fe-55	52.9	2.56E+03
	Co-60	37.9	1.84E+03
	Ni-63	8.6	4.17E+02
	All Other Nuclides Constitute Less than 1% Each for Type c		
d.	H-3	86.5	4.99E-03
	Co-60	8.4	5.32E-05
	Ce-144 D	3.6	1.23E-04
	Cs-137 D	1.3	2.79E-05
	All Other Nuclides Constitute Less than 1% Each for Type d		

C. SOLID WASTE (DISPOSITION)

Number of Shipments	Transportation Mode	Destination
17	Sole Use Vehicle	Energy Solutions, Bear Creek, TN
1	Sole Use Vehicle	Erwin Resin Solutions, Erwin, TN
1	Sole Use Vehicle	Clive Disposal Site, Clive, UT

D. IRRADIATED FUEL SHIPMENTS (DISPOSITION)

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

SECTION VII

ATTACHMENT 1

ODCM and PCP revisions for the period January 1, 2018 through December 31, 2018 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 (PCP).

__1__ revision was made to the Offsite Dose Calculation Manual (ODCM).

__2__ revisions were made to the Process Control Program (PCP).

January 1, 2018 - December 31, 2018

CH-ODCM-0001

Off-Site Dose Calculation Manual (ODCM)

Revision 28

Safety Classification: Non-Safety

Usage Level: Reference

Change No.:	EC 68871
Reason for Change:	Remove unnecessary effluent release points and Iodine requiements.
Preparer:	Marcellus, M.

Fort Calhoun Station

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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 activities. 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 facility environs provides the basis for ensuring that station activities are 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 facility-related, licensed radioactive material) into the unrestricted area.

2.2 Abnormal Release - The unplanned or uncontrolled emission of an effluent (i.e., containing facility-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 functional, 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 Functional-Functionality - A system, subsystem, train, component or device shall be FUNCTIONAL or have FUNCTIONALITY when it is capable of performing its specified 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 function(s) are also capable of performing their related support function(s).

2.8 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.

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

2.10 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.

2.11 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.

2.12 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.

2.13 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.

2.14 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		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

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 FUNCTIONAL 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 non-functional.

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

3.1.2 Surveillance Requirements

A. Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL 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 Functional	Action
1. Radioactivity Monitor Providing Alarm and Automatic Termination of Release.		
1.1 Liquid Radwaste Effluent Line (RM-055)	1	1, 4
2. Flow Rate Measurement Device		
2.1 Liquid Radwaste Effluent Line	1	2
3. Radioactivity Recorder		
3.1 Liquid Radwaste Effluent Line	1	3

Table Notation	
ACTION 1	With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL 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 FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases may continue provided the flow rate is determined at least once per four hours during the actual release.
ACTION 3	With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases may continue provided the radioactivity is recorded manually at least once per four hours during the actual release.
ACTION 4	During the performance of source checks the effluent radiation monitor is unable to respond, hence is considered non-functional. 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 non-functional 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 Monitor Providing Alarm and Automatic Isolation				
1.1 RM-055	----	R	Q	P

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 FUNCTIONAL 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 non-functional.

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

3.2.2 Surveillance Requirements

A. Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL 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 Functional	Action
1. Auxiliary Bldg. Exhaust Stack (RM-052, RM-062)		
1.1 Noble Gas	1	1, 7, 8
1.2 Particulate	1	2, 7, 8
2. Laboratory and Radwaste Processing Building Stack (RM-043)		
2.1 Noble Gas	1	3, 7
2.2 Particulate	1	4, 7
3. Flow Rate Measurement Devices		
3.1 Auxiliary Building Exhaust Stack	1	5
3.2 Laboratory and Radwaste Processing Building Stack	1	5
4. Radioactivity Chart Recorders		
4.1 Auxiliary Building Exhaust Stack	1	6

Table 3.2.1 Radioactive Gaseous Effluent Monitoring Instrumentation	
Table Notation	
ACTION 1	If the Auxiliary Building Exhaust Stack Noble Gas Monitor is non-functional, 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 Particulate Sampler is non-functional, ventilation of the Auxiliary Building 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 non-functionality by the Shift Manager.
ACTION 3	If the Noble Gas Monitor is non-functional, 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 Particulate Sampler is non-functional, 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 non-functionality, by the Shift Manager, in accordance with Table 4.2.
ACTION 5	With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases may continue provided the flowrate is estimated or recorded manually at least once per four hours during the actual release.
ACTION 6	With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases may continue provided the radioactivity level is recorded manually at least once per four hours during the actual release.
ACTION 7	During the performance of source checks the effluent radiation monitor is unable to respond, hence is considered non-functional. 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 non-functional monitor or terminate the effluent release.
ACTION 8	During the ventilation of airborne effluents from the Auxiliary Building Exhaust Stack at least one Auxiliary Building Exhaust fan shall be in operation.

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-062	D	R	Q	M
1.3	RM-052	D	R	Q	M
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	

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 facility operations, Chemistry supervision 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

i	**NOTE** Radioactive liquid waste includes water used for fire suppression in areas of the facility 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. 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	Dissolved Noble Gases (Gamma Emitters) [B]	1.0E-05
Monthly Composite [C]	H-3	1.0E-05
Monthly Composite [C]	Gross Alpha	1.0E-07
Quarterly Composite [C]	Sr-89, Sr-90	5.0E-08
Quarterly Composite [C]	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. 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 FUNCTIONAL, 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 functional and reasons for non-functionality.

      2) Action(s) taken to restore the non-functional equipment to functional 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 FUNCTIONAL.

2. FUNCTIONAL 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 non-functionality of these filters does not affect the dose contributions to any individual in the unrestricted areas via liquid pathways. The non-functionality 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 tanks 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 facility operations, Chemistry supervision 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 facility 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. Auxiliary Building Exhaust Stack [D]

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
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 [C]	Gross Alpha	1.0E-11
Quarterly Composite (Particulate Samples)	Sr-89, Sr-90	1.0E-11

B. Laboratory and Radwaste Building Exhaust Stack [D]

Sampling Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) [A]
Weekly (Particulate Sample)	Principal Gamma Emitters [B]	1.0E-11
Weekly (Noble Gases)	Principal Gamma Emitters [B]	1.0E-4
Monthly Composite [C]	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 particulate releases.

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

D. Particulate 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	
		DF	ACTMULT
RM-062	AB	0.411	2.433
RM-052	AB	0.638	1.567
RM-043	LRWPB	0.809	1.236

ACRONYM DEFINITIONS:

AB - Auxiliary Building Exhaust Stack
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 - 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 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 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 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 Ventilation Exhaust Systems shall be FUNCTIONAL, 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 functional and reasons for non-functionality.

2) Action(s) taken to restore the non-functional equipment to functional 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 Ventilation Exhaust Systems are not fully FUNCTIONAL.

2. FUNCTIONAL is defined as follows:

a. 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 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.

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 facility 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 or 10 CFR Part 72.104 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 or 10 CFR Part 72.104. 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 facility 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 facility 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 facility operations, state and local authorities shall be notified by the end of the next business day. NRC shall be notified per LS-FC-1020, Reportability Tables and Decision Tree. **[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
	D. Other TLDs may be placed at special interest locations beyond the Restricted Area where either a MEMBER OF THE PUBLIC or Omaha Public Power District employees have routine access.	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] Filter for Gamma Isotopic	Weekly Quarterly composite of weekly filters
	B. One background station [F]		
3. Water	A. Missouri River at nearest downstream drinking water intake.	Gamma Isotopic, H-3	Monthly for Gamma isotopic analysis.
	B. Missouri River downstream near the mixing zone.		Quarterly composite for H-3 Analysis
	C. Missouri River upstream of Facility intake (background)[F].		
4. Milk [D]	A. Nearest milk animal (cow or goat) within 5 miles	Gamma Isotopic	Biweekly grazing season (May to October), monthly at other times
	B. Milk animal (cow or goat) between 5 miles and 18.75 miles (background)[F].		
5. Fish	A. Four fish samples within vicinity of Facility discharge.	Gamma Isotopic	Once per season (May to October)
	B. One background sample upstream of Facility discharge.		

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 Facility 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 facility 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 facility, 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".**

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							
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						
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						
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 / Airborne Particulate	TLD	Water	Milk	Sediment	Fish	Vegetables and Food Products	Groundwater
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,F			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	Ve ar Pr
					Airborne Particulate						
28[A]											
29[A]											
30[A]											
31[A]											
32[D]	Valley Substation #902	19.6	221°/SW	L	X	X					
33[A]											
34[A]											
35	Onsite Farm Field	0.52	118°/ESE	F							
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					
38[A]											
39[A]											
40[A]											
41[C]	Dowler Acreage	0.73	175°/S	J	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	Ve ar Pr
					Airborne Particulate						
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	O		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	Ve; ar Pr
					Airborne Particulate						
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							
75[C]	Lomp Acreage	0.65	163°/SSE	H	X	X		B,C			
76	Stangl Farm	3.40	169°/S	J				X			
77[G]	River N-1	0.17	328°/NNW	R		X					
78[G]	River S-1	0.14	85°/EAST	E		X					
79[G]	Lagoon S-1	0.24	131°/SE	G		X					
80[G]	Parking S-1	0.27	158°/SSE	H		X					
81[G]	Training W-1	0.28	194°/SSW	K		X					
82[G]	Switchyard S-1	0.21	219°/SW	L		X					
83[G]	Switchyard SE-1	0.14	231°/SW	L		X					
84[G]	Switchyard NE-1	0.18	256°/WSW	M		X					
85[G]	Switchyard W-1	0.29	233°/WEST	L		X					
86[G]	Switchyard N-1	0.24	262°/WEST	N		X					
87[G]	Range S-1	0.20	286°/WNW	P		X					
88[G]	Mausoleum E-1	0.37	216°/SW	L		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 facility, 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.

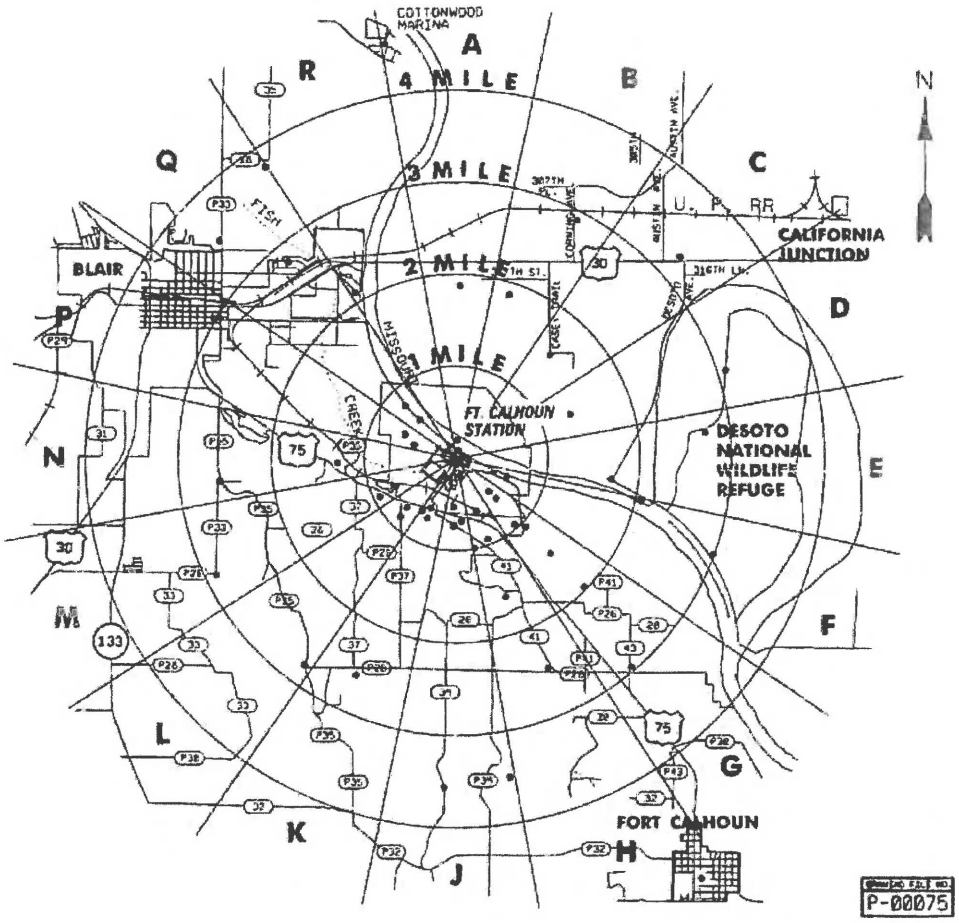
D. Background location (control). All other locations are indicators.

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.

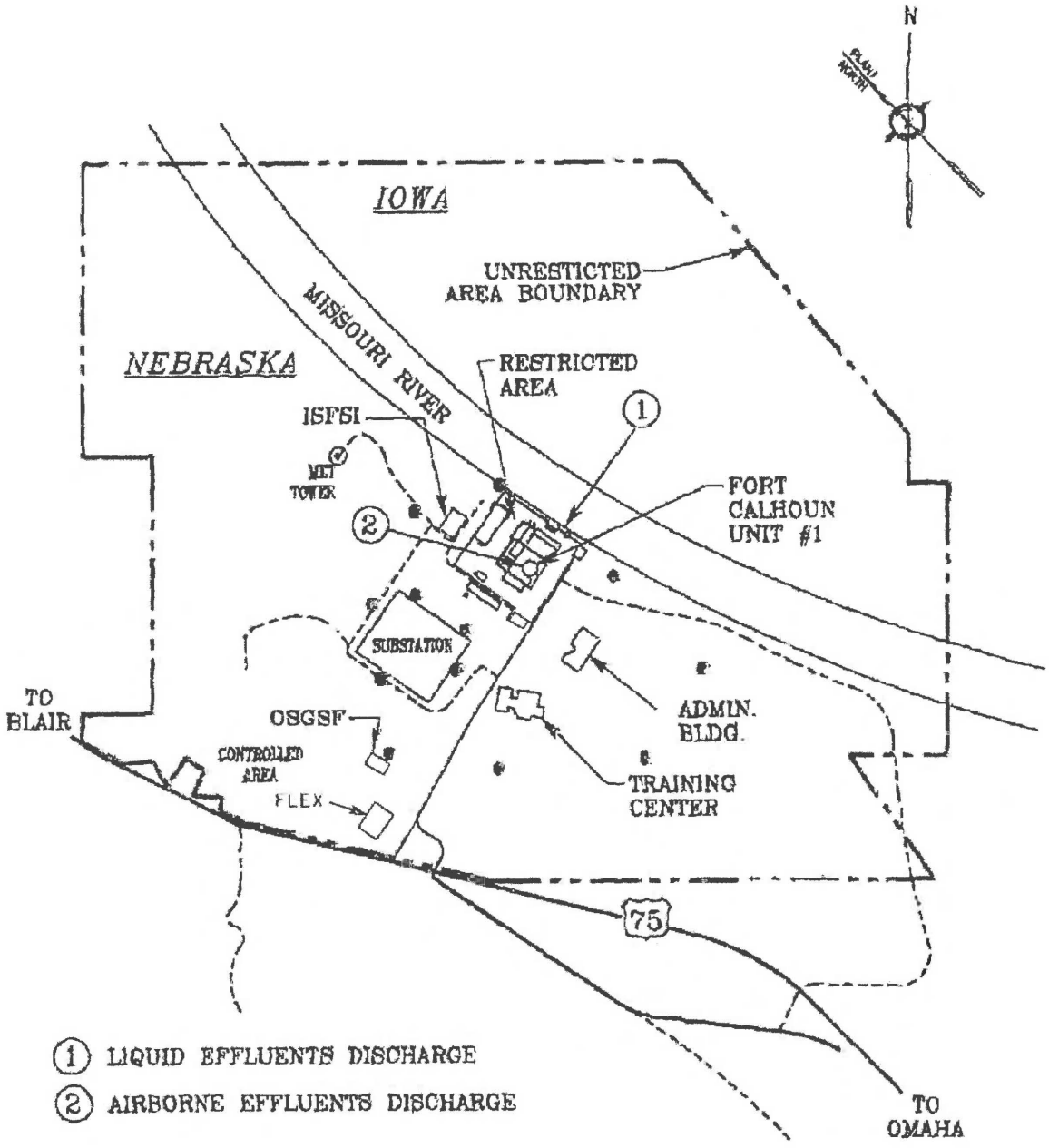
G. Location for special interest monitoring general dose to the public per 40CFR190 (Figure 2)

Figure 1 – Environmental Radiological Sampling Points



(*) Locations currently discontinued are not illustrated.

Figure 2– 40CFR190 Sampling Points



EXCLUSION AND SITE BOUNDARY MAP

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P-00414

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	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	1.5E+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	---	---	---	---	---	---	---	---	1.5E+01	1.8E+01	1.5E+01
Airborne Particulates or Gases	pCi/m^3	1.0E-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)	---	---	---	---	---	---	---	---	6.0E+01	8.0E+01	---

A. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable as Facility 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.

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	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	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	---	---	---	---	---	---	---	---	6.0E+01	7.0E+01	3.0E+02
Airborne Particulates or Gases	pCi/m^3	---	---	---	---	---	---	---	---	1.0E+01	2.0E+01	---
Grass or Broad Leaf Vegetation/ Vegetables or Food Products	pCi/kg (wet)	---	---	---	---	---	---	---	---	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 Facility 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 Facility effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

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 Facility 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 facility 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 facility 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 FUNCTIONAL 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 FUNCTIONAL, 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 facility 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.

E. 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.

6.2.5 ISFSI 10 CFR Part 72.104 Reporting Requirements

The regulatory requirements of 10CFR20, 10CFR72 and 40CFR190 each limit total dose to individual members of the public without regard to specific pathways. The only significant exposure pathways for light water reactors included in 10CFR20, 10CFR72 and 40CFR190 not addressed by 10CFR50 Appendix I are the direct radiation pathway and exposure from on-site activity by members of the public.

The 10CFR72.104 dose limits are the same as those specified in 40CFR190. ISFSI dose contribution is in the form of direct radiation as no liquid or gas releases are expected to occur. If the dose limits of 40CFR190 or 10CFR72.104 are exceeded, a special report to the NRC, as well as an appropriate request for exemption/variance, is required to be submitted to the NRC.

The requirement that the dose limits of 10CFR72.104 apply to any 'real individual' is controlled for ISFSI activities in the ISFSI 72.212 report. Therefore, for the purposes of analyzing dose from the ISFSI, the member of the public as defined in 40CFR190 is the same as for the 'real individual'.

The report of the annual direct radiation required by 10CFR72 shall be submitted prior to 60 days from January 1 of each year.

The external Total Body Dose is comprised of:

1) Total Body Dose due to noble gas radionuclides in gaseous effluents
2) Dose due to radioactive waste and the ISFSI
3) Total Body Dose due to radioactivity deposited on the ground (this dose is accounted for in the determination of the non-noble gas dose and is not considered here)

The Total Body Dose, external is given by:

$D,ext = D,tb + D,osf$

Where D,ext is the external dose
D,tb is the total body dose
D,osf is the dose from on-site storage

The Total Dose is then given by:

$D,tot = D,ext + D,liq + D,nng$

Where D,tot is the total dose
D,ext is the external dose
D,liq is the dose from liquid effluents
D,nng is the dose from non-noble gases

Dose Limits

Total Body, annual	25 mrem
Thyroid, annual	75 mrem
Other Organs, annual	25 mrem

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 Operations 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 Chemistry supervision 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 Defueled 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 FUNCTIONALITY 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 FUNCTIONALITY 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 facility 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 FUNCTIONALITY 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 A to 10 CFR Part 50 and design objective and in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified 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 facility operations, Chemistry supervision 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 - 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 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 FUNCTIONALITY of 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 A to 10 CFR Part 50 and design objective and in Section II.D of Appendix I 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 facility 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 facility 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 is one liquid discharge pathway to the Missouri River. The pathway originates with the radioactive liquid waste processing system (monitor or hotel tanks). This pathway empties into the circulating water system which discharges to the Missouri River (see Figure 1). Figure 2 depicts the liquid discharge pathway and associated radiation monitor. Figure 3 depicts the methods of liquid effluent treatment.

1.1.2 The flowrate for dilution water varies with the number raw water pumps in service

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.