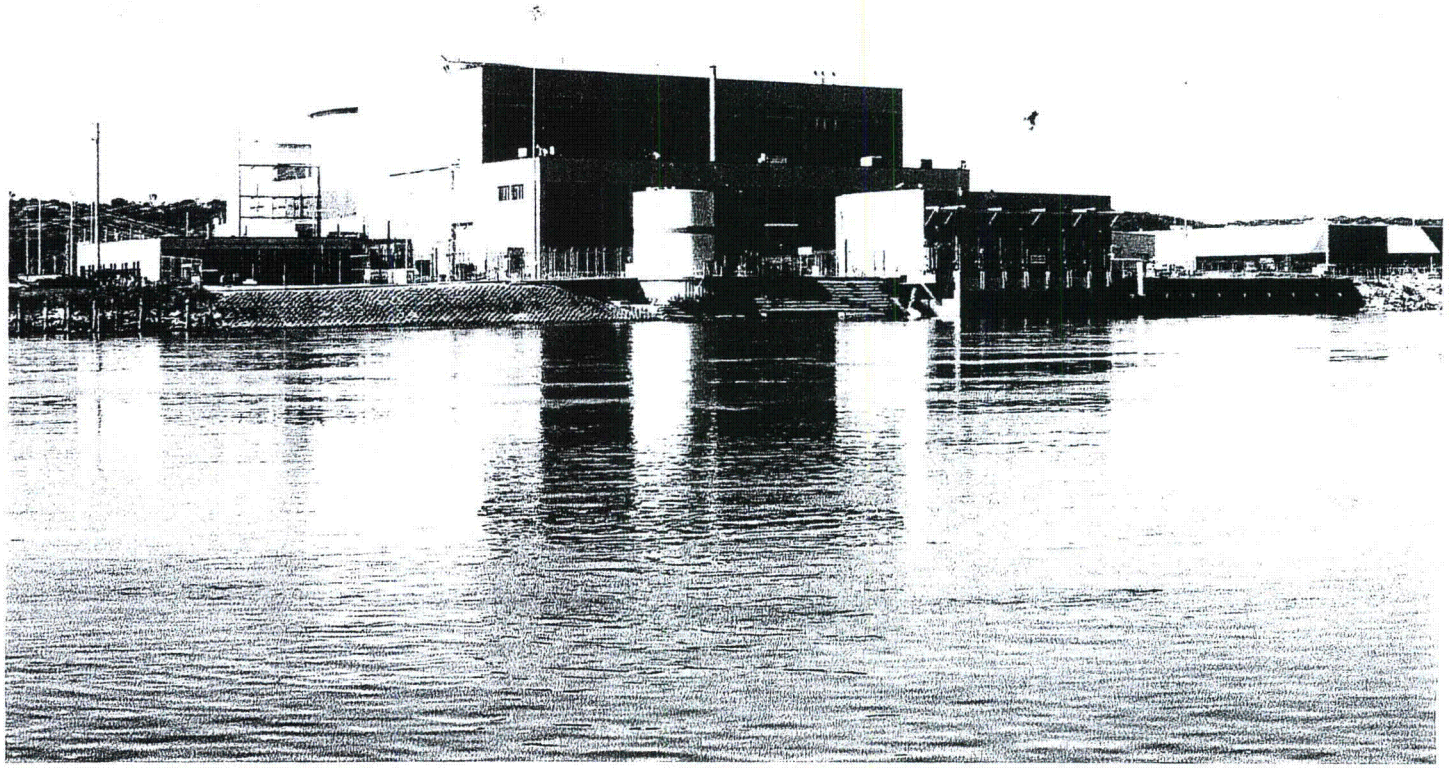
Omaha Public Power District
Fort Calhoun Station Unit No. 1

Annual Report
For
Technical Specification
Section 5.9.4.a

January 1, 2014 to December 31, 2014



DOCKET NO. 50-285 OPERATING LICENSE DPR-40

Omaha Public Power District
Fort Calhoun Station Unit No. 1

Annual Report
For
Technical Specifications,
Section 5.9.4.a

January 1, 2014 to December 31, 2014

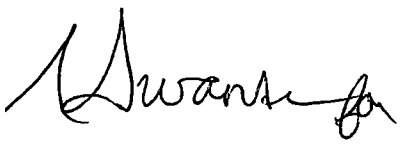
DOCKET NO. 50-285 OPERATING LICENSE DPR-40

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, 2014 through December 31, 2014. 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, 2014 through December 31, 2014.

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



Division Manager Nuclear Operations/Plant Manager

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1.0 INTRODUCTION

This Annual Radiological Effluent Release Report, for Fort Calhoun Station Unit No. 1, is submitted as required by Technical Specification 5.9.4.a for the period January 1, 2014 through December 31, 2014.

1.1 Executive Summary

The Radioactive Effluent Monitoring program for the year 2014 was conducted as described in the following report. Major efforts were made to maintain the release of radioactive effluents to the environment as low as reasonably achievable.

The total airborne activity released from noble gas was 1.49 curies. This was an increase from the 2013 activity of 1.16E-02 curies. The release from 2013 represented one month of station operation, while 2014 represented 12 months of operation.

The total airborne activity from I-131, I-133, and particulates with half-lives > 8 days in 2014 was 0.00 curies. This was the same as the 2013 activity of 0.00 curies.

The total airborne activity from Tritium was 0.904 curies. This was an increase from the 2013 activity of 0.878 curies.

The total airborne activity from C-14 was 2.35 curies. This was an increase from the 2013 activity of 4.76 E-02 curies. This increase is attributed to the station operating 12 months vice just December of 2013. Airborne activity from C-14 is included in the 2014 annual report, per Regulatory Guide 1.21, Revision 2. This is a calculated value based on power generation and days of operation. Critical organ doses from C-14 were calculated using a ratio of 15% as CO_2. This ratio was determined during an NRC in-plant source term study conducted at the Fort Calhoun Station between 1976 and 1977, NUREG/CR-0140.

Dose contributions from airborne effluents at the unrestricted area boundary were; 1.50 E-03 mRad gamma air dose, 7.40E-04 mRad beta air dose, 1.19E-01 mRem total body dose, and 5.90E-01 mRem critical organ dose. Gamma and beta dose showed an increase from 2013 levels of 1.90 E-05 mRad gamma air dose and 6.94E-06 mRad beta air dose, which is attributed to the station being operated 12 months vice just December. Whole body and critical organ doses increased from 2013 levels of 3.17E-03 mRem total body dose and 1.11E-02 mRem critical organ dose. This increase is attributed to the station being operated 12 months vice just December.

Total water activity (excluding tritium, dissolved gases, and alpha) released in 2014 in liquid effluents was 2.17E-03 curies. This was an increase from the 2013 activity of 1.23E-03 curies.
The total activity released increased despite a significant decrease in volume released. Eighty six per cent of the activity released was from Ni-63 being identified in liquid effluent composites. The total water tritium activity released in 2014 in liquid effluents was 186 curies. This was an increase from the 2013 activity of 3.50 curies. This increase was due to the station resuming a full year of power operation.

The calculated whole body dose due to liquid effluents at the site discharge from all sources in 2014 was 5.70E-04 mRem. This was a decrease from the 2013 dose of 1.39E-02 mRem. Dose decreased despite an increase in released activity due to a large increase in dilution flow.

The calculated critical organ dose due to liquid effluents at the site discharge from all sources in 2014 was 6.77E-04 mRem. This was a decrease from the 2013 dose of 2.08E-02 mRem. Dose decreased despite an increase in released activity due to a large increase in dilution flow.

The Fort Calhoun Station meteorological system had a cumulative recovery rate of 96.18% from the station meteorological tower with the remaining 3.82% 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 2014.

During 2014 there were was one change to the Off-site Dose Calculations Manual (ODCM), CH-ODCM-0001 and one change to the Process Control Program, RW-AA-100.

For 2014, the total volume of solid radwaste released from the unit was 0.0 cubic meters. This was a decrease from the 471.3 cubic meters of solid waste released from the unit in 2013. The decrease was attributed to zero shipments made in 2014.

The total activity released from the unit for 2014 was 0.0 curies, 0.00 curies from spent resin and 0.00 curies from dry compressables. This was a decrease from the 2013 value of 0.2217 curies. Overall, the effluent monitoring program was conducted in a manner to ensure the activity released and dose to the public were maintained as low as reasonably achievable.

2.0 SUPPLEMENTAL INFORMATION

2.1 Regulatory Limits

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

2.1.1 Fission and Activation Gases (Noble Gases)

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

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

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

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

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

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

a. The dose to an individual or dose commitment to any organ of an individual in unrestricted areas due to the release of I-131, I-133, C-14, H-3, and radioactive

material in particulate form with half-lives greater than eight days (other than noble gases) in airborne effluents shall not exceed 7.5 millirem from all exposure pathways during any calendar quarter.

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

2.1.3 Liquid Effluents

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

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

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

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

b. During any calendar year: Less than or equal to 3 mRem to the whole body and less than or equal to 10 mRem to any organ.

2.1.4 Total Dose-Uranium Fuel Cycle

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

2.2 Effluent Concentration Limits (ECL)

2.2.1 Liquid Effluents

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

2.2.2 Gaseous Effluents

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

2.3 Measurements and Approximations of Total Radioactivity

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

2.3.1 Liquid Radioactive Effluents

Each batch was sampled and analyzed for gamma emitting radionuclides using gamma spectroscopy, prior to release. Composite samples were analyzed monthly and quarterly for the Monitor Tanks and Steam Generators. Composite samples were analyzed monthly in the onsite laboratory for tritium and gross alpha radioactivity, using liquid scintillation and proportional counting techniques respectively. Composite samples were analyzed quarterly for Sr-89, Sr-90, Fe-55, Ni-63, and Gross Alpha by a contract laboratory (Teledyne Brown Engineering, Inc.). A software program was used to project the total body and critical organ dose contribution at the unrestricted area boundary for each release and the percent contribution to the annual objective dose.

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

2.3.2 Gaseous Radioactive Effluents

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

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

2.4 Estimation of Total Percent Error

The estimated total percent error is calculated as follows:

Total Percent Error = $(E_1^2 + E_2^2 + E_3^2 + ... + E_n^2)^{0.5}$
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 one 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-057, Condenser Off-Gas Effluent Line Radiation Monitor, was inoperable for 44 days (1/1/2014-2/13/2014) after failing in November of 2013. The unavailability of replacement parts prevented the monitor from being repaired in less than 30 days.

Shiftly grab samples and analysis as required in ODCM Table 3.2.1. Note 5 were performed during this unavailability.

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

During 2014, one revision was made to the ODCM:

- Incorporate NRC 0350 inspection recommendations, examples include:

  -define special liquid release
  -Add Carbon 14 dose calculation explanation
  -Add Gross Beta LLD to table 5.3
  -adjust mid-point of life cycle term
  -Change description of met data from real time to current year

- Editorial correction to calculation and LLD table.

- Add REMP sampling location.

During 2014, one revision was made to the Process Control Program, RW-AA-100:

- Change procedure to fleet format.

6.3 New Locations or Modifications for Dose Calculations or Environmental Monitoring

- One sample location, OFM-G-(I), was added to the program. Stangl farm, a goat dairy, was added in March of 2013. Two locations were updated due to landowner changes.

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 2014.

6.4.2 Failure to Meet Specified Sampling Requirements

During 2014, 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 2014, is retained onsite and is maintained as documentation as required by Regulatory Guide 1.21 Rev 2. This data is available for review by the Nuclear Regulatory Commission upon request. Joint Frequency tables are included in Section VII, Attachment 2

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

6.7 Assessment of Doses

6.7.1 Doses Due to Liquid Effluents

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

The LADTAP II program in its annual configuration was also

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

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

6.7.2 Doses Due to Gaseous Effluents

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

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

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

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

6.7.4 Direct Radiation Dose to Individuals and Populations

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

6.7.5 40 CFR 190 Dose Evaluation

ODCM Radiological Effluent Controls require dose evaluations to demonstrate compliance with 40 CFR Part 190 only if calculated yearly doses exceed two times the annual design objectives for liquid and/or gaseous effluents. At no time during **2014** were any of these limits exceeded; therefore, no evaluations were required.

6.8 Groundwater Monitoring Program and Observations

- OPPD conducted groundwater sampling from 19 wells, 2 surface water sites, and 4 storm water headers within the site property per NEI 07-07. Additionally Nebraska requirements regarding avoidance of snow runoff were deleted, so storm water sampling is now performed quarterly, if available.

- No new monitoring wells were added to the sampling program during 2014. Ten sample locations in sectors experiencing significant (>10%) wind direction were established to assess potential atmospheric deposition. After an initial sampling regime in all ten sectors displayed no detectable tritium, the sampling program was switched to 2 affected sectors per rain event and an upwind background test. Four sampling events were conducted. No tritium activity in excess of the vendor's Minimum Detectable Activity (MDA) was reported.

- One tritium activity in excess of the vendor's Minimum Detectable Activity (MDA) was reported in Table III.9. One result greater than a 2 sigma threshold but less than MDA was maintained by plant staff. Both results were at MW-6. MW-6 is hydro-geologically connected to the river and is in close proximity to the licensed effluent release point. MW-6 has historically had activity identified in excess of the MDA when river levels are high. All Table III.9 Sr-90 reported concentrations represent values greater than a 2 sigma threshold but less than MDA, which are evaluated by the plant staff as required by the site groundwater monitoring program. EPRI Report No. 1011730, Groundwater Monitoring Guidance for Nuclear Power Plants, documents plant shallow monitoring well Sr-90 results as typically showing a positive bias toward detection (i.e. background greater than zero). The Fort Calhoun Station Sr-90 results reflect this same bias. Although the data set is too small to perform a complete statistical analysis, the measured values have not exceeded a threshold by which the results could be called "significantly different" from a true background value

and therefore cannot be attributed to a plant environmental impact. The results are all below NRC, EPA, NEI and FCS groundwater protection program administrative reporting limits. Some hard to detect nuclides, were reduced to an annual sample frequency (Ni-63, Fe-55, Sr-90 in deep wells) based on 2 years of quarterly sampling with no detections above MDA.

- The Fort Calhoun REMP sampling showed no detected tritium within the Missouri River downstream at the site boundary or at the nearest municipal drinking water facility. No groundwater drinking pathway exists on site. No state or federal drinking water limits, and no site groundwater protection program administrative limits were exceeded.

- One storm water sample was not collected during per sample schedule for 2014. Due to drought conditions when the first quarter rain event occurred, the water from this event was adsorbed into the ground prior to reaching the sampling point. Gross alpha and beta baseline sampling and analyses are being performed in station monitoring wells and storm drains per ANI and EPRI recommendations. Sampling to date has not displayed values significantly different from naturally occurring background values.

SECTION II

QUARTERLY DOSES FROM EFFLUENTS

Offsite Dose Calculation Manual

January 1, 2014 - December 31, 2014

Quarterly Dose Calculation Results

January 1, 2014 through December 31, 2014

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 2014 calculated doses.

This section presents the results of the quarterly dose calculations performed during the period January 1, 2014 through December 31, 2014. 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 2014 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	3.30E-03	3.54E-03
Continuous:	0.00E+00	0.00E+00
Totals:	3.30E-03	3.54E-03
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.22 %	0.07 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.11 %	0.04 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	7.61E-04	3.28E-04
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.02 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.01 %	0.00 %

B. I-131, I-133, Tritium, C-14, and Particulates with Half-Lives > 8 Days:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Inhalation:	4.76E-05	4.76E-05
Ground and Food:	3.96E-02	1.96E-01
Totals:	3.96E-02	1.96E-01
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.53 %	2.62 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.26 %	1.31 %

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QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN SECOND QUARTER 2014 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	4.13E-03	4.33E-03
Continuous:	0.00E+00	0.00E+00
Totals:	4.13E-03	4.33E-03
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.28 %	0.09 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.25 %	0.08 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	6.98E-04	3.17E-04
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.01 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.01 %	0.00 %

B. I-131, I-133, Tritium, C-14, and Particulates with Half-Lives > 8 Days:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Inhalation:	6.82E-05	6.82E-05
Ground and Food:	4.66E-02	2.32E-01
Totals:	4.67E-02	2.32E-01
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.62 %	3.09 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.58 %	2.85 %

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QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN THIRD QUARTER 2014 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	3.01E-03	3.16E-03
Continuous:	0.00E+00	0.00E+00
Totals:	3.01E-03	3.16E-03
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.20 %	0.06 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.35 %	0.11 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	9.25E-04	4.30E-04
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.02 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.02 %	0.01 %

B. I-131, I-133, Tritium, C-14, and Particulates with Half-Lives > 8 Days:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Inhalation:	8.75E-05	8.75E-05
Ground and Food:	5.21E-02	2.59E-01
Totals:	5.22E-02	2.59E-01
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.70 %	3.46 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	0.92 %	4.58 %

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QUARTERLY CUMULATIVE DOSE CONTRIBUTION FROM RADIOACTIVE EFFLUENTS
FORT CALHOUN FOURTH QUARTER 2014 DOSE PROJECTIONS

I. Liquid Effluents:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Batch:	9.78E-03	1.02E-02
Continuous:	0.00E+00	0.00E+00
Totals:	9.78E-03	1.02E-02
ODCM Quarterly Objective:	1.50E+00	5.00E+00
Percent of Quarterly Obj:	0.65 %	0.20 %
ODCM Annual Objective:	3.00E+00	1.00E+01
YTD Percent of Annual Obj:	0.67 %	0.21 %

II. Gaseous Effluents:	Total Body Gamma Dose (mrad)	Total Body Beta Dose (mrad)
A. Noble Gas Air Dose:	7.93E-04	3.74E-04
ODCM Quarterly Objective:	5.00E+00	1.00E+01
Percent of Quarterly Obj:	0.02 %	0.00 %
ODCM Annual Objective:	1.00E+01	2.00E+01
YTD Percent of Annual Obj:	0.03 %	0.01 %

B. I-131, I-133, Tritium, C-14, and Particulates with Half-Lives > 8 Days:	Total Body Dose (mrem)	Critical Organ Dose (mrem)
Inhalation:	9.37E-05	9.37E-05
Ground and Food:	4.63E-02	2.30E-01
Totals:	4.64E-02	2.30E-01
ODCM Quarterly Objective:	7.50E+00	7.50E+00
Percent of Quarterly Obj:	0.62 %	3.07 %
ODCM Annual Objective:	1.50E+01	1.50E+01
YTD Percent of Annual Obj:	1.23 %	6.11 %

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SECTION III

RADIOLOGICAL EFFLUENT RELEASES

Technical Specification (5.9.4.a)

January 1, 2014 - December 31, 2014

TABLE III.1

BATCH LIQUID AND GASEOUS RELEASE SUMMARY

JANUARY THROUGH DECEMBER 2014

A. Liquid Releases All Sources	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. Number of Batch Releases:	33	23	12	24	92
2. Total Time Period for Batch Releases(min):	4,186	3,045	1,606	3,232	12,069
3. Maximum Time Period for Batch Releases(min):	160	170	190	195	195
4. Average Time Period for Batch Releases(min):	127	132	134	135	131
5. Minimum Time Period for Batch Releases(min):	77	115	115	104	77
6. Average Dilution Stream Flow During Periods of Release into the Missouri River(mls/min):	1.294E+09	1.304E+09	1.363E+09	1.193E+09	1.279E+09

B. Gaseous Releases All Sources	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. Number of Batch Releases:	14	14	14	15	57
2. Total Time Period for Batch Releases(min):	83,765	92,911	99,877	92,386	368,939
3. Maximum Time Period for Batch Releases(min):	9,182	8,490	8,680	8,972	9,182
4. Average Time Period for Batch Releases(min):	5,983	6,637	7,134	6,159	6,473
5. Minimum Time Period for Batch Releases(min):	233	95	239	81	81

TABLE III.2

ABNORMAL BATCH LIQUID AND GASEOUS RELEASE SUMMARY

JANUARY THROUGH DECEMBER 2014

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 2014

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
A.	Fission & Activation Gases					
	Total Release (Ci):	3.12E-01	3.25E-01	4.53E-01	4.00E-01	1.49E+00
	Average Release Rate (uCi/sec):	1.07E-03	1.07E-03	1.48E-03	1.27E-03	1.22E-03
	Total Error (%): 25.91					
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	3.08E-06	2.83E-06	5.37E-06	4.80E-06	1.61E-05
D.	Tritium					
	Total Release (Ci):	1.45E-01	2.08E-01	2.66E-01	2.85E-01	9.04E-01
	Average Release Rate (uCi/sec):	7.53E-04	1.03E-03	1.25E-03	1.34E-03	1.10E-03
	Total Error (%): 25.08					
E.	Carbon-14					
	Total Release (Ci):	5.04E-01	5.93E-01	6.64E-01	5.89E-01	2.35E+00
	Average Release Rate (uCi/sec):	5.46E-03	5.87E-03	6.03E-03	5.76E-03	5.75E-03
	Total Error (%): 25.08					

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

TABLE III.4

GASEOUS EFFLUENTS--GROUND LEVEL RELEASES

JANUARY THROUGH DECEMBER 2014

Batch Mode

Nuclides(Ci)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	YEAR
Fission & Activation Gases					
XE-133	1.34E-01	1.63E-01	2.38E-01	2.17E-01	7.52E-01
XE-135	3.39E-03	3.68E-03	5.27E-03	4.24E-03	1.66E-02
AR-41	1.75E-01	1.59E-01	2.09E-01	1.79E-01	7.21E-01
Totals for Period:	3.12E-01	3.25E-01	4.53E-01	4.00E-01	1.49E+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	2.79E-02	4.44E-02	5.60E-02	5.29E-02	1.81E-01

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 2014

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					
C-14	5.04E-01	5.93E-01	6.64E-01	5.89E-01	2.35E+00
Totals for Period:	5.04E-01	5.93E-01	6.64E-01	5.89E-01	2.35E+00
Tritium and Gross Alpha					
ALPHA	3.08E-06	2.83E-06	5.37E-06	4.80E-06	1.61E-05
H-3	1.17E-01	1.63E-01	2.10E-01	2.32E-01	7.23E-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 2014

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
A. Fission & Activiation Products					
Total Release (No H-3,Gas,Alpha) (Ci):	7.36E-04	9.74E-04	3.42E-05	4.22E-04	2.17E-03
Average Diluted Concentration (uCi/mL):	1.25E-10	1.35E-10	3.63E-12	6.02E-11	3.01E-10
10 CFR 20, App. B Limit 1.00E-06 (uCi/mL) Percent of Limit (%):	1.25E-02	1.35E-02	3.63E-04	6.02E-03	3.01E-02
Total Error (%): 28.25					
B. Tritium					
Total Release (Ci):	3.01E+01	3.79E+01	2.79E+01	9.05E+01	1.86E+02
Average Diluted Concentration (uCi/mL):	5.10E-06	5.26E-06	2.95E-06	1.29E-05	2.59E-05
10 CFR 20, App. B Limit 1.00E-03(uCi/mL) Percent of Limit (%):	5.10E-01	5.26E-01	2.95E-01	1.29E+00	2.59E+00
Total Error (%): 25.08					
C. Dissolved & Entrained Gases					
Total Release (Ci):	1.14E-03	3.41E-04	1.82E-05	3.28E-05	1.53E-03
Average Diluted Concentration (uCi/mL):	1.92E-10	4.73E-11	1.93E-12	4.68E-12	2.12E-10
ODCM Limit 2.00E-04 (uCi/mL): Percent of Limit (%):	9.62E-05	2.37E-05	9.67E-07	2.34E-06	1.06E-04
Total Error (%): 19.08					
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):	4.53E+07	4.02E+07	3.55E+07	3.44E+07	1.55E+08
F. Volume of Dilution Water During Releases (Liters):	3.43E+11	3.49E+11	3.56E+11	3.47E+11	1.40E+12

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

TABLE III.7

LIQUID EFFLUENTS

JANUARY THROUGH DECEMBER 2014

Batch Mode

Nuclides(Ci)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year
Fission & Activation Gases					
TC-99M	9.94E-07	0.00E+00	0.00E+00	0.00E+00	9.94E-07
CS-137	3.44E-05	2.60E-05	2.17E-05	5.75E-05	1.40E-04
CO-58	1.84E-06	2.95E-07	0.00E+00	0.00E+00	2.14E-06
MO-99	9.98E-07	0.00E+00	0.00E+00	0.00E+00	9.98E-07
I-131	3.50E-05	4.26E-06	4.17E-06	1.47E-06	4.49E-05
SB-125	2.69E-06	0.00E+00	0.00E+00	0.00E+00	2.69E-06
NI-63	6.21E-04	9.18E-04	0.00E+00	3.31E-04	1.87E-03
CO-60	3.87E-05	2.57E-05	8.41E-06	3.20E-05	1.05E-04
Totals for Period:	7.36E-04	9.74E-04	3.42E-05	4.22E-04	2.17E-03
Dissolved & Entrained Gases					
XE-133	1.12E-03	3.41E-04	1.82E-05	3.15E-05	1.52E-03
XE-135	8.88E-07	0.00E+00	0.00E+00	1.33E-06	2.22E-06
XE-133M	1.14E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-05
Totals for Period:	1.14E-03	3.41E-04	1.82E-05	3.28E-05	1.53E-03
Tritium and Gross Alpha					
H-3	3.01E+01	3.79E+01	2.79E+01	9.05E+01	1.86E+02

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

TABLE III.8
LIQUID EFFLUENTS

JANUARY THROUGH DECEMBER 2014
Continuous Mode

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

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

TABLE III.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2014

		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	0.00E+00	0.00E+00	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-1B					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-2					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55			0.00E+00	
	NI-63			0.00E+00	
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-2A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		0.00E+00
	NI-63		0.00E+00		
	Sr-90	0.00E+00	0.00E+00	0.00E+00	
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-2B					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-3					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55			0.00E+00	
	NI-63			0.00E+00	
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-3A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90	0.00E+00	0.00E+00	0.00E+00	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
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90		0.00E+00		
	Total Gamma	0.00E+00	0.00E+00		0.00E+00
MW-4A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00		
	NI-63		0.00E+00		
	Sr-90		0.00E+00	0.00E+00	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE III.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2014

		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	0.00E+00	
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-5A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55			0.00E+00	
	NI-63			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-6					
	Tritium	0.00E+00	2.23E+02	4.16E+02	0.00E+00
	FE-55				
	NI-63				
	Sr-90	0.00E+00	0.00E+00	4.98E-01	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-5B					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55			0.00E+00	
	NI-63			0.00E+00	
	Sr-90			0.00E+00	
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	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	0.00E+00	0.00E+00	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-9					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55			0.00E+00	0.00E+00
	NI-63			0.00E+00	0.00E+00
	Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-10					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00	0.00E+00	0.00E+00
	NI-63		0.00E+00	0.00E+00	0.00E+00
	Sr-90	0.00E+00		0.00E+00	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-11					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00	0.00E+00	0.00E+00
	NI-63		0.00E+00	0.00E+00	0.00E+00
	Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MW-12A					
	Tritium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FE-55		0.00E+00	0.00E+00	0.00E+00
	NI-63		0.00E+00	0.00E+00	0.00E+00
	Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE III.9

GROUNDWATER ANALYSIS RESULTS

pCi/L

JANUARY THROUGH DECEMBER 2014

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

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

SECTION IV
DOSE FROM GASEOUS EFFLUENTS

Technical Specification 5.9.4.a

GASPAR II OUTPUT

January 1, 2014 - December 31, 2014

Radioactive Effluent Releases - First, Second, Third and Fourth Quarters 2014

GASEOUS EFFLUENTS

Radioactive gaseous releases for the reporting period totaled 1.49 curies of inert gas. The gross gaseous activity release rates were 1.07E-03 µCi/sec for the first quarter, 1.07E-03 µCi/sec for the second quarter, 1.48E-03 µCi/sec for the third quarter, and 1.27E-03 µCi/sec for the fourth quarter.

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

Radioactive tritium released during the reporting period totaled 9.04E-01 curies.

Carbon-14 released for the reporting period totaled 2.35 curies, this is a calculated value based on reactor power and days of operation.

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

POTENTIAL DOSES TO INDIVIDUALS AND POPULATIONS

A. Potential Annual Doses to Individuals from Gaseous Releases

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

The inputs to GASPAR II for the annual period from January 1, 2014 through December 31, 2014 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.

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 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 1 RES
AT 4.36 MILES N

ANNUAL_BETA_AIR_DOSE = 4.17E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.73E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.40E-06	2.40E-06	2.40E-06	2.40E-06	2.40E-06	2.40E-06	2.43E-06	4.65E-06
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	2.68E-06	2.68E-06	0.00E+00	2.68E-06	2.68E-06	2.68E-06	2.68E-06	2.68E-06
TEEN	2.70E-06	2.70E-06	0.00E+00	2.70E-06	2.70E-06	2.70E-06	2.70E-06	2.70E-06
CHILD	2.38E-06	2.38E-06	0.00E+00	2.38E-06	2.38E-06	2.38E-06	2.38E-06	2.38E-06
INFANT	1.37E-06	1.37E-06	0.00E+00	1.37E-06	1.37E-06	1.37E-06	1.37E-06	1.37E-06

TABLE IV-A- 2

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 2 RES
AT 1.93 MILES NNE

ANNUAL_BETA_AIR_DOSE = 2.72E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.73E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.44E-05	2.44E-05	2.44E-05	2.44E-05	2.44E-05	2.44E-05	2.46E-05	4.31E-05
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	1.30E-05	1.30E-05	0.00E+00	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05
TEEN	1.31E-05	1.31E-05	0.00E+00	1.31E-05	1.31E-05	1.31E-05	1.31E-05	1.31E-05
CHILD	1.16E-05	1.16E-05	0.00E+00	1.16E-05	1.16E-05	1.16E-05	1.16E-05	1.16E-05
INFANT	6.65E-06	6.65E-06	0.00E+00	6.65E-06	6.65E-06	6.65E-06	6.65E-06	6.65E-06

TABLE IV-A- 3

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 3 RES
AT 1.52 MILES NE

ANNUAL_BETA_AIR_DOSE = 4.15E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 6.54E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.29E-05	4.29E-05	4.29E-05	4.29E-05	4.29E-05	4.29E-05	4.31E-05	7.41E-05
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	1.69E-05	1.69E-05	0.00E+00	1.69E-05	1.69E-05	1.69E-05	1.69E-05	1.69E-05
TEEN	1.70E-05	1.70E-05	0.00E+00	1.70E-05	1.70E-05	1.70E-05	1.70E-05	1.70E-05
CHILD	1.50E-05	1.50E-05	0.00E+00	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05
INFANT	8.65E-06	8.65E-06	0.00E+00	8.65E-06	8.65E-06	8.65E-06	8.65E-06	8.65E-06

TABLE IV-A- 4

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 4 RES
AT 4.79 MILES ENE

ANNUAL_BETA_AIR_DOSE = 1.85E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.29E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	8.18E-07	8.18E-07	8.18E-07	8.18E-07	8.18E-07	8.18E-07	8.34E-07	1.70E-06
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	1.32E-06	1.32E-06	0.00E+00	1.32E-06	1.32E-06	1.32E-06	1.32E-06	1.32E-06
TEEN	1.33E-06	1.33E-06	0.00E+00	1.33E-06	1.33E-06	1.33E-06	1.33E-06	1.33E-06
CHILD	1.17E-06	1.17E-06	0.00E+00	1.17E-06	1.17E-06	1.17E-06	1.17E-06	1.17E-06
INFANT	6.75E-07	6.75E-07	0.00E+00	6.75E-07	6.75E-07	6.75E-07	6.75E-07	6.75E-07

TABLE IV-A- 5

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 5 RES
AT 4.67 MILES E

ANNUAL_BETA_AIR_DOSE = 2.88E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.09E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	6.50E-07	6.50E-07	6.50E-07	6.50E-07	6.50E-07	6.50E-07	6.78E-07	1.73E-06
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	2.47E-06	2.47E-06	0.00E+00	2.47E-06	2.47E-06	2.47E-06	2.47E-06	2.47E-06
TEEN	2.49E-06	2.49E-06	0.00E+00	2.49E-06	2.49E-06	2.49E-06	2.49E-06	2.49E-06
CHILD	2.20E-06	2.20E-06	0.00E+00	2.20E-06	2.20E-06	2.20E-06	2.20E-06	2.20E-06
INFANT	1.27E-06	1.27E-06	0.00E+00	1.27E-06	1.27E-06	1.27E-06	1.27E-06	1.27E-06

TABLE IV-A- 6

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 6 RES
AT 4.22 MILES ESE

ANNUAL_BETA_AIR_DOSE = 4.69E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.56E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.94E-06	2.94E-06	2.94E-06	2.94E-06	2.94E-06	2.94E-06	2.97E-06	5.58E-06
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	2.88E-06	2.88E-06	0.00E+00	2.88E-06	2.88E-06	2.88E-06	2.88E-06	2.88E-06
TEEN	2.91E-06	2.91E-06	0.00E+00	2.91E-06	2.91E-06	2.91E-06	2.91E-06	2.91E-06
CHILD	2.57E-06	2.57E-06	0.00E+00	2.57E-06	2.57E-06	2.57E-06	2.57E-06	2.57E-06
INFANT	1.48E-06	1.48E-06	0.00E+00	1.48E-06	1.48E-06	1.48E-06	1.48E-06	1.48E-06

TABLE IV-A- 7

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 7 RES
AT 1.67 MILES SE

ANNUAL_BETA_AIR_DOSE = 4.23E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 6.70E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.40E-05	4.40E-05	4.40E-05	4.40E-05	4.40E-05	4.40E-05	4.42E-05	7.59E-05
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	1.71E-05	1.71E-05	0.00E+00	1.71E-05	1.71E-05	1.71E-05	1.71E-05	1.71E-05
TEEN	1.72E-05	1.72E-05	0.00E+00	1.72E-05	1.72E-05	1.72E-05	1.72E-05	1.72E-05
CHILD	1.52E-05	1.52E-05	0.00E+00	1.52E-05	1.52E-05	1.52E-05	1.52E-05	1.52E-05
INFANT	8.76E-06	8.76E-06	0.00E+00	8.76E-06	8.76E-06	8.76E-06	8.76E-06	8.76E-06

TABLE IV-A- 8

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 8 RES
AT 0.65 MILES SSE

ANNUAL_BETA_AIR_DOSE = 4.30E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 8.32E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	5.49E-04	5.49E-04	5.49E-04	5.49E-04	5.49E-04	5.49E-04	5.51E-04	9.20E-04
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	1.24E-04	1.24E-04	0.00E+00	1.24E-04	1.24E-04	1.24E-04	1.24E-04	1.24E-04
TEEN	1.25E-04	1.25E-04	0.00E+00	1.25E-04	1.25E-04	1.25E-04	1.25E-04	1.25E-04
CHILD	1.10E-04	1.10E-04	0.00E+00	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04
INFANT	6.33E-05	6.33E-05	0.00E+00	6.33E-05	6.33E-05	6.33E-05	6.33E-05	6.33E-05

TABLE IV-A- 9

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 9 RES
AT 0.73 MILES S

ANNUAL_BETA_AIR_DOSE = 1.52E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.45E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.62E-04	2.77E-04
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	5.97E-05	5.97E-05	0.00E+00	5.97E-05	5.97E-05	5.97E-05	5.97E-05	5.97E-05
TEEN	6.02E-05	6.02E-05	0.00E+00	6.02E-05	6.02E-05	6.02E-05	6.02E-05	6.02E-05
CHILD	5.32E-05	5.32E-05	0.00E+00	5.32E-05	5.32E-05	5.32E-05	5.32E-05	5.32E-05
INFANT	3.06E-05	3.06E-05	0.00E+00	3.06E-05	3.06E-05	3.06E-05	3.06E-05	3.06E-05

TABLE IV-A-10

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 10 RES
AT 0.65 MILES SSW

ANNUAL_BETA_AIR_DOSE = 1.28E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.97E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.29E-04	1.29E-04	1.29E-04	1.29E-04	1.29E-04	1.29E-04	1.30E-04	2.24E-04
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	5.35E-05	5.35E-05	0.00E+00	5.35E-05	5.35E-05	5.35E-05	5.35E-05	5.35E-05
TEEN	5.40E-05	5.40E-05	0.00E+00	5.40E-05	5.40E-05	5.40E-05	5.40E-05	5.40E-05
CHILD	4.77E-05	4.77E-05	0.00E+00	4.77E-05	4.77E-05	4.77E-05	4.77E-05	4.77E-05
INFANT	2.74E-05	2.74E-05	0.00E+00	2.74E-05	2.74E-05	2.74E-05	2.74E-05	2.74E-05

TABLE IV-A-11

FORT CALHOUN ANNUAL 2014, *DOSE PROJECTIONS*
SPECIAL LOCATION NO. 11 RES
AT 0.73 MILES SW

ANNUAL_BETA_AIR_DOSE = 1.93E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.22E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.79E-04	2.79E-04	2.79E-04	2.79E-04	2.79E-04	2.79E-04	2.80E-04	4.61E-04
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	3.91E-05	3.91E-05	0.00E+00	3.91E-05	3.91E-05	3.91E-05	3.91E-05	3.91E-05
TEEN	3.95E-05	3.95E-05	0.00E+00	3.95E-05	3.95E-05	3.95E-05	3.95E-05	3.95E-05
CHILD	3.49E-05	3.49E-05	0.00E+00	3.49E-05	3.49E-05	3.49E-05	3.49E-05	3.49E-05
INFANT	2.00E-05	2.00E-05	0.00E+00	2.00E-05	2.00E-05	2.00E-05	2.00E-05	2.00E-05

TABLE IV-A-12

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 12 RES
AT 1.06 MILES WSW

ANNUAL_BETA_AIR_DOSE = 1.22E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.67E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.77E-04	1.77E-04	1.77E-04	1.77E-04	1.77E-04	1.77E-04	1.77E-04	2.91E-04
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	2.47E-05	2.47E-05	0.00E+00	2.47E-05	2.47E-05	2.47E-05	2.47E-05	2.47E-05
TEEN	2.49E-05	2.49E-05	0.00E+00	2.49E-05	2.49E-05	2.49E-05	2.49E-05	2.49E-05
CHILD	2.20E-05	2.20E-05	0.00E+00	2.20E-05	2.20E-05	2.20E-05	2.20E-05	2.20E-05
INFANT	1.27E-05	1.27E-05	0.00E+00	1.27E-05	1.27E-05	1.27E-05	1.27E-05	1.27E-05

TABLE IV-A-13

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 13 RES
AT 1.20 MILES W

ANNUAL_BETA_AIR_DOSE = 5.90E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.09E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	7.17E-05	7.17E-05	7.17E-05	7.17E-05	7.17E-05	7.17E-05	7.19E-05	1.21E-04
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	1.87E-05	1.87E-05	0.00E+00	1.87E-05	1.87E-05	1.87E-05	1.87E-05	1.87E-05
TEEN	1.89E-05	1.89E-05	0.00E+00	1.89E-05	1.89E-05	1.89E-05	1.89E-05	1.89E-05
CHILD	1.67E-05	1.67E-05	0.00E+00	1.67E-05	1.67E-05	1.67E-05	1.67E-05	1.67E-05
INFANT	9.60E-06	9.60E-06	0.00E+00	9.60E-06	9.60E-06	9.60E-06	9.60E-06	9.60E-06

TABLE IV-A-14

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 14 RES
AT 2.60 MILES WNW

ANNUAL_BETA_AIR_DOSE = 1.16E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.29E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	8.39E-06	8.39E-06	8.39E-06	8.39E-06	8.39E-06	8.39E-06	8.47E-06	1.55E-05
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	6.59E-06	6.59E-06	0.00E+00	6.59E-06	6.59E-06	6.59E-06	6.59E-06	6.59E-06
TEEN	6.65E-06	6.65E-06	0.00E+00	6.65E-06	6.65E-06	6.65E-06	6.65E-06	6.65E-06
CHILD	5.87E-06	5.87E-06	0.00E+00	5.87E-06	5.87E-06	5.87E-06	5.87E-06	5.87E-06
INFANT	3.38E-06	3.38E-06	0.00E+00	3.38E-06	3.38E-06	3.38E-06	3.38E-06	3.38E-06

TABLE IV-A-15

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 15 RES
AT 2.40 MILES NW

ANNUAL_BETA_AIR_DOSE = 2.45E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.21E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.10E-05	2.10E-05	2.10E-05	2.10E-05	2.10E-05	2.10E-05	2.11E-05	3.73E-05
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	1.21E-05	1.21E-05	0.00E+00	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05
TEEN	1.23E-05	1.23E-05	0.00E+00	1.23E-05	1.23E-05	1.23E-05	1.23E-05	1.23E-05
CHILD	1.08E-05	1.08E-05	0.00E+00	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05
INFANT	6.23E-06	6.23E-06	0.00E+00	6.23E-06	6.23E-06	6.23E-06	6.23E-06	6.23E-06

TABLE IV-A-16

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 16 RES
AT 2.08 MILES NNW

ANNUAL_BETA_AIR_DOSE = 3.70E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 6.25E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.12E-05	4.12E-05	4.12E-05	4.12E-05	4.12E-05	4.12E-05	4.13E-05	7.02E-05
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	1.36E-05	1.36E-05	0.00E+00	1.36E-05	1.36E-05	1.36E-05	1.36E-05	1.36E-05
TEEN	1.37E-05	1.37E-05	0.00E+00	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05
CHILD	1.21E-05	1.21E-05	0.00E+00	1.21E-05	1.21E-05	1.21E-05	1.21E-05	1.21E-05
INFANT	6.96E-06	6.96E-06	0.00E+00	6.96E-06	6.96E-06	6.96E-06	6.96E-06	6.96E-06

TABLE IV-A-17

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 17 VEG
AT 2.23 MILES NNE

ANNUAL_BETA_AIR_DOSE = 1.82E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.49E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.63E-05	1.63E-05	1.63E-05	1.63E-05	1.63E-05	1.63E-05	1.64E-05	2.88E-05
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	8.65E-04	8.65E-04	4.25E-03	8.65E-04	8.65E-04	8.65E-04	8.65E-04	8.65E-04
TEEN	1.40E-03	1.40E-03	6.89E-03	1.40E-03	1.40E-03	1.40E-03	1.40E-03	1.40E-03
CHILD	3.35E-03	3.35E-03	1.66E-02	3.35E-03	3.35E-03	3.35E-03	3.35E-03	3.35E-03

TABLE IV-A-18

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 18 VEG
AT 1.59 MILES NE

ANNUAL_BETA_AIR_DOSE = 3.15E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.07E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.66E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05	2.68E-05	4.75E-05
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	1.59E-03	1.59E-03	7.79E-03	1.59E-03	1.59E-03	1.59E-03	1.59E-03	1.59E-03
TEEN	2.56E-03	2.56E-03	1.26E-02	2.56E-03	2.56E-03	2.56E-03	2.56E-03	2.56E-03
CHILD	6.14E-03	6.14E-03	3.04E-02	6.14E-03	6.14E-03	6.14E-03	6.14E-03	6.14E-03

TABLE IV-A-19

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 19 VEG
AT 4.79 MILES ENE

ANNUAL_BETA_AIR_DOSE = 1.85E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.29E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	8.18E-07	8.18E-07	8.18E-07	8.18E-07	8.18E-07	8.18E-07	8.34E-07	1.70E-06
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	1.32E-04	1.32E-04	6.47E-04	1.32E-04	1.32E-04	1.32E-04	1.32E-04	1.32E-04
TEEN	2.13E-04	2.13E-04	1.05E-03	2.13E-04	2.13E-04	2.13E-04	2.13E-04	2.13E-04
CHILD	5.10E-04	5.10E-04	2.53E-03	5.10E-04	5.10E-04	5.10E-04	5.10E-04	5.10E-04

TABLE IV-A-20

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 20 VEG
AT 4.22 MILES ESE

ANNUAL_BETA_AIR_DOSE = 4.69E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.56E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.94E-06	2.94E-06	2.94E-06	2.94E-06	2.94E-06	2.94E-06	2.97E-06	5.58E-06
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	2.88E-04	2.88E-04	1.42E-03	2.88E-04	2.88E-04	2.88E-04	2.88E-04	2.88E-04
TEEN	4.65E-04	4.65E-04	2.30E-03	4.65E-04	4.65E-04	4.65E-04	4.65E-04	4.65E-04
CHILD	1.12E-03	1.12E-03	5.53E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03

TABLE IV-A-21

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 21 VEG
AT 1.74 MILES SE

ANNUAL_BETA_AIR_DOSE = 3.84E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 5.91E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.88E-05	3.88E-05	3.88E-05	3.88E-05	3.88E-05	3.88E-05	3.90E-05	6.72E-05
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	1.61E-03	1.61E-03	7.89E-03	1.61E-03	1.61E-03	1.61E-03	1.61E-03	1.61E-03
TEEN	2.59E-03	2.59E-03	1.28E-02	2.59E-03	2.59E-03	2.59E-03	2.59E-03	2.59E-03
CHILD	6.22E-03	6.22E-03	3.08E-02	6.22E-03	6.22E-03	6.22E-03	6.22E-03	6.22E-03

TABLE IV-A-22

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 22 VEG
AT 0.94 MILES SSE

ANNUAL_BETA_AIR_DOSE = 2.64E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 5.78E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.82E-04	3.82E-04	3.82E-04	3.82E-04	3.82E-04	3.82E-04	3.83E-04	6.30E-04
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	5.36E-03	5.36E-03	2.63E-02	5.36E-03	5.36E-03	5.36E-03	5.36E-03	5.36E-03
TEEN	8.64E-03	8.64E-03	4.26E-02	8.64E-03	8.64E-03	8.64E-03	8.64E-03	8.64E-03
CHILD	2.07E-02	2.07E-02	1.03E-01	2.07E-02	2.07E-02	2.07E-02	2.07E-02	2.07E-02

TABLE IV-A-23

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 23 VEG
AT 0.73 MILES S

ANNUAL_BETA_AIR_DOSE = 1.52E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.45E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.62E-04	2.77E-04
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	5.98E-03	5.98E-03	2.93E-02	5.98E-03	5.98E-03	5.98E-03	5.98E-03	5.98E-03
TEEN	9.64E-03	9.64E-03	4.76E-02	9.64E-03	9.64E-03	9.64E-03	9.64E-03	9.64E-03
CHILD	2.31E-02	2.31E-02	1.15E-01	2.31E-02	2.31E-02	2.31E-02	2.31E-02	2.31E-02

TABLE IV-A-24

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 24 VEG
AT 2.00 MILES SSW

ANNUAL_BETA_AIR_DOSE = 1.83E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.00E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.65E-05	2.65E-05	2.65E-05	2.65E-05	2.65E-05	2.65E-05	2.65E-05	4.36E-05
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	3.71E-04	3.71E-04	1.82E-03	3.71E-04	3.71E-04	3.71E-04	3.71E-04	3.71E-04
TEEN	5.98E-04	5.98E-04	2.95E-03	5.98E-04	5.98E-04	5.98E-04	5.98E-04	5.98E-04
CHILD	1.44E-03	1.44E-03	7.12E-03	1.44E-03	1.44E-03	1.44E-03	1.44E-03	1.44E-03

TABLE IV-A-25

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 25 VEG
AT 1.36 MILES SW

ANNUAL_BETA_AIR_DOSE = 2.37E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.21E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.77E-05	2.77E-05	2.77E-05	2.77E-05	2.77E-05	2.77E-05	2.78E-05	4.70E-05
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	8.04E-04	8.04E-04	3.95E-03	8.04E-04	8.04E-04	8.04E-04	8.04E-04	8.04E-04
TEEN	1.30E-03	1.30E-03	6.40E-03	1.30E-03	1.30E-03	1.30E-03	1.30E-03	1.30E-03
CHILD	3.11E-03	3.11E-03	1.54E-02	3.11E-03	3.11E-03	3.11E-03	3.11E-03	3.11E-03

TABLE IV-A-26

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 26 VEG
AT 1.13 MILES WSW

ANNUAL_BETA_AIR_DOSE = 5.63E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 9.56E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	6.29E-05	6.29E-05	6.29E-05	6.29E-05	6.29E-05	6.29E-05	6.31E-05	1.07E-04
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	2.06E-03	2.06E-03	1.01E-02	2.06E-03	2.06E-03	2.06E-03	2.06E-03	2.06E-03
TEEN	3.32E-03	3.32E-03	1.64E-02	3.32E-03	3.32E-03	3.32E-03	3.32E-03	3.32E-03
CHILD	7.97E-03	7.97E-03	3.95E-02	7.97E-03	7.97E-03	7.97E-03	7.97E-03	7.97E-03

TABLE IV-A-27

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 27 VEG
AT 1.30 MILES W

ANNUAL_BETA_AIR_DOSE = 3.46E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 5.15E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.38E-05	3.38E-05	3.38E-05	3.38E-05	3.38E-05	3.38E-05	3.39E-05	5.88E-05
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	1.50E-03	1.50E-03	7.38E-03	1.50E-03	1.50E-03	1.50E-03	1.50E-03	1.50E-03
TEEN	2.43E-03	2.43E-03	1.20E-02	2.43E-03	2.43E-03	2.43E-03	2.43E-03	2.43E-03
CHILD	5.82E-03	5.82E-03	2.89E-02	5.82E-03	5.82E-03	5.82E-03	5.82E-03	5.82E-03

TABLE IV-A-28

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 28 VEG
AT 2.65 MILES WNW

ANNUAL_BETA_AIR_DOSE = 1.05E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.09E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	7.08E-06	7.08E-06	7.08E-06	7.08E-06	7.08E-06	7.08E-06	7.16E-06	1.32E-05
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	6.18E-04	6.18E-04	3.03E-03	6.18E-04	6.18E-04	6.18E-04	6.18E-04	6.18E-04
TEEN	9.97E-04	9.97E-04	4.92E-03	9.97E-04	9.97E-04	9.97E-04	9.97E-04	9.97E-04
CHILD	2.39E-03	2.39E-03	1.19E-02	2.39E-03	2.39E-03	2.39E-03	2.39E-03	2.39E-03

TABLE IV-A-29

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 29 VEG
AT 2.40 MILES NW

ANNUAL_BETA_AIR_DOSE = 2.45E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.21E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.10E-05	2.10E-05	2.10E-05	2.10E-05	2.10E-05	2.10E-05	2.11E-05	3.73E-05
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	1.22E-03	1.22E-03	5.97E-03	1.22E-03	1.22E-03	1.22E-03	1.22E-03	1.22E-03
TEEN	1.96E-03	1.96E-03	9.68E-03	1.96E-03	1.96E-03	1.96E-03	1.96E-03	1.96E-03
CHILD	4.70E-03	4.70E-03	2.33E-02	4.70E-03	4.70E-03	4.70E-03	4.70E-03	4.70E-03

TABLE IV-A-30

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 30 VEG
AT 3.73 MILES NNW

ANNUAL_BETA_AIR_DOSE = 7.06E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 8.67E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	5.65E-06	5.65E-06	5.65E-06	5.65E-06	5.65E-06	5.65E-06	5.69E-06	1.02E-05
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	3.71E-04	3.71E-04	1.82E-03	3.71E-04	3.71E-04	3.71E-04	3.71E-04	3.71E-04
TEEN	5.98E-04	5.98E-04	2.95E-03	5.98E-04	5.98E-04	5.98E-04	5.98E-04	5.98E-04
CHILD	1.44E-03	1.44E-03	7.12E-03	1.44E-03	1.44E-03	1.44E-03	1.44E-03	1.44E-03

TABLE IV-A-31

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 31 BEEF
AT 4.91 MILES E

ANNUAL_BETA_AIR_DOSE = 2.81E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.34E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	8.20E-07	8.20E-07	8.20E-07	8.20E-07	8.20E-07	8.20E-07	8.47E-07	1.97E-06
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	8.32E-05	8.32E-05	4.13E-04	8.32E-05	8.32E-05	8.32E-05	8.32E-05	8.32E-05
TEEN	7.02E-05	7.02E-05	3.49E-04	7.02E-05	7.02E-05	7.02E-05	7.02E-05	7.02E-05
CHILD	1.32E-04	1.32E-04	6.56E-04	1.32E-04	1.32E-04	1.32E-04	1.32E-04	1.32E-04

TABLE IV-A-32

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 32 BEEF
AT 1.82 MILES SSE

ANNUAL_BETA_AIR_DOSE = 3.83E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 7.31E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.82E-05	4.82E-05	4.82E-05	4.82E-05	4.82E-05	4.82E-05	4.84E-05	8.09E-05
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	4.16E-04	4.16E-04	2.07E-03	4.16E-04	4.16E-04	4.16E-04	4.16E-04	4.16E-04
TEEN	3.51E-04	3.51E-04	1.75E-03	3.51E-04	3.51E-04	3.51E-04	3.51E-04	3.51E-04
CHILD	6.58E-04	6.58E-04	3.28E-03	6.58E-04	6.58E-04	6.58E-04	6.58E-04	6.58E-04

TABLE IV-A-33

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 33 BEEF
AT 2.48 MILES S

ANNUAL_BETA_AIR_DOSE = 1.42E-05 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.11E-05 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.06E-05	2.06E-05	2.06E-05	2.06E-05	2.06E-05	2.06E-05	2.06E-05	3.39E-05
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	1.06E-04	1.06E-04	5.26E-04	1.06E-04	1.06E-04	1.06E-04	1.06E-04	1.06E-04
TEEN	8.93E-05	8.93E-05	4.44E-04	8.93E-05	8.93E-05	8.93E-05	8.93E-05	8.93E-05
CHILD	1.68E-04	1.68E-04	8.35E-04	1.68E-04	1.68E-04	1.68E-04	1.68E-04	1.68E-04

TABLE IV-A-34

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 34 BEEF
AT 0.65 MILES SSW

ANNUAL_BETA_AIR_DOSE = 1.28E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 1.97E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.29E-04	1.29E-04	1.29E-04	1.29E-04	1.29E-04	1.29E-04	1.30E-04	2.24E-04
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	1.97E-03	1.97E-03	9.77E-03	1.97E-03	1.97E-03	1.97E-03	1.97E-03	1.97E-03
TEEN	1.66E-03	1.66E-03	8.25E-03	1.66E-03	1.66E-03	1.66E-03	1.66E-03	1.66E-03
CHILD	3.11E-03	3.11E-03	1.55E-02	3.11E-03	3.11E-03	3.11E-03	3.11E-03	3.11E-03

TABLE IV-A-35

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 35 BEEF
AT 0.76 MILES SW

ANNUAL_BETA_AIR_DOSE = 1.72E-04 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 3.78E-04 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	2.50E-04	2.50E-04	2.50E-04	2.50E-04	2.50E-04	2.50E-04	2.51E-04	4.12E-04
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	1.29E-03	1.29E-03	6.39E-03	1.29E-03	1.29E-03	1.29E-03	1.29E-03	1.29E-03
TEEN	1.08E-03	1.08E-03	5.39E-03	1.08E-03	1.08E-03	1.08E-03	1.08E-03	1.08E-03
CHILD	2.03E-03	2.03E-03	1.01E-02	2.03E-03	2.03E-03	2.03E-03	2.03E-03	2.03E-03

TABLE IV-A-36

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 36 BEEF
AT 2.42 MILES WSW

ANNUAL_BETA_AIR_DOSE = 5.82E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 6.47E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	4.19E-06	4.19E-06	4.19E-06	4.19E-06	4.19E-06	4.19E-06	4.23E-06	7.73E-06
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	1.21E-04	1.21E-04	6.01E-04	1.21E-04	1.21E-04	1.21E-04	1.21E-04	1.21E-04
TEEN	1.02E-04	1.02E-04	5.08E-04	1.02E-04	1.02E-04	1.02E-04	1.02E-04	1.02E-04
CHILD	1.91E-04	1.91E-04	9.54E-04	1.91E-04	1.91E-04	1.91E-04	1.91E-04	1.91E-04

TABLE IV-A-37

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 37 BEEF
AT 3.25 MILES W

ANNUAL_BETA_AIR_DOSE = 2.82E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 2.74E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	1.76E-06	1.76E-06	1.76E-06	1.76E-06	1.76E-06	1.76E-06	1.78E-06	3.35E-06
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	6.36E-05	6.36E-05	3.16E-04	6.36E-05	6.36E-05	6.36E-05	6.36E-05	6.36E-05
TEEN	5.36E-05	5.36E-05	2.67E-04	5.36E-05	5.36E-05	5.36E-05	5.36E-05	5.36E-05
CHILD	1.01E-04	1.01E-04	5.01E-04	1.01E-04	1.01E-04	1.01E-04	1.01E-04	1.01E-04

TABLE IV-A-38

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
SPECIAL LOCATION NO. 38 COW
AT 3.44 MILES S

ANNUAL_BETA_AIR_DOSE = 3.23E-06 MILLRADS
ANNUAL_GAMMA_AIR_DOSE = 4.71E-06 MILLRADS

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	3.09E-06	3.09E-06	3.09E-06	3.09E-06	3.09E-06	3.09E-06	3.10E-06	5.39E-06
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
COW MILK								
ADULT	5.82E-05	5.82E-05	2.87E-04	5.82E-05	5.82E-05	5.82E-05	5.82E-05	5.82E-05
TEEN	1.07E-04	1.07E-04	5.29E-04	1.07E-04	1.07E-04	1.07E-04	1.07E-04	1.07E-04
CHILD	2.62E-04	2.62E-04	1.30E-03	2.62E-04	2.62E-04	2.62E-04	2.62E-04	2.62E-04
INFANT	5.47E-04	5.47E-04	2.55E-03	5.47E-04	5.47E-04	5.47E-04	5.47E-04	5.47E-04

TABLE IV-B-1

FORT CALHOUN 1 DOSE CONTRIBUTIONS FROM GASEOUS EFFLUENTS
UNRESTRICTED AREA BOUNDARY
REQUIRED BY TECHNICAL SPECIFICATION 5.9.4.a.
JANUARY 1, 2014 TO DECEMBER 31, 2014

MAXIMUM SITE BOUNDARY GAMMA AIR DOSE - 1.58E-03 MILLRADS

MAXIMUM SITE BOUNDARY BETA AIR DOSE - 7.40E-04 MILLRADS

TABLE IV-C-1

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (PERSON-REM)

PATHWAY	T.BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME	9.59E-05	9.59E-05	9.59E-05	9.59E-05	9.59E-05	9.59E-05	9.84E-05	2.30E-04
	0.28%	0.28%	0.06%	0.28%	0.28%	0.28%	0.29%	0.67%
INHAL	2.13E-04	2.13E-04	0.00E+00	2.13E-04	2.13E-04	2.13E-04	2.13E-04	2.13E-04
	0.62%	0.62%	0.00%	0.62%	0.62%	0.62%	0.62%	0.62%
VEGET	1.93E-02	1.93E-02	9.53E-02	1.93E-02	1.93E-02	1.93E-02	1.93E-02	1.93E-02
	56.61%	56.61%	56.96%	56.61%	56.61%	56.61%	56.61%	56.39%
COW MILK	4.91E-03	4.91E-03	2.43E-02	4.91E-03	4.91E-03	4.91E-03	4.91E-03	4.91E-03
	14.39%	14.39%	14.52%	14.39%	14.39%	14.39%	14.39%	14.34%
MEAT	9.59E-03	9.59E-03	4.76E-02	9.59E-03	9.59E-03	9.59E-03	9.59E-03	9.59E-03
	28.09%	28.09%	28.46%	28.09%	28.09%	28.09%	28.09%	27.98%
TOTAL	3.41E-02	3.41E-02	1.67E-01	3.41E-02	3.41E-02	3.41E-02	3.41E-02	3.43E-02

SECTION V

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

January 1, 2014 - December 31, 2014

Radioactive Effluent Releases - First, Second, Third, and Fourth Quarters 2013

LIQUID EFFLUENTS

During the reporting period, a total of 2.17E-03 curies of radioactive liquid materials less tritium, dissolved noble gases, and alpha were released to the Missouri River at an average concentration of 3.01E-10 µCi/mL. This represents 3.01E-02 percent of the limits specified in Appendix B to 10 CFR 20 (1.0E-06 µCi/mL for unrestricted areas), 186 curies of tritium were discharged at an average diluted concentration of 2.59E-05 µCi/mL or 2.59 percent of ECL (1.0E-03 µCi/mL).

No gross alpha radioactivity was identified by Off-site vendor analysis of quarterly liquid composites for the reporting period. Ni-63 was identified in three of the four quarterly composites, and represented 86% of the total activity released.

Dilution water during the period amounted to 1.40E+12 liters, while liquid waste discharges consisted of 1.55E+08 liters of radioactive liquid waste.

A. Potential Annual Doses to Individuals from Liquid Releases

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

The inputs to LADTAP II for the annual period from January 1, 2013 through December 31, 2013 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 plant discharge rate of 246.9 cubic feet per second (CFS) was utilized for 2013. The average discharge rate during releases was 275.1 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
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EVALUATION OF RADIATION DOSES FROM RELEASES OF RADIACTIVITY

IN NUCLEAR POWER PLANTS LIQUID EFFLUENTS

REVISION DATE: PNL VAX - OCTOBER 1985

FORT CALHOUN ANNUAL 2014, DOSE PROJECTIONS

RADIOLOGICAL ASSESSMENT BRANCH

DIVISION OF SYSTEMS INTEGRATION

U. S. NUCLEAR REGULATORY COMMISSION

WASHINGTON, D. C.

DATE OF RUN: 28-MAR-15

LOCATION 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		1.95E-04	1.76E-04	1.29E-04	4.70E-05	8.51E-05	5.63E-05	4.68E-05
DRINKING		8.76E-06	3.85E-04	3.85E-04	3.87E-04	3.84E-04	3.84E-04	3.85E-04
SHORELINE	3.11E-07	2.65E-07	2.65E-07	2.65E-07	2.65E-07	2.65E-07	2.65E-07	2.65E-07
SWIMMING		1.58E-09	1.58E-09	1.58E-09	1.58E-09	1.58E-09	1.58E-09	1.58E-09
BOATING		7.92E-10	7.92E-10	7.92E-10	7.92E-10	7.92E-10	7.92E-10	7.92E-10
TOTAL	3.11E-07	2.04E-04	5.62E-04	5.14E-04	4.34E-04	4.70E-04	4.41E-04	4.32E-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		2.05E-04	1.72E-04	8.20E-05	3.70E-05	7.73E-05	4.97E-05	3.59E-05
DRINKING		8.35E-06	2.72E-04	2.71E-04	2.73E-04	2.71E-04	2.71E-04	2.71E-04
SHORELINE	1.74E-06	1.48E-06	1.48E-06	1.48E-06	1.48E-06	1.48E-06	1.48E-06	1.48E-06
SWIMMING		8.84E-09	8.84E-09	8.84E-09	8.84E-09	8.84E-09	8.84E-09	8.84E-09
BOATING		4.42E-09	4.42E-09	4.42E-09	4.42E-09	4.42E-09	4.42E-09	4.42E-09
TOTAL	1.74E-06	2.15E-04	4.45E-04	3.55E-04	3.12E-04	3.50E-04	3.22E-04	3.08E-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		2.63E-04	1.54E-04	4.92E-05	3.16E-05	6.58E-05	4.08E-05	2.82E-05
DRINKING		2.53E-05	5.22E-04	5.21E-04	5.26E-04	5.20E-04	5.20E-04	5.20E-04
SHORELINE	3.63E-07	3.10E-07	3.10E-07	3.10E-07	3.10E-07	3.10E-07	3.10E-07	3.10E-07
SWIMMING		1.85E-09	1.85E-09	1.85E-09	1.85E-09	1.85E-09	1.85E-09	1.85E-09
BOATING		9.24E-10	9.24E-10	9.24E-10	9.24E-10	9.24E-10	9.24E-10	9.24E-10
TOTAL	3.63E-07	2.89E-04	6.77E-04	5.70E-04	5.58E-04	5.86E-04	5.61E-04	5.49E-04

	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		1.96E-05	5.13E-04	5.11E-04	5.20E-04	5.11E-04	5.11E-04	5.11E-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	1.96E-05	5.13E-04	5.11E-04	5.20E-04	5.11E-04	5.11E-04	5.11E-04

	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		1.42E-03	1.29E-03	9.40E-04	3.43E-04	6.21E-04	4.11E-04	3.42E-04
DRINKING		2.70E-04	1.19E-02	1.19E-02	1.19E-02	1.18E-02	1.18E-02	1.18E-02
SHORELINE	2.27E-06	1.94E-06	1.94E-06	1.94E-06	1.94E-06	1.94E-06	1.94E-06	1.94E-06
SWIMMING		1.16E-08	1.16E-08	1.16E-08	1.16E-08	1.16E-08	1.16E-08	1.16E-08
BOATING		5.78E-09	5.78E-09	5.78E-09	5.78E-09	5.78E-09	5.78E-09	5.78E-09
TOTAL	2.27E-06	1.69E-03	1.32E-02	1.28E-02	1.23E-02	1.25E-02	1.23E-02	1.22E-02

	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		1.50E-03	1.26E-03	5.99E-04	2.70E-04	5.64E-04	3.63E-04	2.62E-04
DRINKING		2.57E-04	8.37E-03	8.35E-03	8.41E-03	8.34E-03	8.34E-03	8.34E-03
SHORELINE	1.27E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05
SWIMMING		6.45E-08	6.45E-08	6.45E-08	6.45E-08	6.45E-08	6.45E-08	6.45E-08
BOATING		3.23E-08	3.23E-08	3.23E-08	3.23E-08	3.23E-08	3.23E-08	3.23E-08
TOTAL	1.27E-05	1.76E-03	9.64E-03	8.96E-03	8.70E-03	8.92E-03	8.71E-03	8.62E-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		1.92E-03	1.12E-03	3.59E-04	2.30E-04	4.80E-04	2.98E-04	2.06E-04
DRINKING		7.80E-04	1.61E-02	1.60E-02	1.62E-02	1.60E-02	1.60E-02	1.60E-02
SHORELINE	2.65E-06	2.26E-06	2.26E-06	2.26E-06	2.26E-06	2.26E-06	2.26E-06	2.26E-06
SWIMMING		1.35E-08	1.35E-08	1.35E-08	1.35E-08	1.35E-08	1.35E-08	1.35E-08
BOATING		6.74E-09	6.74E-09	6.74E-09	6.74E-09	6.74E-09	6.74E-09	6.74E-09
TOTAL	2.65E-06	2.71E-03	1.72E-02	1.64E-02	1.64E-02	1.65E-02	1.63E-02	1.62E-02

	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		6.04E-04	1.58E-02	1.57E-02	1.60E-02	1.57E-02	1.57E-02	1.57E-02
SHORELINE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	0.00E+00	6.04E-04	1.58E-02	1.57E-02	1.60E-02	1.57E-02	1.57E-02	1.57E-02

	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	

<FF>

* * * FISH CONSUMPTION POPULATION
PERSON-REM

SPORT HARVEST

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH	ADULT	6.10E+04	5.64E-04	5.11E-04	3.73E-04	1.30E-04	2.47E-04	1.63E-04	1.36E-04
FISH	TEENAGER	7.12E+03	9.11E-05	7.65E-05	3.65E-05	1.56E-05	3.44E-05	2.21E-05	1.60E-05
FISH	CHILD	4.93E+03	1.88E-04	1.10E-04	3.51E-05	2.11E-05	4.69E-05	2.91E-05	2.01E-05
FISH	TOTAL	7.30E+04	8.44E-04	6.97E-04	4.45E-04	1.67E-04	3.28E-04	2.15E-04	1.72E-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

COMMERCIAL HARVEST

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH	ADULT	4.18E+06	6.42E-05	5.81E-05	4.25E-05	1.46E-05	2.81E-05	1.86E-05	1.54E-05
FISH	TEENAGER	4.88E+05	1.04E-05	8.70E-06	4.15E-06	1.74E-06	3.91E-06	2.51E-06	1.82E-06
FISH	CHILD	3.38E+05	2.14E-05	1.25E-05	3.99E-06	2.35E-06	5.34E-06	3.31E-06	2.29E-06
FISH	TOTAL	5.01E+06	9.60E-05	7.93E-05	5.06E-05	1.87E-05	3.73E-05	2.44E-05	1.95E-05

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

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

SUPPLIER-OMAHA

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
DRINKING	ADULT	1.39E+08	1.67E-03	7.34E-02	7.33E-02	7.37E-02	7.32E-02	7.32E-02	7.32E-02
DRINKING	TEENAGER	1.51E+07	2.48E-04	8.06E-03	8.04E-03	8.10E-03	8.04E-03	8.03E-03	8.04E-03
DRINKING	CHILD	2.48E+07	1.23E-03	2.54E-02	2.53E-02	2.55E-02	2.53E-02	2.52E-02	2.52E-02
DRINKING	TOTAL	1.79E+08	3.14E-03	1.07E-01	1.07E-01	1.07E-01	1.06E-01	1.06E-01	1.06E-01

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

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

SUPPLIER-COUNCIL BLUFFS

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
DRINKING	ADULT	2.29E+07	2.70E-04	1.19E-02	1.19E-02	1.19E-02	1.18E-02	1.18E-02	1.18E-02
DRINKING	TEENAGER	2.49E+06	4.01E-05	1.30E-03	1.30E-03	1.31E-03	1.30E-03	1.30E-03	1.30E-03
DRINKING	CHILD	4.07E+06	1.99E-04	4.10E-03	4.09E-03	4.13E-03	4.09E-03	4.09E-03	4.09E-03
DRINKING	TOTAL	2.94E+07	5.09E-04	1.73E-02	1.73E-02	1.74E-02	1.72E-02	1.72E-02	1.72E-02

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

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

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

PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
DRINKING	CUMUL TOTAL	2.08E+08	3.65E-03	1.24E-01	1.24E-01	1.25E-01	1.24E-01	1.24E-01	1.24E-01

_____NEPA DOSES_____

NOTE--TOTAL NEPA DOSE INCLUDES SPORT CATCH

			DOSE (PERSON-REM)						
PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH	ADULT	1.22E+05	1.13E-03	1.02E-03	7.47E-04	2.59E-04	4.94E-04	3.27E-04	2.71E-04
FISH	TEENAGER	1.42E+04	1.82E-04	1.53E-04	7.29E-05	3.09E-05	6.87E-05	4.42E-05	3.19E-05
FISH	CHILD	9.85E+03	3.76E-04	2.20E-04	7.02E-05	4.18E-05	9.39E-05	5.82E-05	4.02E-05
FISH	TOTAL	1.46E+05	1.69E-03	1.39E-03	8.90E-04	3.31E-04	6.56E-04	4.29E-04	3.43E-04

_____HYDROSPHERE TRITIUM DOSE_____

AVERAGE INDIVIDUAL WATER CONSUMPTION = 3.0 L/DAY

PATHWAY	AGE GROUP	USAGE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
WATER	TOTAL	2.86E+11	0.00E+00	1.42E-03	1.42E-03	1.42E-03	1.42E-03	1.42E-03	1.42E-03

* * * RECREATION POPULATION D

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	1.06E-03	9.07E-04	9.07E-04

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		5.41E-06	5.41E-06

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		2.70E-06	2.70E-06

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

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

BIOTA	INTERNAL	EXTERNAL	TOTAL
FISH	6.73E-03	7.08E-03	1.38E-02
INVERTEBRATE	5.82E-03	1.42E-02	2.00E-02
ALGAE	5.30E-03	8.44E-06	5.31E-03
MUSKRAT	5.00E-02	4.72E-03	5.47E-02
RACCOON	1.09E-02	3.54E-03	1.44E-02
HERON	1.17E-01	4.72E-03	1.22E-01
DUCK	4.90E-02	7.08E-03	5.61E-02

SECTION VI

RADIOACTIVE EFFLUENT RELEASES - SOLID RADIOACTIVE WASTE
Technical Specifications 5.9.4.a

January 1, 2014 - December 31, 2014

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

January 1, 2014 through December 31, 2014

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

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

1.	Type of Waste	Month Shipped	Number of Shipments	Volume Cu. Meter	Curie Content	Est. Total % Error
a.	Spent resins, filter sludges, evaporator bottoms, etc.	January	0	0	0	N/A
		February	0	0	0	N/A
		March	0	0	0	N/A
		April	0	0	0	N/A
		May	0	0	0	N/A
		June	0	0	0	N/A
		July	0	0	0	N/A
		August	0	0	0	N/A
		September	0	0	0	N/A
		October	0	0	0	N/A
		November	0	0	0	N/A
		December	0	0	0	N/A
Total		(Type a)	0	0	0	N/A
b.	Dry compressable, contaminated equipment, etc.	January	0	0	0	N/A
		February	0	0	0	N/A
		March	0	0	0	N/A
		April	0	0	0	N/A
		May	0	0	0	N/A
		June	0	0	0	N/A
		July	0	0	0	N/A
		August	0	0	0	N/A
		September	0	0	0	N/A
		October	0	0	0	N/A
		November	0	0	0	N/A
		December	0	0	0	N/A
Total		(Type b)	0	0	0	N/A

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

(Continued)

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

III. RADIOACTIVE EFFLUENT RELEASES–SOLID RADIOACTIVE

(Continued)

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

1. Percentage of Curies from Represented Isotopes

	Isotope	Percent	Curies
a.	N/A	N/A	N/A
b.	N/A	N/A	N/A
c.	N/A	N/A	N/A
d.	N/A	N/A	N/A

C. SOLID WASTE (DISPOSITION)

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

D. IRRADIATED FUEL SHIPMENTS (DISPOSITION)

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

SECTION VII

ATTACHMENT 1

ODCM and Process Control Program revisions for the period January 1, 2014 through December 31, 2014 in accordance with Technical Specification 5.17.d and 5.18.d, the radioactive effluent release report shall include any revisions to the Offsite Dose Calculation Manual (ODCM) and the Process Control Program.

Offsite Dose Calculation Manual (ODCM), CH-ODCM-0001, Rev 23.

Process Control Program for Radioactive Wastes, RW-AA-100, Rev 10.

PROCESS CONTROL PROGRAM FOR RADIOACTIVE WASTES

1. PURPOSE

1.1. The purpose of the Process Control Program (PCP) is to:

1.1.1. Establish the process and boundary conditions for the preparation of specific procedures for processing, sampling, analysis, packaging, storage, and shipment of solid radwaste in accordance with local, state, and federal requirements. **(CM-1)**

1.1.2. Establish parameters which will provide reasonable assurance that all Low Level Radioactive Wastes (LLRW), processed by the in-plant waste process systems on-site OR by on-site vendor supplied waste processing systems, meet the acceptance criteria to a Licensed Burial Facility, as required by 10CFR Part 20, 10CFR Part 61, 10CFR Part 71, 49CFR Parts 171-172, "Technical Position on Waste Form (Revision 1)" [1/91], "Low-Level Waste Licensing Branch Technical Position on Radioactive Waste Classification" [5/83], and the Station Technical Specifications, as applicable.

1.1.3. Provide reasonable assurance that waste placed in "on-site storage" meets the requirements as addressed within the Safety Analysis Reports for the low level radwaste storage facilities for dry and/or processed wet waste.

2. TERMS AND DEFINITIONS

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

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

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

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

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

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

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

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

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

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

2.10. **Waste Streams:** Consist of but are not limited to

- Filter media (powdered, bead resin and fiber),
- Filter cartridges,
- Pre-coat body feed material,
- Contaminated charcoal,
- Fuel pool activated hardware,
- Oil Dry absorbent material added to a container to absorb liquids
- Fuel Pool Crud
- Sump and tank sludges,
- High activity filter cartridges,
- Concentrated liquids,
- Contaminated waste oil,
- Dried sewage or wastewater plant waste,
- Dry Active Waste (DAW): Waste such as filters, air filters, low activity cartridge filters, paper, wood, glass, plastic, cardboard, hoses, cloth, and metals, etc, which have become contaminated as a consequence of normal operating, housekeeping and maintenance activities.
- Other radioactive waste generated from cleanup of inadvertent contamination.

2.11. **Concentration Averaging**: Concentration averaging is either: a) the mathematical averaging of waste concentrations, based on the size, geometry, type of radioactive emission, and observed dose rates, or b) the combining of radioactive components in a single container and how their radioactivity may be averaged over the volume of the container. Concentration averaging is subject to constraints identified in the NRC's Branch Technical Position on Concentration Averaging and Encapsulation and may also be constrained by Agreement States or Disposal Facilities.

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

2.13. **Blending:** The intentional mixing of different, but miscible waste streams (such as resins, filter media, etc.) from different batches or systems for the purpose of operational efficiency or ALARA. Blending applies to LLRW streams only. The addition of non-radioactive materials or fillers is not considered blending.

3. RESPONSIBILITIES

3.1. Implementation of this Process Control Program (PCP) is described in procedures at each station and is the responsibility of the each site to implement.

4. MAIN BODY

4.1. Process Control Program Requirements

4.1.1. A change to this PCP (Radioactive Waste Treatment Systems) may be made provided that the change is reported as part of the annual radioactive effluent release report, Regulatory Guide 1.21, and is approved by the Plant Operations Review Committee (PORC).

4.1.2. Changes become effective upon acceptance per station requirements.

4.1.3. A solidification media, approved by the burial site, may be **REQUIRED when** liquid radwaste is solidified to a stable/unstable state.

4.1.4. **When** processing liquid radwaste to meet solidification stability using a vendor supplied solidification system:

1. **If** the vendor has its own Quality Assurance (QA) Program, **then** the vendor shall **ADHERE** to its own QA Program and shall have **SUBMITTED** its process system topical report to the NRC or agreement state.

2. **If** the vendor does **not HAVE** its own Quality Assurance Program, **then** the vendor shall **ADHERE** to an approved Quality Assurance Topical Report standard belonging to the Station or to another approved vendor.

4.1.5. The vendor processing system(s) is/are controlled per the following:

1. A commercial vendor supplied processing system(s) may be **USED** for the processing of LLRW streams.

2. Vendors that process liquid LLRW at the sites shall **MEET** applicable Quality Assurance Topical Report and Augmented Quality Requirements.

4.1.6. Vendor processing system(s) operated at the site shall be **OPERATED and CONTROLLED** in accordance with vendor approved procedures or station procedures based upon vendor approved documents.

4.1.7. All waste streams processed for burial or long term on-site storage shall **MEET** the waste classification and characteristics specified in 10CFR Part 61.55, Part 61.56, the 5-83 Branch Technical Position for waste classification, and the applicable burial site acceptance criteria (for any burial site operating at the time the waste was processed).

4.1.8. An Exelon Nuclear plant may store waste at another Exelon Nuclear plant, provided formal NRC approval has been **RECEIVED** for the transfer of waste.

4.2. General Waste Processing Requirements

NOTE: On-site resin processing involves tank mixing and settling, transferring to the station or vendor processing system via resin water slurry or vacuuming into approved waste containers, and, when applicable, dewatering for burial.

4.2.1. Vendor resin beds may be **USED** for decontamination of plant systems, such as, SFP (Spent Fuel Pool), RWCU (reactor water cleanup), and SDC (Shut Down Cooling). These resins are **then PROCESSED** via the station or vendor processing system.

4.2.2. Various drains and sump discharges will be **COLLECTED** in tanks or suitable containers for processing treatment. Water from these tanks may be **SENT** through a filter, demineralizer, concentrator or vendor supplied processing systems.

4.2.3. Process waste (e.g. filter media, sludges, resin, etc) will be periodically **DISCHARGED** to the station or vendor processing system for onsite waste treatment **or PACKAGED** in containers for shipment to offsite vendor for volume reduction processing.

4.2.4. Process water (e.g. chemical, floor drain, equipment drain, etc.) may be **SENT** to either the site waste processing systems or vendor waste processing systems for further filtration, demineralization for plant re-use, or discharge.

4.2.5. All dewatering and solidification/stabilization will be **PERFORMED** by either utility site personnel or by on-site vendors **or** will be **PACKAGED and SHIPPED** to an off-site vendor low-level radwaste processing facility.

4.2.6. Dry Active Waste (DAW) will be **HANDLED and PROCESSED** per the following:

1. DAW will be **COLLECTED and SURVEYED and** may be **SORTED** for compactable and non-compactable wastes.

2. DAW may be packaged in containers to facilitate on-site pre-compaction and/or off-site vendor contract requirements.

3. DAW items may be **SURVEYED** for release onsite or offsite when applicable.

4. Contaminated filter cartridges will be **PLACED** into a HIC **or** will be **ENCAPSULATED** in an in-situ liner for disposal **or SHIPPED** to an offsite waste processor in drums, boxes or steel liners per the vendor site criteria for processing and disposal.

4.2.7. Filtering devices using pre-coat media may be **USED** for the removal of suspended solids from liquid waste streams. The pre-coat material or cartridges from these devices may be routinely **REMOVED** from the filter vessel and discharged to a Filter Sludge Tank or Liner/HIC. Periodically, the filter sludge may be **DISCHARGED** to the vendor processing system for waste treatment onsite **or PACKAGED** in containers for shipment to offsite vendor for volume reduction processing.

4.2.8. Activated hardware stored in the Spent Fuel Pools will be **PROCESSED** periodically using remote handling equipment **and** may then be **PUT** into a container for shipment or storage in the pool or loading the processed activated hardware into the Dry Cask storage system.

4.2.9. High Integrity Containers (HIC):

1. For disposal at Barnwell, vendors supplying HIC's to the station shall **PROVIDE** a copy of the HIC Certificate of Compliance, which details specific limitations on use of the HIC.

2. For disposal at Clive or WCS, vendors supplying HIC's to the station shall **PROVIDE** a copy of the HIC Certificate of Conformance, which details specific limitations on use of the HIC.

3. Vendors supplying HIC's to the station shall **PROVIDE** a handling procedure which establishes guidelines for the utilization of the HIC. These guidelines serve to protect the integrity of the HIC and ensure the HIC is handled in accordance with the requirements of the Certificate of Compliance or Certificate of Conformance.

4.2.10. Lubricants and oils contaminated as a consequence of normal operating and maintenance activities may be PROCESSED on-site (by incineration, for oils meeting 10CFR20.2004 and applicable state requirements, or by an approved vendor process) **or SHIPPED** offsite (for incineration or other acceptable processing method).

4.2.11. Former in-plant systems GE or Stock Drum Transfer Cart and Drum Storage Areas may be **USED** for higher dose DAW storage at Clinton, Dresden, Quad Cities, Braidwood and Byron.

4.2.12. Certain waste, including flowable solids from holding pond, oily waste separator, cooling tower basin and emergency spray pond, may be disposed of onsite under the provisions of a 10CFR20.2002 permit. Specific requirements associated with the disposal shall be incorporated into station implementing procedures. **(CM-2)**

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

- For homogeneous waste types such as resins and filter media, the concentration of the mixture for classification purposes may be based on either the highest radionuclide concentration in any of the individual waste types contributing to the mixture or the volumetric or weight-averaged nuclide concentrations in the mixture provided that the concentrations of the individual waste type contributors to the mixture are within a factor of 10 of the average concentration of the resulting mixture. (NOTE: a designed collection of homogeneous waste types (from different sources within a facility) is not considered 'mixing' and the concentration for classification purposes may be the average concentration of the combination).
- For non-homogeneous waste types such as activated metals, cartridge filters or components incorporating radioactivity in their design, the concentration should be determined from the total weight or displaced volume (excluding major void spaces) of the component. Mixtures of components in a disposal container is permissible. Concentration averaging of a mixture of components of similar types can be performed in accordance with the NRC's Branch Technical Position on Concentration Averaging and Encapsulation and any State or Disposal Site specific requirements.

4.2.14. Blending may be **PERFORMED** for routine LLRW such as resins and filter media in accordance with the guidance in the NRC's Branch Technical Position on Concentration Averaging and Encapsulation as further clarified in SECY 2010-0043. The concentration of the mixture may be determined based on the total activity of all components in the mixture divided by the total volume or mass of the mixture. Reasonable effort should be made to mix blended LLRW so that activity is evenly distributed.

4.2.15. Encapsulation may be **PERFORMED** for routine wastes such as filters, filter cartridges, or sealed sources centered in an encapsulated mass, in accordance with the guidance in the NRC's Branch Technical Position on Concentration Averaging and Encapsulation. Classification may be based on the overall volume of the final solidified mass provided that;

- The minimum solidified volume or mass should be reasonably difficult to move by hand.
- The maximum solidified volume or mass used for determining concentration for any single discrete source should be no more than 0.2 m^3 or 500Kg (typically 55-gallon drum).
- The maximum amount of gamma-emitting radioactivity or radioactive material is <0.02 mrem/hr on the surface of the encapsulation over a 500-year decay period.

- The maximum amount of any radionuclide in a single encapsulation, when averaged over the waste and encapsulating media, does not exceed the maximum concentration limits for Class C waste.
- Written procedures should be established to ensure that the radiation source(s) is reasonably centered (or distributed) within the encapsulating media.
- All other disposal facility requirements for encapsulated material are met.

4.3. Burial Site Requirements

4.3.1. Waste sent directly to burial shall **COMPLY** with the applicable parts of 49CFR171-172, 10CFR61, 10CFR71, and the acceptance criteria for the applicable burial site.

4.4. Shipping and Inspection Requirements

4.4.1. All shipping/storage containers shall be **INSPECTED**, as required by station procedures, for compliance with applicable requirements (Department of Transportation (DOT), Nuclear Regulatory Commission (NRC), station, on-site storage, and/or burial site requirements) prior to use.

4.4.2. Containers of solidified liquid waste shall be **INSPECTED** for solidification quality and/or dewatering requirements per the burial site, offsite vendor acceptance, or station acceptance criteria, as applicable.

4.4.3. Shipments sent to an off site processor shall be **INSPECTED** to ensure that the applicable processor's waste acceptance criteria are being met.

4.4.4. Shipments sent for off site storage shall **MEET** the storage site's waste acceptance criteria.

4.5. Inspection and Corrective Action

4.5.1. Inspection results that indicate non-compliance with applicable NRC, State, vendor, or site requirements shall be IDENTIFIED and TRACKED through the Corrective Action Program.

4.5.2. Administrative controls for preventing unsatisfactory waste forms from being released for shipment are described in applicable station procedures. **If** the provisions of the Process Control Program are not satisfied, **then SUSPEND** shipments of defectively packaged radioactive waste from the site. **(CM-1)**

4.5.3. **If** freestanding water or solidification **not** meeting program requirements is observed, **then** samples of the particular series of batches shall be **TAKEN** to determine the cause. Additional samples shall be **TAKEN**, as warranted, to ensure that **no** freestanding water is present and solidification requirements are maintained.

4.6. Procedure and Process Reviews

4.6.1. The Exelon Nuclear Process Control Program and subsequent changes (other than editorial/minor changes) shall be **REVIEWED and APPROVED** in accordance with the station procedures, plant-specific Technical Specifications (Tech Spec), Technical Requirements Manual (T&RM), Operation Requirements Manual (ORM), as applicable, for the respective station and LS-AA-106. Changes to the Licensees Controlled Documents, UFSAR, ORM, or TRM are controlled by the provisions of 10CFR 50.59.

4.6.2. Any changes to the PCP shall be reviewed to determine if reportability is required in the Annual Radiological Effluent Release Report (ARERR). The Radwaste Specialist shall ensure correct information is **SUBMITTED** to the ODCM program owner prior to submittal of the ARERR.

4.6.3. Procedures shall be **IMPLEMENTED** as follows:

- Station processes or other vendor waste processing/operating procedures shall be technically reviewed and approved per RM-AA-102-1006.
- Procedures related to waste manifests, shipment inspections, and container activity determinations are **CONTROLLED** by Radiation Protection Standard Procedures (RP-AA-600 Series).
- Site waste processing **IS CONTROLLED** by site operating procedures.
- Liquid processed by vendor equipment shall be **PERFORMED** in accordance with vendor procedures.
- The dewatering procedures implemented by Vendor for the purpose of compliance to the Process Control Program **SHALL BE REVIEWED and APPROVED** in accordance with the plant specific TRM or ORM (either Current Technical Specifications (CTS) or Improved Technical Specifications (ITS), as applicable for the respective stations).

4.7. Waste Types, Point of Generation, and Processing Method

Methods of processing and individual vendors may **CHANGE** due to changing financial and regulatory options. The table below is a representative sample. It is **not** intended be all encompassing.

WASTE STREAM	POINTS OF GENERATION	AVAILABLE WASTE PROCESSING METHODS
Bead Resin	Systems - Fuel Pool, Condensate, Reactor Water Cleanup, Blowdown, Equipment Drain, Chemical and Volume Control Systems, Floor Drain, Maximum Recycle, Blowdown, Boric Acid Recycling System, Vendor Supplied Processing Systems, and Portable Demin System	Dewatering, solidification to an unstable/stable state Thermal Processing Free Release to a Land Fill
Powdered Resin	Systems - (Condensate System, Floor Drain/Equipment Drain filtration, Fuel Pool)	Dewatering, solidification to an unstable/stable state Thermal Processing
Concentrated Waste	Waste generated from Site Evaporators resulting typically from the Floor Drain and Equipment Drain Systems	Solidification to an unstable/stable state Thermal Processing
Sludge	Sedimentation resulting from various sumps, condensers, tanks, cooling tower, emergency spray pond, holding pond, and oily waste separators	Dewatering, solidification to an unstable/stable state Thermal Processing Evaporation on-site or at an offsite processor On-site disposal per 10CFR20.2002 permit
Filter cartridges	Systems - Floor/Equipment Drains, Fuel Pool; cartridge filters are typically generated from clean up activities within the fuel pool, torus, etc	Dewatering, solidification to an unstable/stable state Processed by a vendor for volume reduction
Dry Active Waste	Paper, wood, plastic, rubber, glass, metal, and etc. resulting from daily plant activities	Decon/Sorting for Free Release Compaction/Super-compaction Thermal Processing by Incineration or glass vitrification Sorting for Free Release Metal melting to an ingot
Contaminated Oil	Oil contaminated with radioactive materials from any in-plant system.	Solidification unstable state Thermal Processing by Incineration Free Release for recycling
Drying Bed Sludge	Sewage Treatment and Waste Water Treatment Facilities	Free release to a landfill or burial
Metals	See DAW	See DAW
Irradiated Hardware	Fuel Pool, Reactor Components	Volume Reduction for packaging efficiencies

5. DOCUMENTATION

5.1. Records of reviews performed shall be retained for the duration of the unit operating license. This documentation shall contain:

1. Sufficient information to support the change together with the appropriate analyses or evaluations justifying the change, and

2. A determination which documents that the change will maintain the overall conformance of waste products to Federal (10CFR61 and the Branch Technical Position), State, or other applicable requirements, including applicable burial site criteria.

6. REFERENCES

6.1. Technical Specifications:

6.1.1. The details contained in Current Tech Specs (CTS) or Improved Technical Specifications (ITS), as applicable, in regard to the Process Control Program (PCP), are to be relocated to the Licensee Controlled Documents. Some facilities have elected to relocate these details into the Operational Requirements Manual (ORM). Relocation of the description of the PCP from the CTS or ITS does **not** affect the safe operation of the facility. Therefore, the relocation details are **not** required to be in the CTS or the ITS to provide adequate protection of the public health and safety.

6.2. Writers' References:

6.2.1. Code of Federal Regulations: 10 CFR Part 20, Part 61, Part 71, 49 CFR Parts 171-172

6.2.2. Low Level Waste Licensing Branch Technical Position on Radioactive Waste Classification, May 1983

6.2.3. Technical Position on Waste Form (Revision 1), January 1991

6.2.4. USNRC Branch Technical Position on Concentration Averaging and Encapsulation, January 1995

6.2.5. Regulatory Guide 1.21, Measuring Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants

6.2.6. I.E. Circular 80.18, 10CFR 50.59 Safety Evaluation for Changes to Radioactive Waste Treatment Systems

6.2.7. Amendment No. 202 to Facility Operating License No. NPF-11 and Amendment No. 189 to Facility Operating License (FOL) No. NPF-18 for the LaSalle County Station (LSCS), Units 1 and 2

6.2.8. NRC Branch Technical Position on Blending of Low-Level Radioactive Waste, SECY-10-0043

6.3. Users' References:

6.3.1. Quality Assurance Program (QATR)

6.3.2. LS-AA-106, Plant Operations Review Committee

6.3.3. RM-AA-102-1006, Processing Vendor Documents

6.3.4. RP-AA-600 Series, Radioactive Material/Waste Shipments

6.3.5. CY-AA-170-2000, Annual Radioactive Effluent Release Report

6.4. Station Commitments:

6.4.1. Peach Bottom

CM-1, T03819, Letter from G.A. Hunger, Jr., dated Sept. 29 1994, transmitting TSCR 93-16 (Improved Technical Specifications). (Step 1.1.1, 4.5.2)

6.4.2. Limerick

CM-2, T03896, 10CFR20.2002 permit granted to Limerick via letter dated July 10, 1996. (Step 4.2.12)

7. **ATTACHMENTS** - None

CH-ODCM-0001

Off-Site Dose Calculation Manual (ODCM)

Revision 23

Safety Classification: Non-Safety

Usage Level: Reference

Change No.:	EC 64536
Reason for Change:	NRC 350 recommendations and enhancements found during training.
Requestor:	R. Layman
Preparer:	J. Shirah
Issued:	09-16-14 3:00 pm

Fort Calhoun Station

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PART II

1.0 PURPOSE AND SCOPE

1.1 Purpose

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

1.2 Scope

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

2.0 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 1.2 - Frequency Notation

The surveillance intervals are defined as follows:

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

Table 1.3 - Radiological Effluent Controls Program Technical Specification Implementation

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

3.0 INSTRUMENTATION

3.1 Radioactive Liquid Effluent Instrumentation

3.1.1 Limiting Condition for Operation

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

APPLICABILITY: At all times

ACTION:

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

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

3.1.2 Surveillance Requirements

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

Table 3.1.1 - Radioactive Liquid Effluent Monitoring Instrumentation

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

Table 3.1.1 (continued)

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

Table 3.1.2 - Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements

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

A. Visual Flowcheck Daily

3.2 Radioactive Gaseous Effluent Instrumentation

3.2.1 Limiting Condition for Operation

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

APPLICABILITY: At all times

ACTION:

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

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

3.2.2 Surveillance Requirements

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

Table 3.2.1 - Radioactive Gaseous Effluent Monitoring Instrumentation

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

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

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

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

Table 3.2.2 - Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

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

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

4.0 RADIOACTIVE EFFLUENTS

4.1 Radioactive Liquid Effluents

4.1.1 Concentration

A. Limiting Condition for Operation

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

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

   APPLICABILITY: At all times

   ACTION:

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

B. Surveillance Requirements

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

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

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

4.1.1B (continued)

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

Table 4.1 - Radioactive Liquid Effluent Sampling and Analysis

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

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

B. Steam Generator Blowdown

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

NOTES:

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

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

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

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

4.1.2 Dose from Radioactive Liquid Effluents

A. Limiting Condition for Operation

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

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

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

APPLICABILITY: At all times

ACTION:

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

B. Surveillance Requirements

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

4.1.3 Liquid Radwaste Treatment

A. Limiting Condition for Operation

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

APPLICABILITY: At all times

ACTION:

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

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

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

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

B. Surveillance Requirements

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

2. OPERABLE is defined as follows:

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

4.1.3B.2 (continued)

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

4.1.4 Liquid Holdup Tanks

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

A. Limiting Condition for Operation

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

APPLICABILITY: At all times

ACTION:

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

B. Surveillance Requirements

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

4.2 Radioactive Gaseous Effluents

4.2.1 Concentration

A. Limiting Condition for Operation

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

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

   APPLICABILITY: At all times

   ACTION:

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

B. Surveillance Requirements

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

Table 4.2 - Radioactive Airborne Effluent Sampling and Analysis

A. Gas Decay Tank Releases

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

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

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

C. Condenser Off Gas Releases [E]

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

D. Auxiliary Building Exhaust Stack [E]

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

Table 4.2 - Radioactive Airborne Effluent Sampling and Analysis

E. Laboratory and Radwaste Building Exhaust Stack [E]

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

NOTES:

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

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

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

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

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

Table 4.3 - Sampler Deposition/Transportation Correction Factors

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

ACRONYM DEFINITIONS:

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

4.2.2 Dose - Noble Gases

A. Limiting Condition for Operation

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

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

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

APPLICABILITY: At all times

ACTION:

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

B. Surveillance Requirements

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

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

A. Limiting Condition for Operation

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

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

4.2.3A.1 (continued)

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

APPLICABILITY: At all times

ACTION:

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

B. Surveillance Requirements

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

4.2.4 Gaseous Radwaste Treatment

A. Limiting Condition for Operation

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

a. 0.2 mrad to air from gamma radiation, or

b. 0.4 mrad to air from beta radiation, or

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

4.2.4A.1 (continued)

APPLICABILITY: At all times

ACTION:

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

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

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

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

B. Surveillance Requirements

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

4.2.4B (continued)

2. OPERABLE is defined as follows:

   a. Waste Gas System

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

   b. Ventilation Exhaust Systems

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

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

4.2.4B.2.b (continued)

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

4.3 Uranium Fuel Cycle

4.3.1 Total Dose-Uranium Fuel Cycle

A. Limiting Condition for Operation

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

   APPLICABILITY: At all times

   ACTION:

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

4.3.1 (continued)

B. Surveillance Requirements

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

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

5.1 Monitoring Program

5.1.1 Limiting Condition for Operation

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

APPLICABILITY: At all times

ACTION:

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

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

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

5.1.1A (continued)

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

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

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

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

5.1.2 Surveillance Requirements

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

Table 5.1 - Radiological Environmental Monitoring Program

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

Table 5.1 - Radiological Environmental Monitoring Program

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

NOTES:

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

Table 5.2 - Radiological Environmental Sampling Locations And Media

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

Table 5.2 - Radiological Environmental Sampling Locations And Media

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

Table 5.2 - Radiological Environmental Sampling Locations And Media

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

Table 5.2 - Radiological Environmental Sampling Locations And Media

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

Table 5.2 - Radiological Environmental Sampling Locations And Media

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

NOTES:

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

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

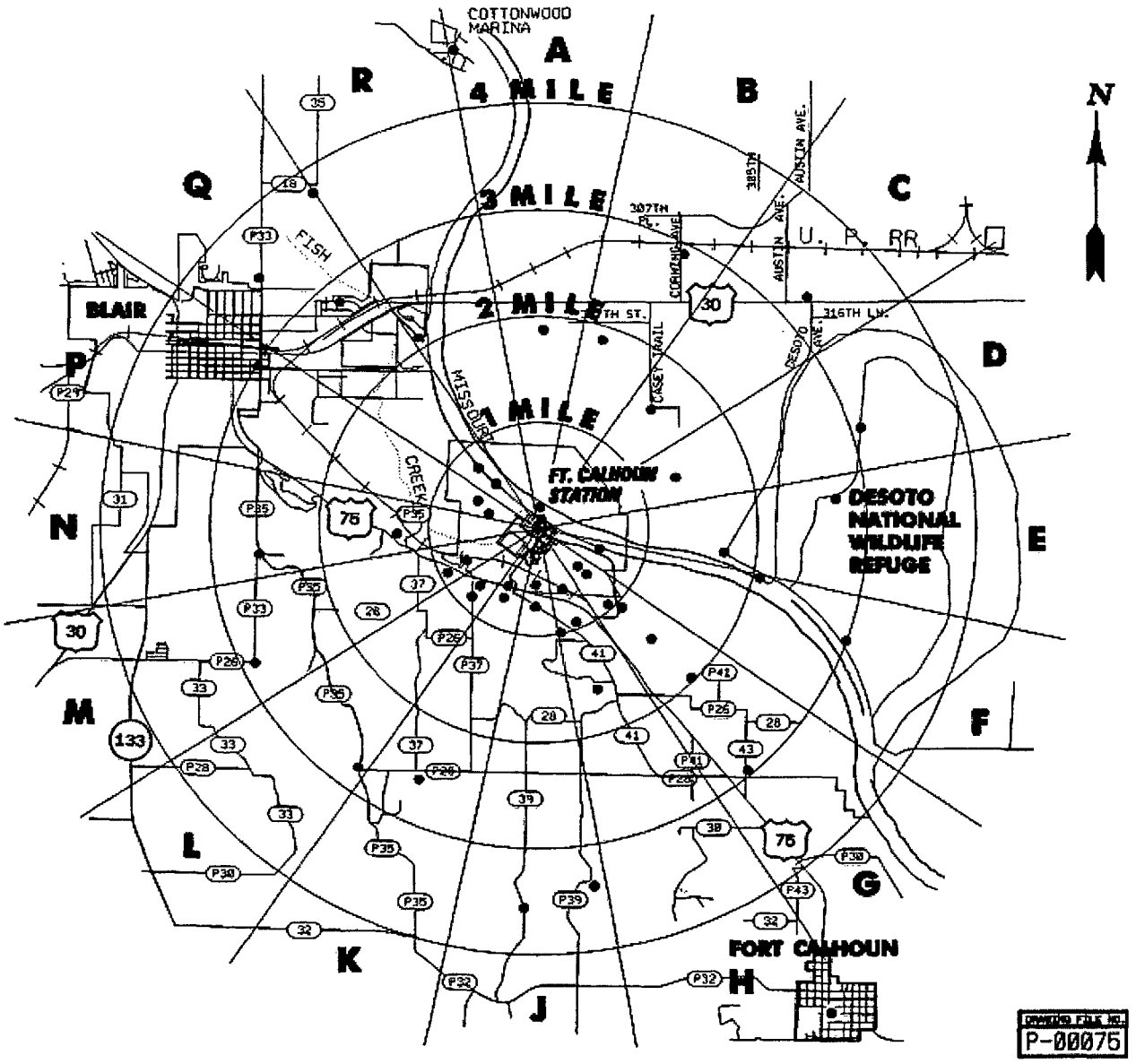
C. Locations represent highest potential exposure pathways as determined by the biennial Land Use Survey, performed in accordance with Part I, Section 7.3.2, of the Off-Site Dose Calculation Manual and are monitored as such.

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

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

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

Figure 1 – Environmental Radiological Sampling Points



(*) Locations currently discontinued are not illustrated.

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

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

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

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

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

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

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

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

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

5.2 Land Use Survey

5.2.1 Limiting Condition for Operation

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

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

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

APPLICABILITY: At all times

ACTION:

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

5.2.1A.2 (continued)

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

5.2.2 Surveillance Requirements

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

5.3 Interlaboratory Comparison Program

5.3.1 Limiting Condition for Operation

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

APPLICABILITY: At all times

ACTION:

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

5.3.2 Surveillance Requirements

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

6.0 ADMINISTRATIVE CONTROLS

6.1 Responsibilities

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

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

6.2 Radioactive Effluent Reporting Requirements

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

6.2.1 Annual Radioactive Effluent Release Report

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

The Radioactive Effluent Release Report shall include:

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

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

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

D. Changes to the Process Control Program (PCP) or to the Offsite Dose Calculation Manual (ODCM) made during the reporting period. Each change shall be identified by markings in the margin of the affected pages clearly indicating the area of the page that was changed and shall indicate the date the change was implemented.

6.2.1 (continued)

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

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

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

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

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

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

6.2.2 Annual Radiological Environmental Operating Report

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

A. Summarized and tabulated results of the radiological environmental sampling/analysis activities following the format of Regulatory Guide 4.8, Table 1. In the event that some results are not available, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

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

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

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

6.2.2 (continued)

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

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

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

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

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

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

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

6.2.3 Special Report

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

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

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

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

6.2.4 EPA 40 CFR Part 190 Reporting Requirements

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

6.3 Change Mechanism

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

6.4 Meteorological Data

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

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

6.5 References

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

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

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

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

6.5.5 NRC Branch Technical Position, March 1978

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

6.5.7 NUREG-1301 - Offsite Dose Calculation Manual Guidance.

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

6.5.9 Code of Federal Regulations, Title 10, Part 20

6.5.10 Code of Federal Regulations, Title 10, Part 50

6.5.11 Code of Federal Regulations, Title 40, Part 190

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

6.5.13 Fort Calhoun Technical Specifications (Unit No. 1)

6.5.14 Updated Safety Analysis Report

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

6.5.16 AR 39127, NEI Industry Initiative on Groundwater Protection

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

7.0 BASIS

7.1 Instrumentation

7.1.1 Radioactive Liquid Effluent Instrumentation

The Radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive material in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip setpoints for these instruments shall be calculated in accordance with Part II of the Offsite Dose Calculation Manual to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

7.1.2 Radioactive Gaseous Effluent Instrumentation

The Radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive material in gaseous effluents during actual or potential releases of gaseous effluents. The Alarm/Trip setpoints for these instruments shall be calculated in accordance with Part II of the Offsite Dose Calculation Manual to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

7.2 Radioactive Effluents

7.2.1 Radioactive Liquid Effluents

A. Concentration

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

7.2.1 (continued)

B. Dose

This specification is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable". Also, with fresh water sites with drinking water supplies which can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. The dose calculation methodology and parameters in Part II of the Off-Site Dose Calculation Manual, implement the requirements in Section III.A that conformance with the guides of Appendix I is to be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in Part II of the Off-Site Dose Calculation Manual, for calculating the doses due to the actual release rates of radioactive material in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977, and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

C. Liquid Waste Treatment System

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

7.2.1 (continued)

D. Liquid Holdup Tanks

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

7.2.2 Radioactive Gaseous Effluents

A. Concentration

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

7.2.2 (continued)

B. Dose - Noble Gases

This specification is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition For Operation implements the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I assure that the releases of radioactive material in gaseous effluents will be kept as low as is reasonably achievable. The surveillance requirements implement the requirements in Section III.A of Appendix I that conform with the guides of Appendix I to be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in Part II of the Off-Site Dose Calculation Manual, for calculating the doses due to actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, October 1977 and Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Revision 1, July 1977. The Off-Site Dose Calculation Manual, equations provided for determining the air doses at the site boundary are consistent with Regulatory Guides 1.109 and 1.111.

7.2.2 (continued)

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

This specification is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition For Operation implements the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I assure that the releases of radioactive material in gaseous effluents will be kept as low as is reasonably achievable. The surveillance requirements implement the requirements in Section III.A of Appendix I that conform with the guides of Appendix I to be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in Part II of the Off-Site Calculation Manual, for calculating the doses due to actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, October 1977 and Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Revision 1, July 1977. The release rate specification for I-131, radioactive material in particulate form with half-lives greater than eight days (other than noble gases) and tritium are dependent on the existing radionuclide pathways to man in the areas at or beyond the site boundary. The pathways that were examined in the development of these calculations were:
1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

7.2.2 (continued)

D. Gaseous Waste Treatment

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

7.2.2 (continued)

E. Total Dose - Uranium Fuel Cycle

This specification is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20.1301(d). This requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mRems to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mRems. It is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the plant remains within twice the dose design objectives of Appendix I, 10 CFR Part 50, and if direct radiation doses (including outside storage tanks, etc.) are kept small. The Special Report shall describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report, with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.2203(a)(4) and 20.2203(b) is considered to be a timely request and fulfills the requirements 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle. Demonstration of compliance with the limits of 40 CFR Part 190 or with the design objectives of Appendix I to 10 CFR Part 50 will be considered to demonstrate compliance with the 0.1 rem limit of 10 CFR Part 20.1301.

7.3 Radiological Environmental Monitoring

7.3.1 Monitoring Program

The radiological environmental monitoring program required by this specification provides measurements of radiation and radioactive materials in those exposure pathways and for radionuclides which lead to the highest potential radiation exposures of individuals resulting from the station operation. This monitoring program thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. The initially specified monitoring program was effective for at least the first three years of commercial operation. Following this period, program changes are initiated based on operational experience.

7.3.2 Land Use Survey

This specification is provided to ensure that changes in the use of unrestricted areas are identified and that modifications to the monitoring program are made if required by the results of this survey. The frequency of the Land Use Survey has been reduced to a biennial requirement in site procedures because persons knowledgeable in land use census monitor usage characteristics perform routine REMP sampling. This approach allows knowledge gained during sample collection to be integrated into the program, maintaining its effectiveness. The best survey information from door to door, aerial or consulting with local agricultural authorities, or equivalent, shall be used. This survey satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the survey to gardens of greater than 500 square feet provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were used, 1) that 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and 2) a vegetation yield of 2 kg/m^2.

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

7.3.3 Interlaboratory Comparison Program

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

7.4 Abnormal Release or Abnormal Discharge Reporting

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

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

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

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

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

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

E. Abnormal discharges to an unrestricted area.

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

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

PART II

CALCULATIONS

1.0 EFFLUENT MONITOR SETPOINTS

1.1 Liquid Effluents

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

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

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

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

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

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

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

1.1.7 Liquid Effluent Radiation Monitors

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

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

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

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

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

Where:

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

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

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

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

1.1.7A (continued)

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

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

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

Where:

0.75 = An administrative correction factor which includes the following:

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

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

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

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

B = Background (CPM)

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

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

1.1.7 (continued)

B. Overboard Discharge Header Monitor (RM-055)

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

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

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

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

Where:

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

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

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

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

1.1.7B (continued)

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

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

Where:

0.75 = An administrative correction factor which includes the following:

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

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

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

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

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

B = Background (CPM)

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

1.2 Airborne Effluents

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

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

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

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

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

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

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

1.2.2 Airborne Effluent Radiation Monitors

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

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

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

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

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

Where:

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

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

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

1.2.2A (continued)

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

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

Where:

0.75 = An administrative correction factor which includes the following:

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

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

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

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

60 = Conversion (seconds to minutes).

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

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

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

B = Background (CPM)

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

1.2.2 (continued)

B. Condenser Off Gas Monitor (RM-057)

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

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

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

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

Where:

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

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

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

1.2.2B (continued)

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

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

Where:

0.75 = An administrative correction factor which includes the following:

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

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

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

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

60 = Conversion (seconds to minutes).

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

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

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

B = Background (CPM)

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

1.2.2 (continued)

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

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

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

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

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

Where:

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

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

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

1.2.2C (continued)

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

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

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

Where:

0.75 = An administrative correction factor which includes the following:

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

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

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

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

60 = Conversion (seconds to minutes).

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

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

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

B = Background (CPM)

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

Table 1 - Allocation Factors for Simultaneous Releases

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

Figure 1 - Exclusion and Site Boundary Map

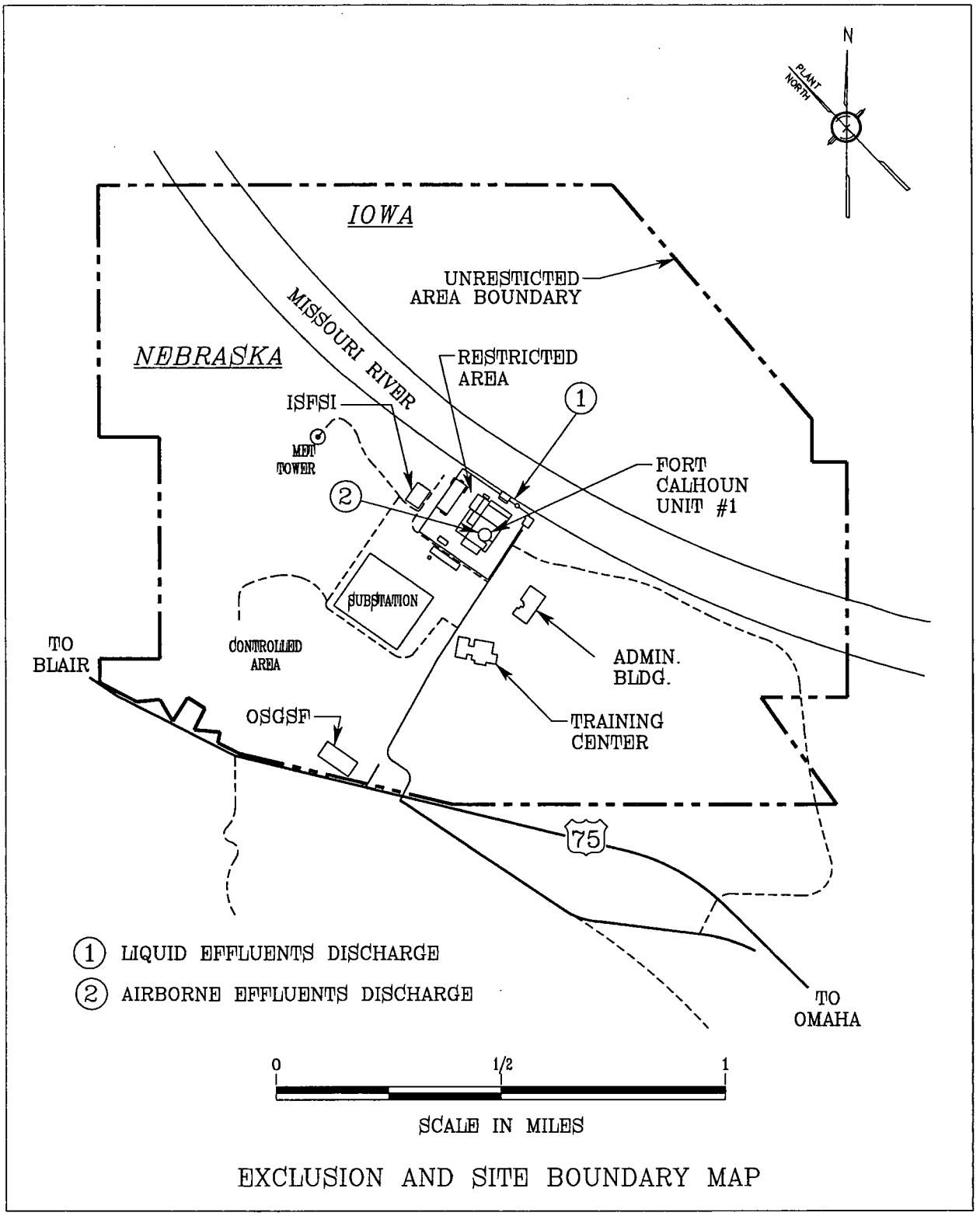
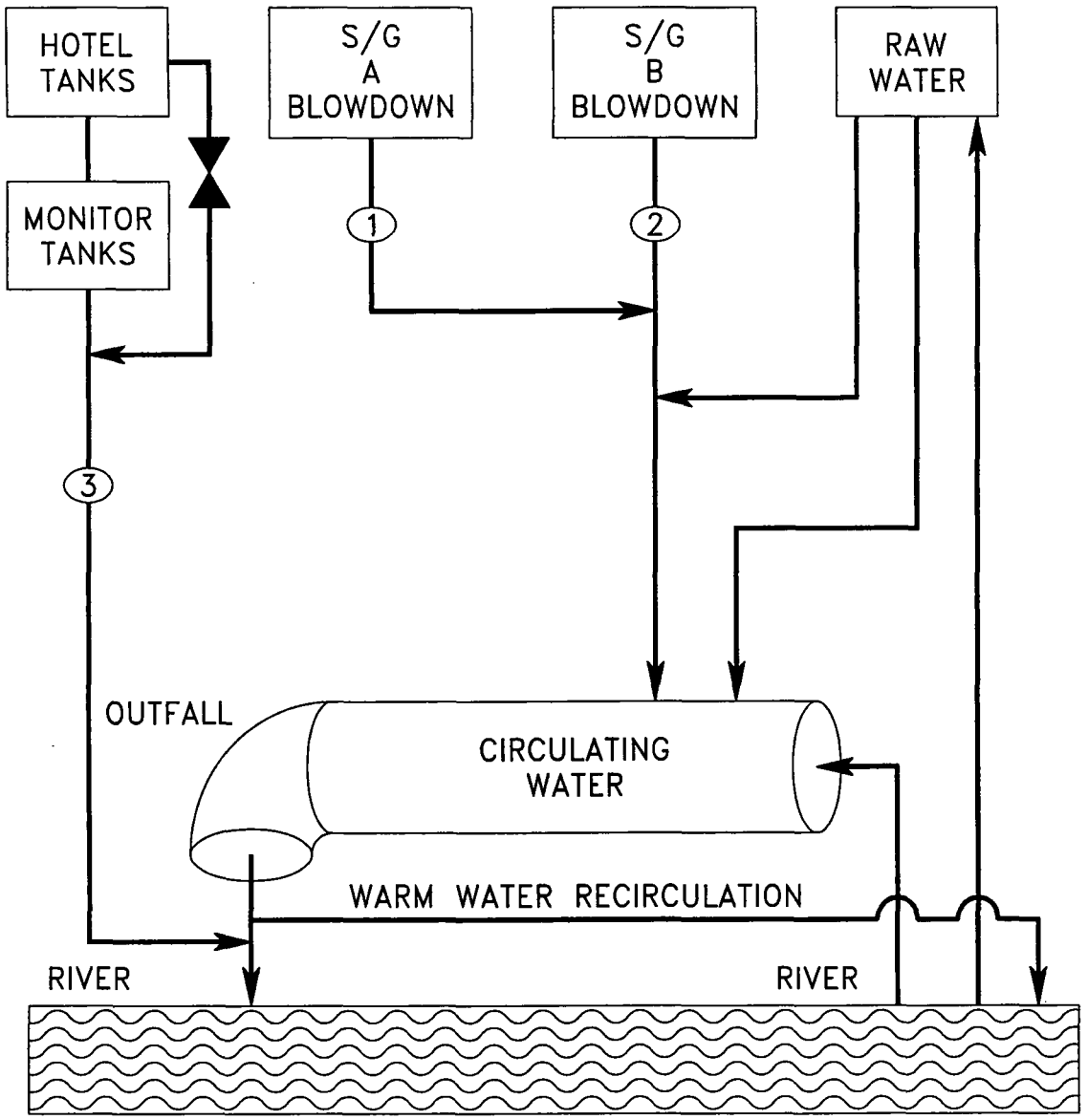


Figure 2 - Liquid Radioactive Discharge Pathways



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

LIQUID RADIOACTIVE DISCHARGE PATHWAYS

Figure 3 - Liquid Radioactive Waste Disposal System

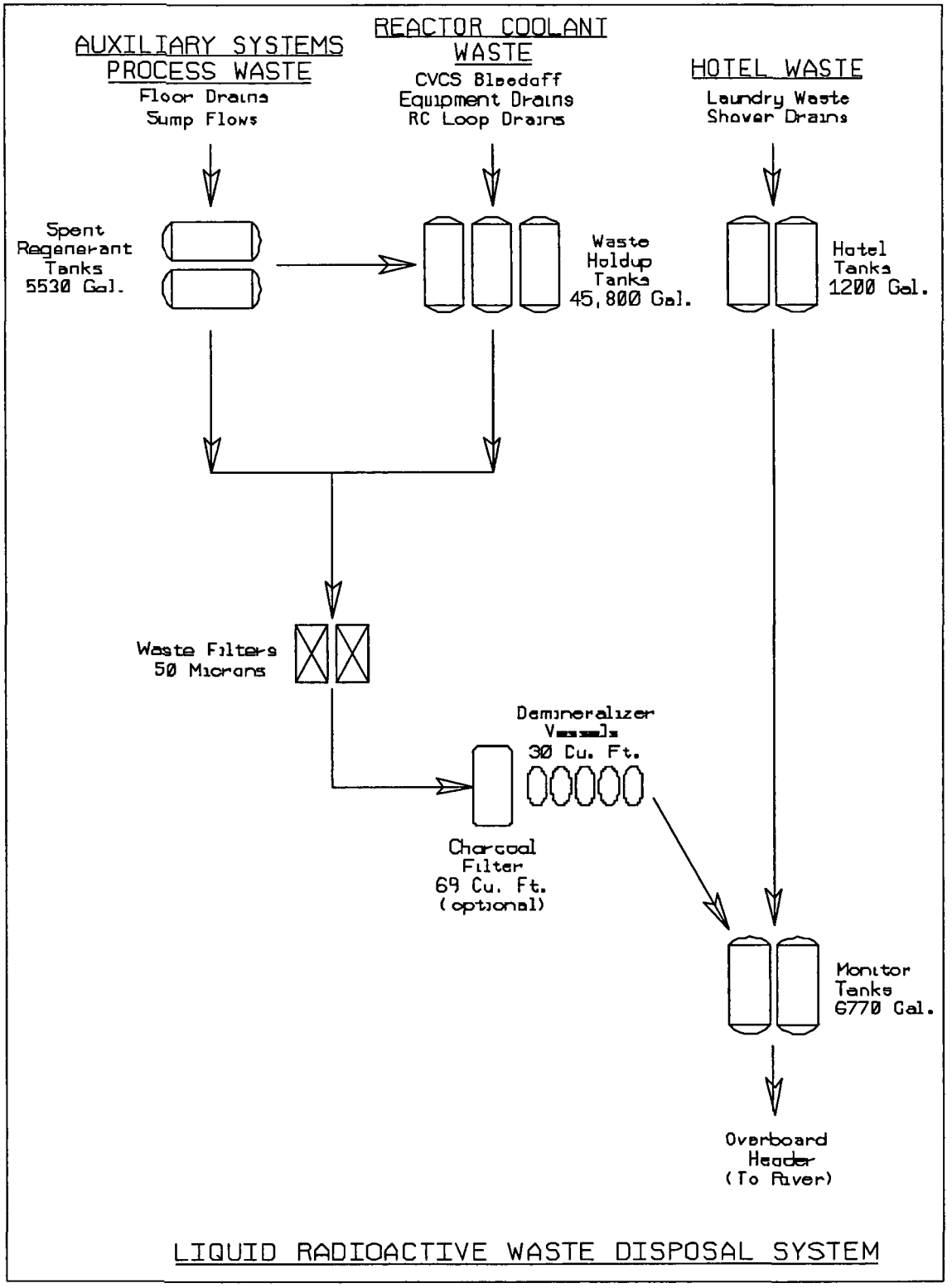


Figure 4 - Airborne Effluent Discharge Pathways

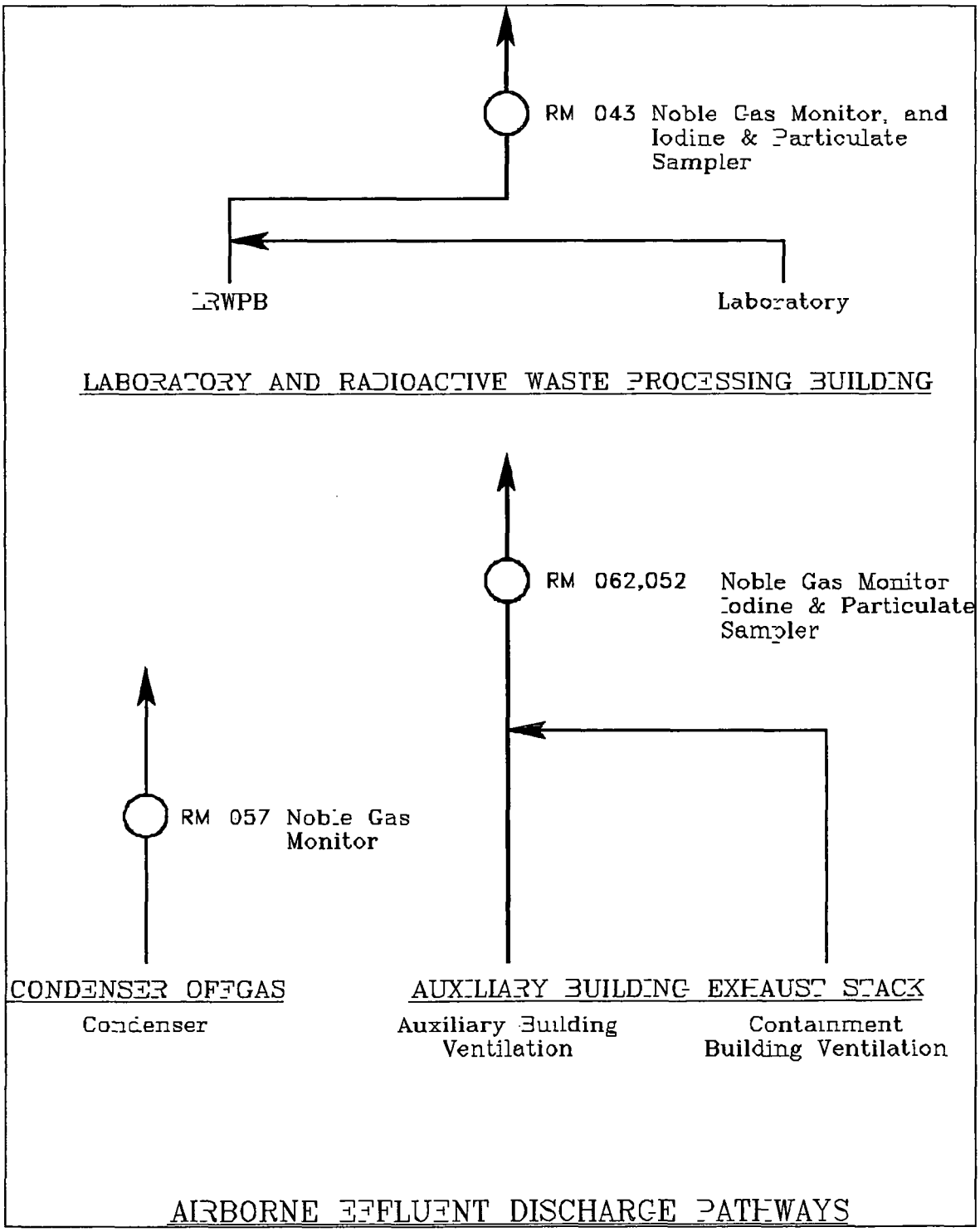
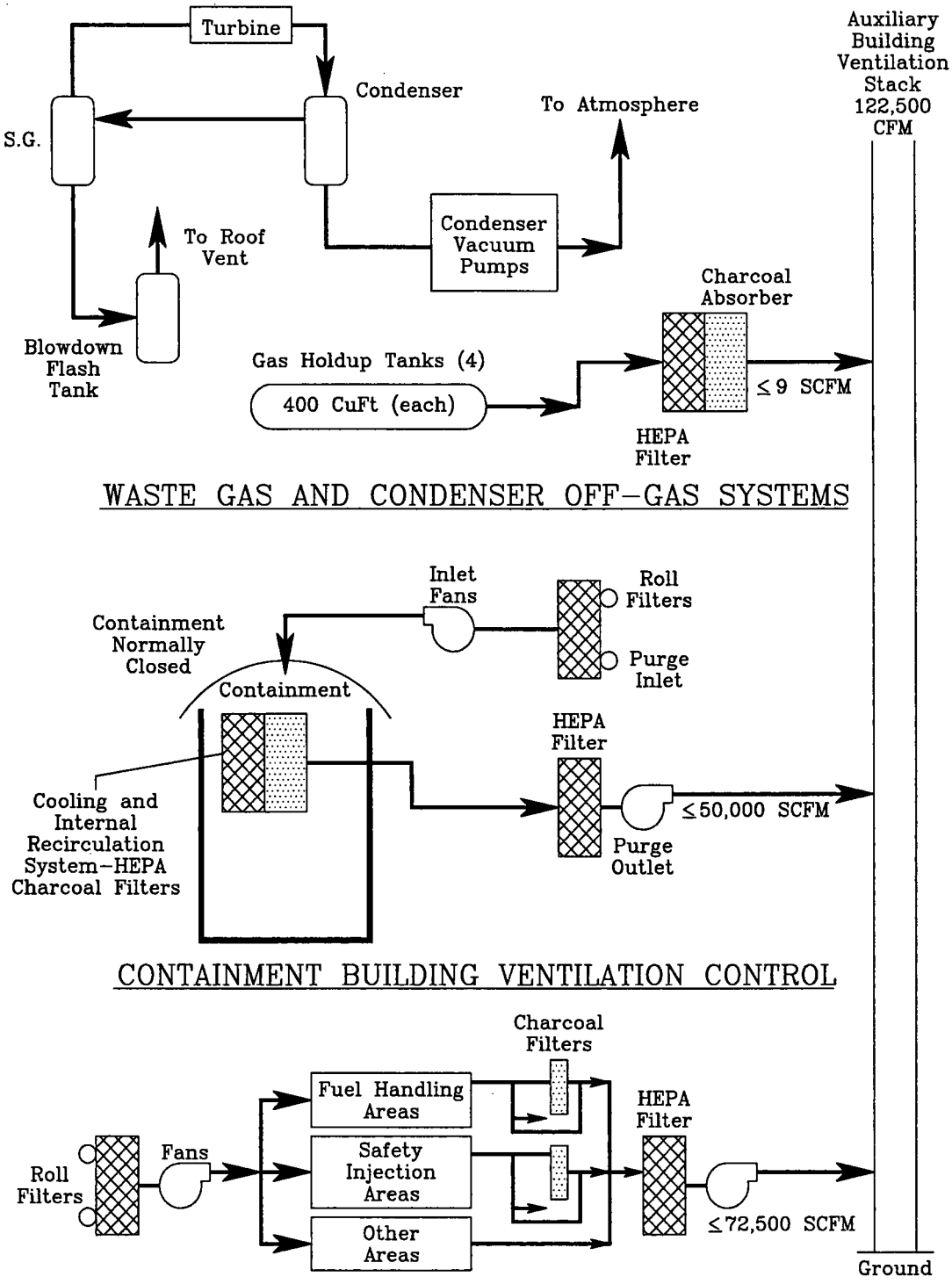


Figure 5 - Airborne Radioactive Waste Disposal System



2.0 EFFLUENT CONCENTRATIONS

2.1 Liquid Effluent Concentrations

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

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

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

Radionuclide concentration at site discharge:

Where:

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

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

f = undiluted effluent flowrate, in gpm.

F = total diluted effluent flowrate in gpm.

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

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

2.2 Airborne Effluent Concentrations

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

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

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

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

Where:

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

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

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

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

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

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

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

3.0 RADIOACTIVE EFFLUENT DOSE CALCULATIONS

3.1 Liquid Effluent Dose Calculations

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

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

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

and

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

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

3.1.3 Doses from Liquid Effluent Pathways

A. Potable Water

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

Where:

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

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

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

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

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

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

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

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

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

3.1.3 (continued)

B. Aquatic Foods

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

Where:

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

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

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

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

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

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

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

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

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

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

3.1.3 (continued)

C. Shoreline Deposits

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

Where:

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

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

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

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

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

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

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

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

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

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

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

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

3.2 Airborne Effluent Dose Calculations

3.2.1 Noble Gas

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

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

and

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

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

A. Doses from Noble Gases

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

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

Where:

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

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

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

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

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

3.2.1A (continued)

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

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

Where:

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

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

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

S_f = Shielding Factor (Table 17)

3. Annual Skin Dose from All Other Noble Gas Releases

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

Where:

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

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

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

3.2.2 Radioiodine, Tritium, and Particulates

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

- During any calendar quarter
  ≤ 7.5 mrem to any organ

and

- During any calendar year
  ≤ 15 mrem to any organ

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

Radioiodine, Tritium, and Particulates (continued)

3.2.2 (continued)

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

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

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

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

Where:

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

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

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

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

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

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

3.2.2A (continued)

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

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

Where:

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

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

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

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

8760 = is the number of hours in a year

B. Annual Dose from Inhalation of Radionuclides in Air

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

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

Where:

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

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

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

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

3.2.2B (continued)

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

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

Where:

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

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

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

3.2.3 Concentrations of Radionuclides in Foods and Vegetation from Atmospheric Releases

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

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

Where:

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

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

3.2.3A (continued)

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

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

Where:

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

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

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

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

3.2.3 (continued)

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

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

Where:

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

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

3.2.3 (continued)

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

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

Where:

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

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

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

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

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

3.2.4 Parameters for Calculating Radionuclide Concentration in Cow and Goat Milk

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

Where:

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

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

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

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

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

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

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

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

Where:

C^F_i (r,θ) = is the concentration of radionuclide (i) in meat, in pCi/liter.

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

t_s = is the average time from slaughter to consumption. (Table 17)

3.2.6 Parameters for Calculating Tritium Concentrations in Vegetation

The concentration of tritium in vegetation is calculated from its concentration in the air surrounding the vegetation.

$$C_T^V\ (r,\theta) = 3.17\ x\ 10^7\ Q_T\ \frac{[\chi/Q](r,\theta)(0.75)(0.5)}{H} = 1.2\ x\ 10^7\ Q_T\ \frac{[\chi/Q](r,\theta)}{H}$$

Where:

C^V_T(r, θ) = is the concentration of tritium in vegetation grown at distance r, in the sector at angle θ, in pCi/kg.

H = is the absolute humidity of the atmosphere at distance r, in the sector at angle θ, in g/m^3. H=8 gm/kg.

Q_T = is the annual release rate of tritium, in Ci/yr.

[χ/Q](r,θ) = is the atmospheric dispersion factor, in sec/m^3. (Table 4)

0.5 = is the ratio of tritium concentration in plant water to tritium concentration in atmospheric water, dimensionless.

0.75 = is the fraction of total plant mass that is water, dimensionless.

3.2.7 Annual Dose from Atmospherically Released Radionuclides in Foods

A. The total annual dose to organ (j) of an individual in age group (a) resulting from ingestion of all radionuclides in produce, milk, and leafy vegetables is given by:

$$D_{ja}^{D}(r,\theta) = \sum_{i} DFI_{ija}\left[U_a^V f_g C_i^V(r,\theta) + U_a^M C_i^M(r,\theta) + U_a^F C_i^F(r,\theta) + U_a^L f_\ell C_i^L(r,\theta)\right]$$

Where:

$D^{D}_{ja}(r,\theta)$ = is the annual dose to organ (j) of an individual in age group (a) from dietary intake of atmospherically released radionuclides, in mrem/yr.

DFI_{ija} = is the dose conversion factor for the ingestion of radionuclide (i), organ (j), and age group (a), in mrem/pCi. Tables 13-16.

U^{V}_{a}, U^{M}_{a} = are the ingestion rates of produce (non-leafy vegetables, fruits, and grains); milk, meat, and leafy UFa,ULa vegetables, respectively for individuals in age group (a). (Table 6)

f_g = Fraction of ingested produce grown in garden of interest (Table 17)

f_ℓ = Fraction of leafy vegetables grown in garden of interest (Table 17)

3.2.7 (continued)

B. Calculating the Ingested Dose from Leafy and Non-Leafy (produce) Vegetation for Radionuclide (i) to Each Organ (j) and Age Group (a)

$$D_{ja}^{D}(r,\theta) = DFI_{ja}\left[U_a^L f_\ell C_i^L(r,\theta) + U_a^V f_g C_i^V(r,\theta)\right]$$

Where:

$D_{ja}^{D}(r,\theta)$ = is the annual dose from the ingestion of radionuclide (i) to organ (j) of an individual in age group (a) from dietary intake of atmospherically released radionuclides in vegetation, in mrem/yr.

DFI_{ija} = is the dose conversion factor for the ingestion of radionuclide (i), organ (j), and age group (a), in mrem/pci. Tables 13-16

U_a^L, U_a^V = are the ingestion rates of leafy vegetables and produce (non-leafy vegetables, fruits, and grains), for individuals in age group (a), in kg/yr. (Table 6)

C_i^L = is the concentration of radionuclide (i) in and on leafy vegetation, in pCi/kg.

C_i^V = is the concentration of radionuclide (i) in and on produce, in pCi/kg.

C. Calculation Determining the Ingested Dose from Cow Milk for Radionuclide (i), Organ (j), and Age Group (a)

$$D_{ja}^{D}(r,\theta) = DFI_{ija}\left[U_a^M C_i^M(r,\theta)\right]$$

Where:

$D_{ja}^{D}(r,\theta)$ = is the annual dose from the ingestion of radionuclide (i), organ (j) of an individual in age group (a) from dietary intake of atmospherically released radionuclides in cow milk, in mrem/yr.

DFI_{ija} = is the dose conversion factor for the ingestion of radionuclide (i), organ (j), and age group (a), in mrem/pCi. (Tables 13-16)

U_a^M = is the ingestion rate of cow milk for individuals in age group (a), in ℓ/yr. (Table 6)

C_i^M = is the radionuclide concentration in cow milk, in pCi/kg. Equation 3.2.4

3.2.7 (continued)

D. Calculation Determining the Ingested Dose from Meat for Radionuclide (i) to Organ (j) and Age Group (a)

$$D_{ja}^{D}(r,\theta) = DFI_{ija}\left[U_a^F\ C_i^F\ (r,\theta)\right]$$

Where:

$D^{D}_{ja}(r,\theta)$ = is the annual dose from the ingestion of radionuclide (i), organ (j) of an individual in age group (a) from dietary intake of atmospherically released radionuclides in meat, in mrem/yr.

DFI_{ija} = is the dose conversion factor for the ingestion of radionuclide (i), organ (j), and age group (a), in mrem/pCi. (Tables 13-16)

U^{F}_{a} = is the ingestion rate of meat for individuals in age group (a), in kg/yr. (Table 6)

C^{F}_{i} = is the radionuclide (i) concentration in meat, in pCi/kg.

3.2.8 Annual Dose from Carbon 14

A. This is a calculated value based on power generation and days of operation. Critical organ doses from C-14 were calculated using a ratio of 15% as CO_2. This ratio was determined during an NRC in-plant source term study conducted at the Fort Calhoun Station between 1976 and 1977, NUREG/CR-0140.

4.0 LOWER LIMIT OF DETECTION (LLD)

4.1 The lower limit of detection (LLD) for liquid and airborne effluent discharges and environmental samples referenced in Part I, Tables 4.1, 4.2 and 5.3, of the Off-Site Dose Calculation Manual, is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66 * S_b}{E * V * D * Y * \exp(-\lambda \Delta t)}$$

Where:

LLD = the lower limit of detection as defined above, in either picoCuries or microCuries, per unit mass or volume as a function of the value of D

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

E = the counting efficiency, as counts per disintegration

V = the sample size in units of mass or volume

D = 2.22E+06 of disintegrations per minute per microCurie or 2.22 disintegrations per minute per picoCurie

Y = the fractional radiochemical yield, when applicable

λ = the radioactive decay constant for the particular radionuclide

Δt = the elapsed time between the midpoint of sample collection and time of counting

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

4.3 It should be recognized that the LLD is defined as an A Priori limit representing the capability of a measurement system and not as a limit for a particular measurement.

4.4 LLD verifications will be performed on a periodic basis. This determination is to ensure that the counting system is able to detect levels of radiation at the LLD values for the specific type of analysis required. They will be performed with a blank (non-radioactive) sample in the same counting geometry as the actual sample.

Table 2 - Dose Factors for Exposure to a Semi-Infinite Cloud of Noble Gases

Nuclide	β-Air[1] (Df^{β}_i)	β-Skin[2] (DFSi)	γ-Air[1] (Df^{γ}_i)	γ-Body[2] (DFB_i)
Kr-83m	2.88E-04	---	1.93E-05	7.56E-08
Kr-85m	1.97E-03	1.46E-03	1.23E-03	1.17E-03
Kr-85	1.95E-03	1.34E-03	1.72E-05	1.61E-05
Kr-87	1.03E-02	9.73E-03	6.17E-03	5.92E-03
Kr-88	2.93E-03	2.37E-03	1.52E-02	1.47E-02
Kr-89	1.06E-02	1.01E-02	1.73E-02	1.66E-02
Kr-90	7.83E-03	7.29E-03	1.63E-02	1.56E-02
Xe-131m	1.11E-03	4.67E-04	1.56E-04	9.15E-05
Xe-133m	1.48E-03	9.94E-04	3.27E-04	2.51E-04
Xe-133	1.05E-03	3.06E-04	3.53E-04	2.94E-04
Xe-135m	7.39E-04	7.11E-04	3.36E-03	3.12E-03
Xe-135	2.46E-03	1.86E-03	1.92E-03	1.81E-03
Xe-137	1.27E-02	1.22E-02	1.51E-03	1.42E-03
Xe-138	4.75E-03	4.13E-03	9.21E-03	8.83E-03
Ar-41	3.28E-03	2.69E-03	9.30E-03	8.84E-03

1. $\frac{mrad - m^3}{pCi - yr}$

2. $\frac{mrem - m^3}{pCi - r}$

3. $2.88E - 04 = 2.88\ x\ 10^{-4}$

Table 3 - Bioaccumulation Factors
(pCi/kg per pCi/liter)

FRESHWATER

Element	Fish	Invertebrate
H	9.0E-01	9.0E-01
C	4.6E+03	9.1E+03
Na	1.0E+02	2.0E+02
P	1.0E+05	2.0E+04
Cr	2.0E+02	2.0E+03
Mn	4.0E+02	9.0E+04
Fe	1.0E+02	3.2E+03
Co	5.0E+01	2.0E+02
Ni	1.0E+02	1.0E+02
Cu	5.0E+01	4.0E+02
Zn	2.0E+03	1.0E+04
Br	4.2E+02	3.3E+02
Rb	2.0E+03	1.0E+03
Sr	3.0E+01	1.0E+02
Y	2.5E+01	1.0E+03
Zr	3.3E+00	6.7E+00
Nb	3.0E+04	1.0E+02
Mo	1.0E+01	1.0E+01
Tc	1.5E+01	5.0E+00
Ru	1.0E+01	3.0E+02
Rh	1.0E+01	3.0E+02
Te	4.0E+02	6.1E+03
I	1.5E+01	5.0E+00
Cs	2.0E+03	1.0E+03
Ba	4.0E+00	2.0E+02
La	2.5E+01	1.0E+03
Ce	1.0E+00	1.0E+03
Pr	2.5E+01	1.0E+03
Nd	2.5E+01	1.0E+03
W	1.2E+03	1.0E+01
Np	1.0E+01	4.0E+02

Table 4 - Highest Potential Exposure Pathways for Estimating Dose

i	**NOTE** The Annual Radiological Effluent Report uses the highest calculated value from real time meteorological data obtained for the entire year for calculating dose.

Exposure Pathway	Location [B]	Direction [B]	Distance from Containment (miles) [B]	X/Q [A] {χ/Q (r,θ)} (sec/m^3)	D/Q [A] {δ (r,θ)} (m^{-2})
Direct Exposure	Site Boundary	SSE	0.60	1.30E-05	N/A
Inhalation	Site Boundary	SSE	0.60	1.30E-05	N/A
Ingestion	Residence	SSE	0.60	N/A	7.6E-08

A. These values are used for calculating quarterly dose estimates during the annual reporting period and are based on a 2 year average, updated only upon a +10% change from the previous value. At least ten percent (10%) should be added to these values for dose estimates during the reporting periods.

B. The location is subject to change based on an annual evaluation and is utilized only for ingestion exposure pathway dose estimates. This location may differ from the highest ingestion exposure pathway for offsite air monitoring locations as determined by the Land Use Survey performed biennially in accordance with Part 1, Section 7.3.2, of the Off-Site Dose Calculation Manual.

Table 5 - Stable Element Transfer Data

Element	B_{iv} Veg./Soil	F_m (cow) Milk (d/l)	F_f Meat (d/kg)
H	4.8E+00	1.0E-02	1.2E-02
C	5.5E+00	1.2E-02	3.1E-02
Na	5.2E-02	4.0E-02	3.0E-02
P	1.1E+00	2.5E-02	4.6E-02
Cr	2.5E-04	2.2E-03	2.4E-03
Mn	2.9E-02	2.5E-04	8.0E-04
Fe	6.6E-04	1.2E-03	4.0E-02
Co	9.4E-03	1.0E-03	1.3E-02
Ni	1.9E-02	6.7E-03	5.3E-02
Cu	1.2E-01	1.4E-02	8.0E-03
Zn	4.0E-01	3.9E-02	3.0E-02
Rb	1.3E-01	3.0E-02	3.1E-02
Sr	1.7E-02	8.0E-04	6.0E-04
Y	2.6E-03	1.0E-05	4.6E-03
Zr	1.7E-04	5.0E-06	3.4E-02
Nb	9.4E-03	2.5E-03	2.8E-01
Mo	1.2E-01	7.5E-03	8.0E-03
Tc	2.5E-01	2.5E-02	4.0E-01
Ru	5.0E-02	1.0E-06	4.0E-01
Rh	1.3E+1	1.0E-02	1.5E-03
Ag	1.5E-01	5.0E-02	1.7E-02
Te	1.3E+00	1.0E-03	7.7E-02
I	2.0E-02	6.0E-03	2.9E-03
Cs	1.0E-02	1.2E-02	4.0E-03
Ba	5.0E-03	4.0E-04	3.2E-03
La	2.5E-03	5.0E-06	2.0E-04
Ce	2.5E-03	1.0E-04	1.2E-03
Pr	2.5E-03	5.0E-06	4.7E-03
Nd	2.4E-03	5.0E-06	3.3E-03
W	1.8E-02	5.0E-04	1.3E-03
Np	2.5E-03	5.0E-06	2.0E-04

Table 6 - Recommended Values for U_{ap} to Be Used for the Maximum Exposed Individual in Lieu of Site Specific Data

Pathway	**Infant**	**Child**	**Teen**	**Adult**
Fruits, vegetables, & grain (kg/yr)	---	520	630	520
Leafy vegetables (kg/yr)	---	26	42	64
Milk (ℓ/yr)	330	330	400	310
Meat & poultry (kg/yr)	---	41	65	110
Fish (fresh or salt)(kg/yr)	---	6.9	16	21
Other Seafood (kg/yr)	---	1.7	3.8	5
Drinking water (ℓ/yr)	330	510	510	730
Shoreline recreation (hr/yr)	---	14	67	12
Inhalation (m^3/yr)	1400	3700	8000	8000

Table 7 - Animal Consumption Rates

Animal	**Q_F Feed or Forage [Kg/day (wet weigh)]**	**Q_{AW} Water (ℓ/day)**
Milk Cow	50	60
Beef Cattle	50	50
Goats	6	8

Table 8 - External Dose Factors for Standing on Contaminated Ground
(mrem/hr per pCi/m^2)

Element	Total Body	Skin
H-3	---	---
C-14	---	---
Na-24	2.50E-08	2.90E-08
P-32	---	---
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	---	---
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	---	---
Nr-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	---	---
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	---	---
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91M	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Mo-99	1.90E-09	2.20E-09
Tc-99M	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09
Ru-103	3.60E-09	4.20E-09

Table 8 - External Dose Factors for Standing on Contaminated Ground
(mrem/hr per pCi/m^2)

Element	Total Body	Skin
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110M	1.80E-08	2.10E-08
Te-125M	3.50E-11	4.80E-11
Te-127M	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129M	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131M	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
I-130	1.40E-08	1.70E-08
I-131	2.80E-09	3.40E-09
I-132	1.70E-08	2.00E-08
I-133	3.70E-09	4.50E-09
I-134	1.60E-08	1.90E-08
I-135	1.20E-08	1.40E-08
Cs-134	1.20E-08	1.40E-08
Cs-136	1.50E-08	1.70E-08
Cs-137	4.20E-09	4.90E-09
Cs-138	2.10E-08	2.40E-08
Ba-139	2.40E-09	2.70E-09
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
Ba-142	7.90E-09	9.00E-09
La-140	1.50E-08	1.70E-08
La-142	1.50E-08	1.80E-08
Ce-141	5.50E-10	6.20E-10
Ce-143	2.20E-09	2.50E-09
Ce-144	3.20E-10	3.70E-10
Pr-143	---	---
Pr-144	2.00E-10	2.30E-10
Nd-147	1.00E-09	1.20E-09
W-187	3.10E-09	3.60E-09
Np-239	9.50E-10	1.10E-09

Table 9 - Inhalation Dose Factors for Adult
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	8.98E-08	8.98E-08	8.98E-08	8.98E-08	8.98E-08	8.98E-08
C-14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
Na-24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P-32	1.65E-04	9.64E-06	6.26E-06	---	---	---	1.08E-05
Cr-51	---	---	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	---	4.95E-06	7.87E-07	---	1.23E-06	1.75E-04	9.67E-06
Mn-56	---	1.55E-10	2.29E-11	---	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	---	---	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	---	---	1.27E-04	2.35E-05
Co-58	---	1.98E-07	2.59E-07	---	---	1.16E-04	1.33E-05
Co-60	---	1.44E-06	1.85E-06	---	---	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.93E-06	1.81E-06	---	---	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	---	---	7.00E-07	1.54E-06
Cu-64	---	1.83E-10	7.69E-11	---	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	---	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	---	5.27E-12	1.15E-07	2.04E-09
Br-83	---	---	3.01E-08	---	---	---	2.90E-08
Br-84	---	---	3.91E-08	---	---	---	2.05E-13
Br-85	---	---	1.60E-09	---	---	---	---
Rb-86	---	1.69E-05	7.37E-06	---	---	---	2.08E-06
Rb-88	---	4.84E-08	2.41E-08	---	---	---	4.18E-19
Rb-89	---	3.20E-08	2.12E-08	---	---	---	1.16E-21
Sr-89	3.80E-05	---	1.09E-06	---	---	1.75E-04	4.37E-05
Sr-90	3.59E-03	---	7.21E-05	---	---	1.20E-03	9.02E-05
Sr-91	7.74E-09	---	3.13E-10	---	---	4.56E-06	2.39E-05
Sr-92	8.43E-10	---	3.64E-11	---	---	2.06E-06	5.38E-06
Y-90	2.61E-07	---	7.01E-09	---	---	2.12E-05	6.32E-05
Y-91M	3.26E-11	---	1.27E-12	---	---	2.40E-07	1.66E-10
Y-91	5.78E-05	---	1.55E-06	---	---	2.13E-04	4.81E-05
Y-92	1.29E-09	---	3.77E-11	---	---	1.96E-06	9.19E-06
Y-93	1.18E-08	---	3.26E-10	---	---	6.06E-06	5.27E-05
Zr-95	1.34E-05	4.30E-06	2.91E-06	---	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	---	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	---	9.67E-07	6.31E-05	1.30E-05
Mo-99	---	1.51E-08	2.87E-09	---	3.64E-08	1.14E-05	3.10E-05
Tc-99M	1.29E-13	3.64E-13	4.63E-12	---	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	---	1.35E-13	4.99E-08	1.36E-21

Table 9 - Inhalation Dose Factors for Adult
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.91E-07	---	8.23E-08	---	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	---	3.89E-11	---	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	---	1.09E-06	---	1.67E-05	1.17E-03	1.14E-04
Ag-110M	1.35E-06	1.25E-06	7.43E-07	---	2.46E-06	5.79E-04	3.78E-05
Te-125M	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
Te-127M	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
Te-127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
Te-129M	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
Te-129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
Te-131M	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
Te-131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
Te-132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I-130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	---	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	---	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	---	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	---	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	---	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	---	6.56E-07
Cs-134	4.66E-05	1.06E-04	9.10E-05	---	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	---	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	---	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-08	7.76E-08	4.05E-08	---	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	---	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	---	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	---	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	---	2.86E-15	1.49E-07	1.96E-26
La-140	4.30E-08	2.17E-08	5.73E-09	---	---	1.70E-05	5.73E-05
La-142	8.54E-11	3.88E-11	9.65E-12	---	---	7.91E-07	2.64E-07
Ce-141	2.49E-06	1.69E-06	1.91E-07	---	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	---	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	---	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	---	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	---	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	---	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	---	---	3.63E-06	1.94E-05
Np-239	2.87E-08	2.54E-08	1.55E-09	---	8.75E-09	4.70E-06	1.49E-05

Table 10 - Inhalation Dose Factors for Teenager
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08
C-14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.019E-07	6.09E-07	6.09E-07
Na-24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P-32	2.36E-04	1.37E-05	8.95E-06	---	---	---	1.16E-05
Cr-51	---	---	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	---	6.39E-06	1.05E-06	---	1.59E-06	2.48E-04	8.35E-06
Mn-56	---	2.12E-10	3.15E-11	---	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	---	---	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	---	---	1.91E-04	2.23E-05
Co-58	---	2.59E-07	3.47E-07	---	---	1.68E-04	1.19E-05
Co-60	---	1.89E-06	2.48E-06	---	---	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	---	---	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	---	---	1.17E-06	4.59E-06
Cu-64	---	2.54E-10	1.06E-10	---	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	---	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	---	7.53E-12	1.98E-07	3.56E-08
Br-83	---	---	4.30E-08	---	---	---	---
Br-84	---	---	5.41E-08	---	---	---	---
Br-85	---	---	2.29E-09	---	---	---	---
Rb-86	---	2.38E-05	1.05E-05	---	---	---	2.21E-06
Rb-88	---	6.82E-08	3.40E-08	---	---	---	3.65E-15
Rb-89	---	4.40E-08	2.91E-08	---	---	---	4.22E-17
Sr-89	5.43E-05	---	1.56E-06	---	---	3.02E-04	4.64E-05
Sr-90	4.14E-03	---	8.33E-05	---	---	2.06E-03	9.56E-05
Sr-91	1.10E-08	---	4.39E-10	---	---	7.59E-06	3.24E-05
Sr-92	1.19E-09	---	5.08E-11	---	---	3.43E-06	1.49E-05
Y-90	3.73E-07	---	1.00E-08	---	---	3.66E-05	6.99E-05
Y-91M	4.63E-11	---	1.77E-12	---	---	4.00E-07	3.77E-09
Y-91	8.26E-05	---	2.21E-06	---	---	3.67E-04	5.11E-05
Y-92	1.84E-09	---	5.36E-11	---	---	3.35E-06	2.06E-05
Y-93	1.69E-08	---	4.65E-10	---	---	1.04E-05	7.24E-05
Zr-95	1.82E-05	5.73E-06	3.94E-06	---	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	---	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	---	1.25E-06	9.39E-05	1.21E-05
Mo-99	---	2.11E-08	4.03E-09	---	5.14E-08	1.92E-05	3.36E-05
Tc-99M	1.73E-13	4.83E-13	6.24E-12	---	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	---	1.90E-13	8.34E-08	1.09E-16

Table 10 - Inhalation Dose Factors for Teenager
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	2.63E-07	---	1.12E-07	---	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	---	5.42E-11	---	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	---	1.55E-06	---	2.38E-05	2.01E-03	1.20E-04
Ag-110M	1.73E-06	1.64E-06	9.99E-07	---	3.13E-06	8.44E-04	3.41E-05
Te-125M	6.10E-07	2.80E-07	8.34E-08	1.75E-07	---	6.70E-05	9.38E-06
Te-127M	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
Te-127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
Te-129M	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
Te-129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
Te-131M	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
Te-131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
Te-132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	---	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	---	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	---	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	---	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	---	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	---	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	---	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	---	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	---	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	---	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	---	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	---	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	---	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	---	3.92E-15	2.39E-07	5.99E-20
La-140	5.99E-08	2.95E-08	7.82E-09	---	---	2.68E-05	6.09E-05
La-142	1.20E-10	5.31E-11	1.32E-11	---	---	1.27E-06	1.50E-06
Ce-141	3.55E-06	2.37E-06	2.71E-07	---	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	---	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	---	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	---	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	---	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	---	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	---	---	5.92E-06	2.21E-05
Np-239	4.23E-08	3.60E-08	2.21E-09	---	1.25E-08	8.11E-06	1.65E-05

Table 11 - Inhalation Dose Factors for Child
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	1.73E-07	1.73E-07	1.73E-07	1.73E-07	1.73E-07	1.73E-07
C-14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
Na-24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P-32	7.04E-04	3.09E-05	2.67E-05	---	---	---	1.14E-05
Cr-51	---	---	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	---	1.16E-05	2.57E-06	---	2.71E-06	4.26E-04	6.19E-06
Mn-56	---	4.48E-10	8.43E-11	---	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	---	---	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	---	---	3.43E-04	1.91E-05
Co-58	---	4.79E-07	8.55E-07	---	---	2.99E-04	9.29E-06
Co-60	---	3.55E-06	6.12E-06	---	---	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	---	---	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	---	---	2.21E-06	2.27E-05
Cu-64	---	5.39E-10	2.90E-10	---	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	---	1.93E-05	2.69E-04	4.41E-06
Zn-69	1.81E-11	2.61E-11	2.41E-12	---	1.58E-11	3.84E-07	2.75E-06
Br-83	---	---	1.28E-07	---	---	---	---
Br-84	---	---	1.48E-07	---	---	---	---
Br-85	---	---	6.84E-09	---	---	---	---
Rb-86	---	5.36E-05	3.09E-05	---	---	---	2.16E-06
Rb-88	---	1.52E-07	9.90E-08	---	---	---	4.66E-09
Rb-89	---	9.33E-08	7.85E-08	---	---	---	5.11E-10
Sr-89	1.62E-04	---	4.66E-06	---	---	5.83E-04	4.52E-05
Sr-90	1.04E-02	---	2.07E-04	---	---	3.99E-03	9.28E-05
Sr-91	3.28E-08	---	1.24E-09	---	---	1.44E-05	4.70E-05
Sr-92	3.54E-09	---	1.42E-10	---	---	6.49E-06	6.55E-05
Y-90	1.11E-06	---	2.99E-08	---	---	7.07E-05	7.24E-05
Y-91M	1.37E-10	---	4.98E-12	---	---	7.60E-07	4.64E-07
Y-91	2.47E-04	---	6.59E-06	---	---	7.10E-04	4.97E-05
Y-92	5.50E-09	---	1.57E-10	---	---	6.46E-06	6.46E-05
Y-93	5.04E-08	---	1.38E-09	---	---	2.01E-05	1.05E-04
Zr-95	5.13E-05	1.13E-05	1.00E-05	---	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	---	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	---	2.33E-06	1.66E-04	1.00E-05
Mo-99	---	4.66E-08	1.15E-08	---	1.06E-07	3.66E-05	3.42E-05
Tc-99M	4.81E-13	9.41E-13	1.56E-11	---	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	---	3.92E-13	1.58E-07	4.41E-09

Table 11 - Inhalation Dose Factors for Child
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	7.55E-07	---	2.90E-07	---	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	---	1.50E-10	---	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	---	4.57E-06	---	4.97E-05	3.87E-03	1.16E-04
Ag-110M	4.56E-06	3.08E-06	2.47E-06	---	5.74E-06	1.48E-03	2.71E-05
Te-125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	---	1.29E-04	9.13E-06
Te-127M	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
Te-127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129M	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
Te-129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
Te-131M	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
Te-131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
Te-132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I-130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	---	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	---	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	---	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	---	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	---	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	---	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	---	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	---	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	---	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	---	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	---	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	---	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	---	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	---	7.87E-15	4.44E-07	7.41E-10
La-140	1.74E-07	6.08E-08	2.04E-08	---	---	4.94E-05	6.10E-05
La-142	3.50E-10	1.11E-10	3.49E-11	---	---	2.35E-06	2.05E-05
Ce-141	1.06E-05	5.28E-06	7.83E-07	---	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.89E-08	5.37E-08	7.77E-09	---	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	---	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	---	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	---	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	---	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	---	---	1.11E-05	2.46E-05
Np-239	1.26E-07	8.14E-08	6.35E-09	---	2.63E-08	1.57E-05	1.73E-05

Table 12 - Inhalation Dose Factors for Infant
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	2.63E-07	2.63E-07	2.63E-07	2.63E-07	2.63E-07	2.63E-07
C-14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
Na-24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P-32	1.45E-03	8.03E-05	5.53E-05	---	---	---	1.15E-05
Cr-51	---	---	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	---	1.81E-05	3.56E-06	---	3.56E-06	7.14E-04	5.04E-06
Mn-56	---	1.10E-09	1.58E-10	---	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	---	---	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	---	---	7.25E-04	1.77E-05
Co-58	---	8.71E-07	1.30E-06	---	---	5.55E-04	7.95E-06
Co-60	---	5.73E-06	8.41E-06	---	---	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	---	---	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	---	---	5.80E-06	3.58E-05
Cu-64	---	1.34E-09	5.53E-10	---	2.84E-09	6.64E-06	1.07E-05
Zn-65	1.38E-05	4.47E-05	2.22E-05	---	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	---	2.87E-11	1.05E-06	9.44E-06
Br-83	---	---	2.72E-07	---	---	---	---
Br-84	---	---	2.86E-07	---	---	---	---
Br-85	---	---	1.46E-08	---	---	---	---
Rb-86	---	1.36E-04	6.30E-05	---	---	---	2.17E-06
Rb-88	---	3.98E-07	2.05E-07	---	---	---	2.42E-07
Rb-89	---	2.29E-07	1.47E-07	---	---	---	4.87E-08
Sr-89	2.84E-04	---	8.15E-06	---	---	1.45E-03	4.57E-05
Sr-90	1.11E-02	---	2.23E-04	---	---	8.03E-03	9.36E-05
Sr-91	6.83E-08	---	2.47E-09	---	---	3.76E-05	5.24E-05
Sr-92	7.50E-09	---	2.79E-10	---	---	1.70E-05	1.00E-04
Y-90	2.35E-06	---	6.30E-08	---	---	1.92E-04	7.43E-05
Y-91M	2.91E-10	---	9.90E-12	---	---	1.99E-06	1.68E-06
Y-91	4.20E-04	---	1.12E-05	---	---	1.75E-03	5.02E-05
Y-92	1.17E-08	---	3.29E-10	---	---	1.75E-05	9.04E-05
Y-93	1.07E-07	---	2.91E-09	---	---	5.46E-05	1.19E-04
Zr-95	8.24E-05	1.99E-05	1.45E-05	---	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	---	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	---	3.37E-06	3.42E-04	9.05E-06
Mo-99	---	1.18E-07	2.31E-08	---	1.89E-07	9.63E-05	3.48E-05
Tc-99M	9.98E-13	2.06E-12	2.66E-11	---	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-14	5.80E-13	---	6.99E-13	4.17E-07	6.03E-07

Table 12 - Inhalation Dose Factors for Infant
(mrem per pCi Inhaled)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.44E-06	---	4.85E-07	---	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	---	2.93E-10	---	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	---	7.77E-06	---	7.61E-05	8.26E-03	1.17E-04
Ag-110M	7.13E-06	5.16E-06	3.57E-06	---	7.80E-06	2.62E-03	2.36E-05
Te-125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	---	3.19E-04	9.22E-06
Te-127M	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
Te-127	1.59E-09	6.81E-10	3.40E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
Te-129M	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
Te-129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
Te-131M	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
Te-131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
Te-132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I-130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	---	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	---	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	---	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	---	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	---	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	---	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	---	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	---	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	---	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	---	2.93E-07	4.67E-08	6.26E-07
Ba-139	119.06E-09	7.03E-13	3.07E-11	---	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	---	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	---	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	---	1.36E-14	1.11E-06	4.95E-07
La-140	3.61E-07	1.43E-07	3.68E-08	---	---	1.20E-04	6.06E-05
La-142	7.36E-10	2.69E-10	6.46E-11	---	---	5.87E-06	4.25E-05
Ce-141	1.98E-05	1.19E-05	1.42E-06	---	3.75E-06	3.69E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	---	4.03E-08	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	---	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	---	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	---	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	---	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	---	---	2.83E-05	2.54E-05
Np-239	2.65E-07	2.13E-07	1.34E-08	---	4.73E-08	4.25E-05	1.78E-05

Table 13 - Ingestion Dose Factors for Adult
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	5.99E-08	5.99E-08	5.99E-08	5.99E-08	5.99E-08	5.99E-08
C-14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
Na-24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P-32	1.93E-04	1.20E-05	7.46E-06	---	---	---	2.17E-05
Cr-51	---	---	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	---	4.57E-06	8.72E-07	---	1.36E-06	---	1.40E-05
Mn-56	---	1.15E-07	2.04E-08	---	1.46E-07	---	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	---	---	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	---	---	2.85E-06	3.40E-05
Co-58	---	7.45E-07	1.67E-06	---	---	---	1.51E-05
Co-60	---	2.14E-06	4.72E-06	---	---	---	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	---	---	---	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	---	---	---	1.74E-06
Cu-64	---	8.33E-08	3.91E-08	---	2.10E-07	---	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	---	1.03E-05	---	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	---	1.28E-08	---	2.96E-09
Br-83	---	---	4.02E-08	---	---	---	5.79E-08
Br-84	---	---	5.21E-08	---	---	---	4.09E-13
Br-85	---	---	2.14E-09	---	---	---	---
Rb-86	---	2.11E-05	9.83E-06	---	---	---	4.16E-06
Rb-88	---	6.05E-08	3.21E-08	---	---	---	8.36E-19
Rb-89	---	4.01E-08	2.82E-08	---	---	---	2.33E-21
Sr-89	3.08E-04	---	8.84E-06	---	---	---	4.94E-05
Sr-90	8.71E-03	---	1.75E-04	---	---	---	2.19E-04
Sr-91	5.67E-06	---	2.29E-07	---	---	---	2.70E-05
Sr-92	2.15E-06	---	9.30E-08	---	---	---	4.26E-05
Y-90	9.62E-09	---	2.58E-10	---	---	---	1.02E-04
Y-91M	9.09E-11	---	3.52E-12	---	---	---	2.67E-10
Y-91	1.41E-07	---	3.77E-09	---	---	---	7.76E-05
Y-92	8.45E-10	---	2.47E-11	---	---	---	1.48E-05
Y-93	2.68E-09	---	7.40E-11	---	---	---	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	---	1.53E-08	---	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	---	5.12E-10	---	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	---	3.42E-09	---	2.10E-05
Mo-99	---	4.31E-06	8.20E-07	---	9.76E-06	---	9.99E-06
Tc-99M	2.47E-10	6.98E-10	8.89E-09	---	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	---	6.59E-09	1.87E-10	1.10E-21

Table 13 - Ingestion Dose Factors for Adult
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.85E-07	---	7.97E-08	---	7.06E-07	---	2.16E-05
Ru-105	1.54E-08	---	6.08E-09	---	1.99E-07	---	9.42E-06
Ru-106	2.75E-06	---	3.48E-07	---	5.31E-06	---	1.78E-04
Ag-110M	1.60E-07	1.48E-07	8.79E-08	---	2.91E-07	---	6.04E-05
Te-125M	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	---	1.07E-05
Te-127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	---	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	---	8.68E-06
Te-129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	---	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	---	2.37E-08
Te-131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	---	8.40E-05
Te-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	---	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	---	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	---	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	---	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	---	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	---	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	---	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	---	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	---	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	---	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	---	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	---	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	---	6.46E-11	3.92E-11	1.72E-07
Ba-140	2.03E-05	2.55E-08	1.33E-06	---	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	---	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	---	1.85E-11	1.24E-11	3.00E-26
La-140	2.50E-09	1.26E-09	3.33E-10	---	---	---	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	---	---	---	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	---	2.94E-09	---	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	---	5.37E-10	---	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	---	1.21E-07	---	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	---	2.13E-09	---	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	---	7.05E-12	---	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	---	4.25E-09	---	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	---	---	---	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	---	3.65E-10	---	2.40E-05

Table 14 - Ingestion Dose Factors for Teenager
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	--	6.04E-08	6.04E-08	6.04E-08	6.04E-08	6.04E-08	6.04E-08
C-14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
Na-24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P-32	2.76E-04	1.71E-05	1.07E-05	---	---	---	2.32E-05
Cr-51	---	---	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
Mn-54	---	5.90E-06	1.17E-06	---	1.76E-06	---	1.21E-05
Mn-56	---	1.58E-07	2.81E-08	---	2.00E-07	---	1.04E-05
Fe-55	3.78E-06	2.68E-06	6.25E-07	---	---	1.70E-06	1.16E-06
Fe-59	5.87E-06	1.37E-05	5.29E-06	---	---	4.32E-06	3.24E-05
Co-58	---	9.72E-07	2.24E-06	---	---	---	1.34E-05
Co-60	---	2.81E-06	6.33E-06	---	---	---	3.66E-05
Ni-63	1.77E-04	1.25E-05	6.00E-06	---	---	---	1.99E-06
Ni-65	7.49E-07	9.57E-08	4.36E-08	---	---	---	5.19E-06
Cu-64	---	1.15E-07	5.41E-08	---	2.91E-07	---	8.92E-06
Zn-65	5.76E-06	2.00E-05	9.33E-06	---	1.28E-05	---	8.47E-06
Zn-69	1.47E-08	2.80E-08	1.96E-09	---	1.83E-08	---	5.16E-08
Br-83	---	---	5.74E-08	---	---	---	---
Br-84	---	---	7.22E-08	---	---	---	---
Br-85	---	---	3.05E-09	---	---	---	---
Rb-86	---	2.98E-05	1.40E-05	---	---	---	4.41E-06
Rb-88	---	8.52E-08	4.54E-08	---	---	---	7.30E-15
Rb-89	---	5.50E-08	3.89E-08	---	---	---	8.43E-17
Sr-89	4.40E-04	---	1.26E-05	---	---	---	5.24E-05
Sr-90	1.02E-02	---	2.04E-04	---	---	---	2.33E-04
Sr-91	8.07E-06	---	3.21E-07	---	---	---	3.66E-05
Sr-92	3.05E-06	---	1.30E-07	---	---	---	7.77E-05
Y-90	1.37E-08	---	3.69E-10	---	---	---	1.13E-04
Y-91M	1.29E-10	---	4.93E-12	---	---	---	6.09E-09
Y-91	2.01E-07	---	5.39E-09	---	---	---	8.24E-05
Y-92	1.21E-09	---	3.50E-11	---	---	---	3.32E-05
Y-93	3.83E-09	---	1.05E-10	---	---	---	1.17E-04
Zr-95	4.12E-08	1.30E-08	8.94E-09	---	1.91E-08	---	3.00E-05
Zr-97	2.37E-09	4.69E-10	2.16E-10	---	7.11E-10	---	1.27E-04
Nb-95	8.22E-09	4.56E-09	2.51E-09	---	4.42E-09	---	1.95E-05
Mo-99	---	6.03E-06	1.15E-06	---	1.38E-05	---	1.08E-05
Tc-99M	3.32E-10	9.26E-10	1.20E-08	---	1.38E-08	5.14E-10	6.08E-07
Tc-101	3.60E-10	5.12E-10	5.03E-09	---	9.26E-09	3.12E-10	8.75E-17

Table 14 - Ingestion Dose Factors for Teenager
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	2.55E-07	---	1.09E-07	---	8.99E-07	---	2.13E-05
Ru-105	2.18E-08	---	8.46E-09	---	2.75E-07	---	1.76E-05
Ru-106	3.92E-06	---	4.94E-07	---	7.56E-06	---	1.88E-04
Ag-110M	2.05E-07	1.94E-07	1.18E-07	---	3.70E-07	---	5.45E-05
Te-125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	---	---	1.13E-05
Te-127M	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	---	2.41E-05
Te-127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	---	1.22E-05
Te-129M	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	---	6.12E-05
Te-129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	---	2.45E-07
Te-131M	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	---	9.39E-05
Te-131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	---	2.29E-09
Te-132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	---	7.00E-05
I-130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	---	2.29E-06
I-131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	---	1.62E-06
I-132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	---	3.18E-07
I-133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	---	2.58E-06
I-134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	---	5.10E-09
I-135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	---	1.74E-06
Cs-134	8.37E-05	1.97E-04	9.14E-05	---	6.26E-05	2.39E-05	2.45E-06
Cs-136	8.59E-06	3.38E-05	2.27E-05	---	1.84E-05	2.90E-06	2.72E-06
Cs-137	1.12E-04	1.49E-04	5.19E-05	---	5.07E-05	1.97E-05	2.12E-06
Cs-138	7.76E-08	1.49E-07	7.45E-08	---	1.10E-07	1.28E-08	4.76E-11
Ba-139	1.39E-07	9.78E-11	4.05E-09	---	9.22E-11	6.74E-11	1.24E-06
Ba-140	2.84E-05	3.48E-08	1.83E-06	---	1.18E-08	2.34E-08	4.38E-05
Ba-141	6.71E-08	5.01E-11	2.24E-09	---	4.65E-11	3.43E-11	1.43E-13
Ba-142	2.99E-08	2.99E-11	1.84E-09	---	2.53E-11	1.99E-11	9.18E-20
La-140	3.48E-09	1.71E-09	4.55E-10	---	---	---	9.28E-05
La-142	1.79E-10	7.95E-11	1.98E-11	---	---	---	2.42E-06
Ce-141	1.33E-08	8.88E-09	1.02E-09	---	4.18E-09	---	2.54E-05
Ce-143	2.35E-09	1.71E-06	1.91E-10	---	7.67E-10	---	5.14E-05
Ce-144	6.96E-07	2.88E-07	3.74E-08	---	1.72E-07	---	1.75E-04
Pr-143	1.31E-08	5.23E-09	6.52E-10	---	3.04E-09	---	4.31E-05
Pr-144	4.30E-11	1.76E-11	2.18E-12	---	1.01E-11	---	4.74E-14
Nd-147	9.38E-09	1.02E-08	6.11E-10	---	5.99E-09	---	3.68E-05
W-187	1.46E-07	1.19E-07	4.17E-08	---	---	---	3.22E-05
Np-239	1.76E-09	1.66E-10	9.22E-11	---	5.21E-10	---	2.67E-05

Table 15 - Ingestion Dose Factors for Child
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	1.16E-07	1.16E-07	1.16E-07	1.16E-07	1.16E-07	1.16E-07
C-14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
Na-24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P-32	8.25E-04	3.86E-05	3.18E-05	---	---	---	2.28E-05
Cr-51	---	---	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
Mn-54	---	1.07E-05	2.85E-06	---	3.00E-06	---	8.98E-06
Mn-56	---	3.34E-07	7.54E-08	---	4.04E-07	---	4.84E-05
Fe-55	1.15E-05	6.10E-06	1.89E-06	---	---	3.45E-06	1.13E-06
Fe-59	1.65E-05	2.67E-05	1.33E-05	---	---	7.74E-06	2.78E-05
Co-58	---	1.80E-06	5.51E-06	---	---	---	1.05E-05
Co-60	---	5.29E-06	1.56E-05	---	---	---	2.93E-05
Ni-63	5.38E-04	2.88E-05	1.83E-05	---	---	---	1.94E-06
Ni-65	2.22E-06	2.09E-07	1.22E-07	---	---	---	2.56E-05
Cu-64	---	2.45E-07	1.48E-07	---	5.92E-07	---	1.15E-05
Zn-65	1.37E-05	3.65E-05	2.27E-05	---	2.30E-05	---	6.41E-06
Zn-69	4.38E-08	6.33E-08	5.85E-09	---	3.84E-08	---	3.99E-06
Br-83	---	---	1.71E-07	---	---	---	---
Br-84	---	---	1.98E-07	---	---	---	---
Br-85	---	---	9.12E-09	---	---	---	---
Rb-86	---	6.70E-05	4.12E-05	---	---	---	4.31E-06
Rb-88	---	1.90E-07	1.32E-07	---	---	---	9.32E-09
Rb-89	---	1.17E-07	1.04E-07	---	---	---	1.02E-09
Sr-89	1.32E-03	---	3.77E-05	---	---	---	5.11E-05
Sr-90	2.56E-02	---	5.15E-04	---	---	---	2.29E-04
Sr-91	2.40E-05	---	9.06E-07	---	---	---	5.30E-05
Sr-92	9.03E-06	---	3.62E-07	---	---	---	1.71E-04
Y-90	4.11E-08	---	1.10E-09	---	---	---	1.17E-04
Y-91M	3.82E-10	---	1.39E-11	---	---	---	7.48E-07
Y-91	6.02E-07	---	1.61E-08	---	---	---	8.02E-05
Y-92	3.60E-09	---	1.03E-10	---	---	---	1.04E-04
Y-93	1.14E-08	---	3.13E-10	---	---	---	1.70E-04
Zr-95	1.16E-07	2.55E-08	2.27E-08	---	3.65E-08	---	2.66E-05
Zr-97	6.99E-09	1.01E-09	5.96E-10	---	1.45E-09	---	1.53E-04
Nb-95	2.25E-08	8.76E-09	6.26E-09	---	8.23E-09	---	1.62E-05
Mo-99	---	1.33E-05	3.29E-06	---	2.84E-05	---	1.10E-05
Tc-99M	9.23E-10	1.81E-09	3.00E-08	---	2.63E-08	9.19E-10	1.03E-06
Tc-101	1.07E-09	1.12E-09	1.42E-08	---	1.91E-08	5.92E-10	3.56E-09

Table 15 - Ingestion Dose Factors for Child
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	7.31E-07	---	2.81E-07	---	1.84E-06	---	1.89E-05
Ru-105	6.45E-08	---	2.34E-08	---	5.67E-07	---	4.21E-05
Ru-106	1.17E-05	---	1.46E-06	---	1.58E-05	---	1.82E-04
Ag-110M	5.39E-07	3.64E-07	2.91E-07	---	6.78E-07	---	4.33E-05
Te-125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	---	---	1.10E-05
Te-127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	---	2.34E-05
Te-127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	---	1.84E-05
Te-129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	---	5.94E-05
Te-129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	---	8.34E-06
Te-131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	---	1.01E-04
Te-131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	---	4.36E-07
Te-132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	---	4.50E-05
I-130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	---	2.76E-06
I-131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	---	1.54E-06
I-132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	---	1.73E-06
I-133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	---	2.95E-06
I-134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	---	5.16E-07
I-135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	---	2.40E-06
Cs-134	2.34E-04	3.84E-04	8.10E-05	---	1.19E-04	4.27E-05	2.07E-06
Cs-136	2.35E-05	6.46E-05	4.18E-05	---	3.44E-05	5.13E-06	2.27E-06
Cs-137	3.27E-04	3.13E-04	4.62E-05	---	1.02E-04	3.67E-05	1.96E-06
Cs-138	2.28E-07	3.17E-07	2.01E-07	---	2.23E-07	2.40E-08	1.46E-07
Ba-139	4.14E-07	2.21E-10	1.20E-08	---	1.93E-10	1.30E-10	2.39E-05
Ba-140	8.31E-05	7.28E-08	4.85E-06	---	2.37E-08	4.34E-08	4.21E-05
Ba-141	2.00E-07	1.12E-10	6.51E-09	---	9.69E-11	6.58E-10	1.14E-07
Ba-142	8.74E-08	6.29E-11	4.88E-09	---	5.09E-11	3.70E-11	1.14E-09
La-140	1.01E-08	3.53E-09	1.19E-09	---	---	---	9.84E-05
La-142	5.24E-10	1.67E-10	5.23E-11	---	---	---	3.31E-05
Ce-141	3.97E-08	1.98E-08	2.94E-09	---	8.68E-09	---	2.47E-05
Ce-143	6.99E-09	3.79E-06	5.49E-10	---	1.59E-09	---	5.55E-05
Ce-144	2.08E-06	6.52E-07	1.11E-07	---	3.61E-07	---	1.70E-04
Pr-143	3.93E-08	1.18E-08	1.95E-09	---	6.39E-09	---	4.24E-05
Pr-144	1.29E-10	3.99E-11	6.49E-12	---	2.11E-11	---	8.59E-08
Nd-147	2.79E-08	2.26E-08	1.75E-09	---	1.24E-08	---	3.58E-05
W-187	4.29E-07	2.54E-07	1.14E-07	---	---	---	3.57E-05
Np-239	5.25E-09	3.77E-10	2.65E-10	---	1.09E-09	---	2.79E-05

Table 16 - Ingestion Dose Factors for Infant
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	---	1.76E-07	1.76E-07	1.76E-07	1.76E-07	1.76E-07	1.76E-07
C-14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
Na-24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P-32	1.70E-03	1.00E-04	6.59E-05	---	---	---	2.30E-05
Cr-51	---	---	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
Mn-54	---	1.99E-05	4.51E-06	---	4.41E-06	---	7.31E-06
Mn-56	---	8.18E-07	1.41E-07	---	7.03E-07	---	7.43E-05
Fe-55	1.39E-05	8.98E-06	2.40E-06	---	---	4.36E-06	1.14E-06
Fe-59	3.08E-05	5.38E-05	2.12E-05	---	---	1.59E-05	2.57E-05
Co-58	---	3.60E-06	8.98E-06	---	---	---	8.97E-06
Co-60	---	1.08E-05	2.55E-05	---	---	---	2.57E-05
Ni-63	6.34E-04	3.92E-05	2.20E-05	---	---	---	1.95E-06
Ni-65	4.70E-06	5.32E-07	2.42E-07	---	---	---	4.05E-05
Cu-64	---	6.09E-07	2.82E-07	---	1.03E-06	---	1.25E-05
Zn-65	1.84E-05	6.31E-05	2.91E-05	---	3.06E-05	---	5.33E-05
Zn-69	9.33E-08	1.68E-07	1.25E-08	---	6.98E-08	---	1.37E-05
Br-83	---	---	3.63E-07	---	---	---	---
Br-84	---	---	3.82E-07	---	---	---	---
Br-85	---	---	1.94E-08	---	---	---	---
Rb-86	---	1.70E-04	8.40E-05	---	---	---	4.35E-06
Rb-88	---	4.98E-07	2.73E-07	---	---	---	4.85E-07
Rb-89	---	2.86E-07	1.97E-07	---	---	---	9.74E-08
Sr-89	2.51E-03	---	7.20E-05	---	---	---	5.16E-05
Sr-90	2.83E-02	---	5.74E-04	---	---	---	2.31E-04
Sr-91	5.00E-05	---	1.81E-06	---	---	---	5.92E-05
Sr-92	1.92E-05	---	7.13E-07	---	---	---	2.07E-04
Y-90	8.69E-08	---	2.33E-09	---	---	---	1.20E-04
Y-91M	8.10E-10	---	2.76E-11	---	---	---	2.70E-06
Y-91	1.13E-06	---	3.01E-08	---	---	---	8.10E-05
Y-92	7.65E-09	---	2.15E-10	---	---	---	1.46E-04
Y-93	2.43E-08	---	6.62E-10	---	---	---	1.92E-04
Zr-95	2.06E-07	5.02E-08	3.56E-08	---	5.41E-08	---	2.50E-05
Zr-97	1.48E-08	2.54E-09	1.16E-09	---	2.56E-09	---	1.62E-04
Nb-95	4.20E-08	1.73E-08	1.00E-08	---	1.24E-08	---	1.46E-05
Mo-99	---	3.40E-05	6.63E-06	---	5.08E-05	---	1.12E-05
Tc-99M	1.92E-09	3.96E-09	5.10E-08	---	4.26E-08	2.07E-09	1.15E-06
Tc-101	2.27E-09	2.86E-09	2.83E-08	---	3.40E-08	1.56E-09	4.86E-07

Table 16 - Ingestion Dose Factors for Infant
(mrem per pCi Ingested)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.48E-06	---	4.95E-07	---	3.08E-06	---	1.80E-05
Ru-105	1.36E-07	---	4.58E-08	---	1.00E-06	---	5.41E-05
Ru-106	2.41E-05	---	3.01E-06	---	2.85E-05	---	1.83E-04
Ag-110M	9.96E-07	7.27E-07	4.81E-07	---	1.04E-06	---	3.77E-05
Te-125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	---	---	1.11E-05
Te-127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	---	2.36E-05
Te-127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	---	2.10E-05
Te-129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	---	5.97E-05
Te-129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	---	2.27E-05
Te-131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	---	1.03E-04
Te-131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	---	7.11E-06
Te-132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	---	3.81E-05
I-130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	---	2.83E-06
I-131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	---	1.51E-06
I-132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	---	2.73E-06
I-133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	---	3.08E-06
I-134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	---	1.84E-06
I-135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	---	2.62E-06
Cs-134	3.77E-04	7.03E-04	7.10E-05	---	1.81E-04	7.42E-05	1.91E-06
Cs-136	4.59E-05	1.35E-04	5.04E-05	---	5.38E-05	1.10E-05	2.05E-06
Cs-137	5.22E-04	6.11E-04	4.33E-05	---	1.64E-04	6.64E-05	1.91E-06
Cs-138	4.81E-07	7.82E-07	3.79E-07	---	3.90E-07	6.09E-08	1.25E-06
Ba-139	8.81E-07	5.84E-10	2.55E-08	---	3.51E-10	3.54E-10	5.58E-05
Ba-140	1.71E-04	1.71E-07	8.81E-06	---	4.06E-08	1.05E-07	4.20E-05
Ba-141	4.25E-07	2.91E-10	1.34E-08	---	1.75E-10	1.77E-10	5.19E-06
Ba-142	1.84E-07	1.53E-10	9.06E-09	---	8.81E-11	9.26E-11	7.59E-07
La-140	2.11E-08	8.32E-09	2.14E-09	---	---	---	9.77E-05
La-142	1.10E-09	4.04E-10	9.67E-11	---	---	---	6.86E-05
Ce-141	7.87E-08	4.80E-08	5.65E-09	---	1.48E-08	---	2.48E-05
Ce-143	1.48E-08	9.82E-06	1.12E-09	---	2.86E-09	---	5.73E-05
Ce-144	2.98E-06	1.22E-06	1.67E-07	---	4.93E-07	---	1.71E-04
Pr-143	8.13E-08	3.04E-08	4.03E-09	---	1.13E-08	---	4.29E-05
Pr-144	2.74E-10	1.06E-10	1.38E-11	---	3.84E-11	---	4.93E-06
Nd-147	5.53E-08	5.68E-08	3.48E-09	---	2.19E-08	---	3.60E-05
W-187	9.03E-07	6.28E-07	2.17E-07	---	---	---	3.69E-05
Np-239	1.11E-08	9.93E-10	5.61E-10	---	1.98E-09	---	2.87E-05

Table 17 - Recommended Values for Other Parameters

Parameter Symbol	Definition	Values
f_g	Fraction of ingested produce grown in garden of interest.	0.76
f_ℓ	Fraction of leafy vegetables grown in garden of interest.	1.0
P	Effective surface density of soil (assumes a 15 cm plow layer, expressed in dry weight)	240 kg/m^2
r	Fraction of deposited activity retained on crops, leafy vegetables, or pasture grass	0.25 1.0 (iodines) 0.2 (other particulates)
S_f	Attenuation factor accounting for shielding provided by residential structures	0.7 (maximum individual) 0.5 (general population)
t_b	Period of long-term buildup for activity in sediment or soil (20 years)	1.752E5 hr
t_e	Period of crop, leafy vegetable, or pasture grass exposure during growing season	30 days (grass-cow-milk-man pathway) 60 days (crop/vegetation-man pathway)
f	Transport time from animal feed-milk-man provided by residential structures	2 days (maximum individual) 4 days (general population)
t_h	Time delay between harvest of vegetation or crops and ingestion:	
	• For ingestion of forage by animals	Zero (pasture grass) 90 days (stored feed)
	• For ingestion of crops by man	1 day (leafy vegetables and max. individual feed) 60 days (produce and max. individual) 14 days (general population)
f_s	The fraction of daily feed that is pasture grass while the animals graze on pasture.	1.0
M_p	The mixing ratio at the point of withdrawal of drinking water.	Site Discharge 7.14 M.U.D. Intake 30.8
f_p	Fraction of the year that animals graze on pasture.	0.5

Table 17 - Recommended Values for Other Parameters

Parameter Symbol	Definition	Values
t_p	Environmental transit time, release to receptor (add time from release to exposure individual point to minimums shown for distribution)	12 hrs. (maximum) 1 day (maximum individual) 1 day (general population) 7 days (population--sport fish doses) 10 days (population--commercial fish doses)
t_s	Average time from slaughter of meat animal to consumption	20 days
Y_v	Agricultural productivity by unit area (measured in wet weight)	0.7 kg/m^2 (grass-cow-milk-man pathway) 2.0 kg/m^2 (produce or leafy vegetable ingested by man)
W	Shore-width factor for river shoreline	0.2
λ_w	Rate constant for removal of activity on plant or leaf structures by weathering (corresponds to a 14-day half-life)	0.0021 hr^{-1}
$\%CO_2$	Fraction of C-14 used for organ dose calculations from gaseous releases.	0.15

Table 18 - Estimated Doses Received by the General Public from On-Site Exposure

i	**NOTE** The Dose Estimates are based on normal public activities conducted within the Fort Calhoun Station Site Boundary.

Location	Direction	Distance from Containment (miles)	Estimated Individual Dose Rate (mR/hour)		Estimated Total Combined Annual Dose (mRem)[B]	
			Direct Exposure (Total Body)	Inhalation (Critical Organ[A])	Direct Exposure (Total Body)	Inhalation (Critical Organ[A])
Firing Range	200°	0.24	4.08E-05	9.67E-06	5.08E+00	1.20E+00
Burn Pad	241°	0.33	1.95E-05	4.63E-06	1.41E-01	3.34E-02
On-Site Farming	118°	0.52	2.12E-05	5.03E-06	2.38E-02	5.64E-03
On-Site Farming	200°	0.51	1.03E-05	2.45E-06	2.30E-02	5.50E-03
On-Site Farming	308°	0.50	2.77E-05	6.64E-06	4.66E-02	1.12E-02
Site Maintenance Admin Bldg	145°	0.20	1.18E-04	2.84E-05	5.50E-02	1.33E-02
Site Maintenance Training Center	180°	0.20	1.45E-04	3.50E-05	6.78E-02	1.64E-02

A. Critical organ doses are based on adult thyroid.
B. Estimated totals are based on summation of all individual doses for members of the General Public while within the Fort Calhoun Station site boundary.

SECTION VII

ATTACHMENT 2

JOINT FREQUENCY DISTRIBUTION WIND DIRECTION VS. WIND SPEED
BY STABILITY CLASS AND METEOROLOGICAL DATA

(Regulatory Guide 1.21)

January 1, 2014 - December 31, 2014

JOINT FREQUENCY DISTRIBUTION WIND DIRECTION VS. WIND SPEED BY STABILITY CLASS AND METEOROLOGICAL DATA

A. Meteorological Data Recovery

Data availability from the on-site weather tower for the period January 1, 2014 through December 31, 2014 had a cumulative recovery rate of 96.18% from the meteorological tower with the remaining 3.82% provided by Eppley Airfield Weather Station, a branch of the National Weather Service. The data provided by Eppley Airfield Weather Station. The following table is a summary of the parameters and their respective recovery rates for the period.

The tabulations of the Weather Tower Data for the period January 1, 2014 through December 31, 2014 look appropriate for the season indicated. The Pasquill Classes observed for the twelve-month period are detailed below.

Pasquill Class	A	B	C	D	E	F	G	Total
% Obs.	12.97	5.64	7.32	41.95	20.14	7.64	4.02	100

On the basis of the data and its cross-checks, the weather data as amended is completely valid for use in tabulating atmospheric releases.

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
EXTREMELY UNSTABLE (delta T/ delta z <= -1.9)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL A
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0	2	3	10	35	45	23	2	1	0	0	121
NNE	0	2	3	5	12	9	3	1	0	0	0	35
NE	0	1	1	4	10	9	1	0	1	0	0	27
ENE	0	1	2	4	6	2	2	2	3	0	0	22
E	0	0	1	4	1	4	0	1	0	0	0	11
ESE	1	5	1	3	10	7	8	1	1	0	0	37
SE	0	1	2	7	14	19	9	2	5	2	0	61
SSE	0	0	2	5	11	14	10	12	10	0	0	64
S	0	0	1	1	10	15	15	10	7	0	0	59
SSW	0	1	1	6	8	10	6	2	3	2	0	39
SW	0	0	1	6	10	9	5	3	3	1	0	38
WSW	0	0	0	3	16	6	1	1	0	0	0	27
W	0	2	4	6	11	2	1	1	5	0	0	32
WNW	0	1	2	5	22	16	8	4	1	1	0	60
NW	0	3	4	10	32	32	40	33	14	4	0	172
NNW	2	4	10	21	74	95	60	41	21	3	0	331
Total	3	23	38	100	282	294	192	116	75	13	0	1136

Number of Calms 0
Number of Invalid Hours 0
Number of Valid Hours 1136

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
MODERATELY UNSTABLE (-1.9 < delta T/ delta z <= -1.7)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL B
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0	1	1	11	24	8	10	2	1	0	0	58
NNE	0	0	1	4	8	1	0	0	0	0	0	14
NE	0	1	6	1	5	1	0	0	1	0	0	15
ENE	0	0	1	3	9	2	0	0	0	0	0	15
E	0	0	0	3	4	2	2	1	0	0	0	12
ESE	1	1	2	1	6	2	3	1	0	0	0	17
SE	0	0	0	4	9	12	10	1	0	1	0	37
SSE	0	1	1	1	6	14	9	3	6	0	0	41
S	0	0	0	3	3	11	11	8	2	1	0	39
SSW	0	0	1	3	3	1	2	3	2	0	0	15
SW	0	0	1	1	2	1	4	3	4	0	0	16
WSW	0	2	0	4	3	3	1	2	1	0	0	16
W	0	0	1	2	7	4	0	0	1	0	0	15
WNW	0	3	1	0	5	6	1	3	0	0	0	19
NW	0	3	2	1	2	10	9	7	6	2	1	43
NNW	1	1	5	7	29	31	20	13	13	2	0	122
Total	2	13	23	49	125	109	82	47	37	6	1	494

Number of Calms 0
Number of Invalid Hours 0
Number of Valid Hours 494

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
SLIGHTLY UNSTABLE (-1.7 < delta T/ delta z <= -1.5)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL C
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0	8	8	22	25	9	2	1	1	0	0	77
NNE	0	4	11	9	7	1	1	1	2	0	0	39
NE	0	2	1	6	8	4	1	1	1	0	0	24
ENE	0	2	1	6	7	3	2	0	1	0	0	22
E	1	2	4	5	5	5	1	2	0	0	0	25
ESE	1	0	0	5	8	5	2	1	2	0	0	24
SE	1	1	4	2	7	9	4	3	1	1	0	33
SSE	0	0	4	1	15	14	9	2	0	1	0	49
S	0	2	1	5	11	13	6	4	5	5	0	52
SSW	0	1	1	1	6	5	7	3	5	2	0	31
SW	0	0	0	1	2	1	7	3	2	1	0	17
WSW	0	0	6	0	1	4	2	1	0	0	0	14
W	0	2	1	2	9	2	0	0	0	0	0	16
WNW	0	1	2	3	11	2	4	0	1	0	0	24
NW	1	2	8	7	8	8	12	7	8	0	0	62
NNW	0	3	9	13	32	19	32	14	13	4	1	143
Total	4	30	61	88	162	104	92	43	42	14	1	641

Number of Calms 11
Number of Invalid Hours 0
Number of Valid Hours 652

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
NEUTRAL (-1.5 < delta T/ delta z <= -0.5)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL D
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	1	19	31	42	74	37	13	6	2	0	0	228
NNE	1	8	27	18	26	2	3	2	1	1	0	89
NE	0	16	20	12	7	4	1	0	0	0	0	60
ENE	1	7	24	26	28	7	2	1	0	0	0	96
E	1	6	17	24	54	20	9	4	0	0	0	135
ESE	1	11	14	20	71	39	21	12	13	3	0	205
SE	2	7	17	44	98	105	60	29	18	13	3	396
SSE	0	3	10	28	88	108	134	96	108	24	5	604
S	1	5	6	13	59	75	79	64	95	25	9	432
SSW	1	6	5	5	30	33	32	16	21	24	4	177
SW	0	5	7	9	14	17	12	10	10	4	3	91
WSW	0	7	14	10	18	10	2	4	1	0	0	66
W	1	4	7	11	21	9	3	2	2	0	0	60
WNW	2	9	11	15	38	15	9	9	8	1	0	117
NW	0	13	14	19	68	99	97	52	28	10	5	405
NNW	1	5	30	50	131	123	91	42	38	5	2	520
Total	13	131	254	346	825	703	568	349	345	110	31	3675

Number of Calms 6
Number of Invalid Hours 0
Number of Valid Hours 3681

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
SLIGHTLY STABLE (-0.5 < delta T/ delta z <= 1.5)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL E
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	2	12	9	9	4	1	0	1	0	0	0	38
NNE	3	4	6	6	5	0	0	0	0	0	0	24
NE	1	7	4	5	4	0	0	0	0	0	0	21
ENE	2	8	4	5	4	0	1	0	0	0	0	24
E	3	10	13	7	9	0	0	0	0	0	0	42
ESE	0	11	22	26	43	8	3	0	1	0	0	114
SE	3	9	34	54	111	59	23	7	5	0	0	305
SSE	3	8	19	32	80	62	40	18	4	0	0	266
S	0	8	4	12	21	41	26	21	12	3	0	148
SSW	1	11	6	5	15	9	10	17	15	5	1	95
SW	1	4	4	5	11	9	6	9	16	9	1	75
WSW	1	11	8	7	9	6	7	1	0	0	3	53
W	7	17	23	16	30	14	3	0	0	0	0	110
WNW	6	30	23	34	51	14	5	1	1	0	0	165
NW	7	17	23	27	48	15	10	6	2	0	0	155
NNW	2	19	15	26	35	11	16	4	1	0	0	129
Total	42	186	217	276	480	249	150	85	57	17	5	1764

Number of Calms 0
Number of Invalid Hours 0
Number of Valid Hours 1764

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
MODERATELY STABLE (1.5 < delta T/ delta z <= 4.0)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL F
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	1	7	1	0	2	0	0	0	0	0	0	14
NNE	1	0	3	0	0	0	0	0	0	0	0	4
NE	1	7	3	0	0	0	0	0	0	0	0	11
ENE	2	7	1	1	0	0	0	0	0	0	0	11
E	0	6	8	2	0	0	0	0	0	0	0	16
ESE	7	14	12	13	15	2	0	0	0	0	0	63
SE	13	16	17	27	44	6	1	0	0	0	0	125
SSE	5	18	11	7	16	5	0	0	0	0	0	67
S	5	14	6	3	13	11	4	2	2	0	0	60
SSW	5	9	3	0	7	4	4	1	0	0	0	33
SW	10	20	4	1	1	4	8	1	1	0	0	50
WSW	6	15	5	5	1	1	1	0	0	0	0	34
W	22	28	7	4	1	0	0	0	0	0	0	62
WNW	12	39	22	11	6	2	0	0	0	0	0	92
NW	4	7	4	5	1	1	0	0	0	0	0	22
NNW	2	6	1	0	2	1	1	1	0	0	0	14
Total	96	213	108	79	109	37	19	5	3	0	0	669

Number of Calms 9
Number of Invalid Hours 0
Number of Valid Hours 678

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY EVENTS
EXTREMELY STABLE (delta T/ delta z > 4.0)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL G
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	1	1	0	0	0	0	0	0	0	0	0	3
NNE	3	3	0	0	0	0	0	0	0	0	0	6
NE	2	5	2	0	0	0	0	0	0	0	0	9
ENE	4	10	0	0	0	0	0	0	0	0	0	14
E	2	9	4	1	0	0	0	0	0	0	0	16
ESE	9	17	6	4	6	0	0	0	0	0	0	42
SE	5	21	14	7	6	0	0	0	0	0	0	55
SSE	5	27	3	4	2	0	0	0	0	0	0	41
S	14	19	3	3	1	1	0	0	0	0	0	41
SSW	14	22	3	0	2	4	0	0	0	0	0	45
SW	6	16	1	1	0	1	0	0	0	0	0	25
WSW	5	11	1	0	0	0	0	0	0	0	0	17
W	5	7	0	0	0	0	0	0	0	0	0	12
WNW	1	12	2	0	0	0	0	0	0	0	0	15
NW	4	4	2	1	0	0	0	0	0	0	0	11
NNW	1	2	0	0	0	0	0	0	0	0	0	3
Total	81	186	41	21	17	6	0	0	0	0	0	352

Number of Calms 3
Number of Invalid Hours 0
Number of Valid Hours 355

Hours Accounted For: 8760

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
EXTREMELY UNSTABLE (delta T/ delta z <= -1.9)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL A
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.00	0.02	0.03	0.11	0.40	0.51	0.26	0.02	0.01	0.00	0.00	1.38
NNE	0.00	0.02	0.03	0.06	0.14	0.10	0.03	0.01	0.00	0.00	0.00	0.40
NE	0.00	0.01	0.01	0.05	0.11	0.10	0.01	0.00	0.01	0.00	0.00	0.31
ENE	0.00	0.01	0.02	0.05	0.07	0.02	0.02	0.02	0.03	0.00	0.00	0.25
E	0.00	0.00	0.01	0.05	0.01	0.05	0.00	0.01	0.00	0.00	0.00	0.13
ESE	0.01	0.06	0.01	0.03	0.11	0.08	0.09	0.01	0.01	0.00	0.00	0.42
SE	0.00	0.01	0.02	0.08	0.16	0.22	0.10	0.02	0.06	0.02	0.00	0.70
SSE	0.00	0.00	0.02	0.06	0.13	0.16	0.11	0.14	0.11	0.00	0.00	0.73
S	0.00	0.00	0.01	0.01	0.11	0.17	0.17	0.11	0.08	0.00	0.00	0.67
SSW	0.00	0.01	0.01	0.07	0.09	0.11	0.07	0.02	0.03	0.02	0.00	0.45
SW	0.00	0.00	0.01	0.07	0.11	0.10	0.06	0.03	0.03	0.01	0.00	0.43
WSW	0.00	0.00	0.00	0.03	0.18	0.07	0.01	0.01	0.00	0.00	0.00	0.31
W	0.00	0.02	0.05	0.07	0.13	0.02	0.01	0.01	0.06	0.00	0.00	0.37
WNW	0.00	0.01	0.02	0.06	0.25	0.18	0.09	0.05	0.01	0.01	0.00	0.68
NW	0.00	0.03	0.05	0.11	0.37	0.37	0.46	0.38	0.16	0.05	0.00	1.96
NNW	0.02	0.05	0.11	0.24	0.84	1.08	0.68	0.47	0.24	0.03	0.00	3.78
Total	0.03	0.26	0.43	1.14	3.22	3.36	2.19	1.32	0.86	0.15	0.00	12.97

Percent of Calms 0.00
Percent of Invalid Hours 0.00
Percent of Valid Hours 12.97

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
MODERATELY UNSTABLE (-1.9 < delta T/ delta z <= -1.7)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL B
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.00	0.01	0.01	0.13	0.27	0.09	0.11	0.02	0.01	0.00	0.00	0.66
NNE	0.00	0.00	0.01	0.05	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.16
NE	0.00	0.01	0.07	0.01	0.06	0.01	0.00	0.00	0.01	0.00	0.00	0.17
ENE	0.00	0.00	0.01	0.03	0.10	0.02	0.00	0.00	0.00	0.00	0.00	0.17
E	0.00	0.00	0.00	0.03	0.05	0.02	0.02	0.01	0.00	0.00	0.00	0.14
ESE	0.01	0.01	0.02	0.01	0.07	0.02	0.03	0.01	0.00	0.00	0.00	0.19
SE	0.00	0.00	0.00	0.05	0.10	0.14	0.11	0.01	0.00	0.01	0.00	0.42
SSE	0.00	0.01	0.01	0.01	0.07	0.16	0.10	0.03	0.07	0.00	0.00	0.47
S	0.00	0.00	0.00	0.03	0.03	0.13	0.13	0.09	0.02	0.01	0.00	0.45
SSW	0.00	0.00	0.01	0.03	0.03	0.01	0.02	0.03	0.02	0.00	0.00	0.17
SW	0.00	0.00	0.01	0.01	0.02	0.01	0.05	0.03	0.05	0.00	0.00	0.18
WSW	0.00	0.02	0.00	0.05	0.03	0.03	0.01	0.02	0.01	0.00	0.00	0.18
W	0.00	0.00	0.01	0.02	0.08	0.05	0.00	0.00	0.01	0.00	0.00	0.17
WNW	0.00	0.03	0.01	0.00	0.06	0.07	0.01	0.03	0.00	0.00	0.00	0.22
NW	0.00	0.03	0.02	0.01	0.02	0.11	0.10	0.08	0.07	0.02	0.01	0.49
NNW	0.01	0.01	0.06	0.08	0.33	0.35	0.23	0.15	0.15	0.02	0.00	1.39
Total	0.02	0.15	0.26	0.56	1.43	1.24	0.94	0.54	0.42	0.07	0.01	5.64

Percent of Calms 0.00
Percent of Invalid Hours 0.00
Percent of Valid Hours 5.64

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
SLIGHTLY UNSTABLE (-1.7 < delta T/ delta z <= -1.5)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL C
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.00	0.09	0.09	0.25	0.29	0.10	0.02	0.01	0.01	0.00	0.00	0.88
NNE	0.00	0.05	0.13	0.10	0.08	0.01	0.01	0.01	0.02	0.00	0.00	0.45
NE	0.00	0.02	0.01	0.07	0.09	0.05	0.01	0.01	0.01	0.00	0.00	0.27
ENE	0.00	0.02	0.01	0.07	0.08	0.03	0.02	0.00	0.01	0.00	0.00	0.25
E	0.01	0.02	0.05	0.06	0.06	0.06	0.01	0.02	0.00	0.00	0.00	0.29
ESE	0.01	0.00	0.00	0.06	0.09	0.06	0.02	0.01	0.02	0.00	0.00	0.27
SE	0.01	0.01	0.05	0.02	0.08	0.10	0.05	0.03	0.01	0.01	0.00	0.38
SSE	0.00	0.00	0.05	0.01	0.17	0.16	0.10	0.02	0.00	0.01	0.00	0.56
S	0.00	0.02	0.01	0.06	0.13	0.15	0.07	0.05	0.06	0.06	0.00	0.59
SSW	0.00	0.01	0.01	0.01	0.07	0.06	0.08	0.03	0.06	0.02	0.00	0.35
SW	0.00	0.00	0.00	0.01	0.02	0.01	0.08	0.03	0.02	0.01	0.00	0.19
WSW	0.00	0.00	0.07	0.00	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.16
W	0.00	0.02	0.01	0.02	0.10	0.02	0.00	0.00	0.00	0.00	0.00	0.18
WNW	0.00	0.01	0.02	0.03	0.13	0.02	0.05	0.00	0.01	0.00	0.00	0.27
NW	0.01	0.02	0.09	0.08	0.09	0.09	0.14	0.08	0.09	0.00	0.00	0.71
NNW	0.00	0.03	0.10	0.15	0.37	0.22	0.37	0.16	0.15	0.05	0.01	1.63
Total	0.05	0.34	0.70	1.00	1.85	1.19	1.05	0.49	0.48	0.16	0.01	7.32

Percent of Calms 0.13
Percent of Invalid Hours 0.00
Percent of Valid Hours 7.44

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
NEUTRAL (-1.5 < delta T/ delta z <= -0.5)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL D
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.01	0.22	0.35	0.48	0.84	0.42	0.15	0.07	0.02	0.00	0.00	2.60
NNE	0.01	0.09	0.31	0.21	0.30	0.02	0.03	0.02	0.01	0.01	0.00	1.02
NE	0.00	0.18	0.23	0.14	0.08	0.05	0.01	0.00	0.00	0.00	0.00	0.68
ENE	0.01	0.08	0.27	0.30	0.32	0.08	0.02	0.01	0.00	0.00	0.00	1.10
E	0.01	0.07	0.19	0.27	0.62	0.23	0.10	0.05	0.00	0.00	0.00	1.54
ESE	0.01	0.13	0.16	0.23	0.81	0.45	0.24	0.14	0.15	0.03	0.00	2.34
SE	0.02	0.08	0.19	0.50	1.12	1.20	0.68	0.33	0.21	0.15	0.03	4.52
SSE	0.00	0.03	0.11	0.32	1.00	1.23	1.53	1.10	1.23	0.27	0.06	6.89
S	0.01	0.06	0.07	0.15	0.67	0.86	0.90	0.73	1.08	0.29	0.10	4.93
SSW	0.01	0.07	0.06	0.06	0.34	0.38	0.37	0.18	0.24	0.27	0.05	2.02
SW	0.00	0.06	0.08	0.10	0.16	0.19	0.14	0.11	0.11	0.05	0.03	1.04
WSW	0.00	0.08	0.16	0.11	0.21	0.11	0.02	0.05	0.01	0.00	0.00	0.75
W	0.01	0.05	0.08	0.13	0.24	0.10	0.03	0.02	0.02	0.00	0.00	0.68
WNW	0.02	0.10	0.13	0.17	0.43	0.17	0.10	0.10	0.09	0.01	0.00	1.34
NW	0.00	0.15	0.16	0.22	0.78	1.13	1.11	0.59	0.32	0.11	0.06	4.62
NNW	0.01	0.06	0.34	0.57	1.50	1.40	1.04	0.48	0.43	0.06	0.02	5.94
Total	0.15	1.50	2.90	3.95	9.42	8.03	6.48	3.98	3.94	1.26	0.35	41.95

Percent of Calms 0.07
Percent of Invalid Hours 0.00
Percent of Valid Hours 42.02

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
SLIGHTLY STABLE (-0.5 < delta T/ delta z <= 1.5)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL E
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.02	0.14	0.10	0.10	0.05	0.01	0.00	0.01	0.00	0.00	0.00	0.43
NNE	0.03	0.05	0.07	0.07	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.27
NE	0.01	0.08	0.05	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.24
ENE	0.02	0.09	0.05	0.06	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.27
E	0.03	0.11	0.15	0.08	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.48
ESE	0.00	0.13	0.25	0.30	0.49	0.09	0.03	0.00	0.01	0.00	0.00	1.30
SE	0.03	0.10	0.39	0.62	1.27	0.67	0.26	0.08	0.06	0.00	0.00	3.48
SSE	0.03	0.09	0.22	0.37	0.91	0.71	0.46	0.21	0.05	0.00	0.00	3.04
S	0.00	0.09	0.05	0.14	0.24	0.47	0.30	0.24	0.14	0.03	0.00	1.69
SSW	0.01	0.13	0.07	0.06	0.17	0.10	0.11	0.19	0.17	0.06	0.01	1.08
SW	0.01	0.05	0.05	0.06	0.13	0.10	0.07	0.10	0.18	0.10	0.01	0.86
WSW	0.01	0.13	0.09	0.08	0.10	0.07	0.08	0.01	0.00	0.00	0.03	0.61
W	0.08	0.19	0.26	0.18	0.34	0.16	0.03	0.00	0.00	0.00	0.00	1.26
WNW	0.07	0.34	0.26	0.39	0.58	0.16	0.06	0.01	0.01	0.00	0.00	1.88
NW	0.08	0.19	0.26	0.31	0.55	0.17	0.11	0.07	0.02	0.00	0.00	1.77
NNW	0.02	0.22	0.17	0.30	0.40	0.13	0.18	0.05	0.01	0.00	0.00	1.47
Total	0.48	2.12	2.48	3.15	5.48	2.84	1.71	0.97	0.65	0.19	0.06	20.14

Percent of Calms 0.00
Percent of Invalid Hours 0.00
Percent of Valid Hours 20.14

Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
MODERATELY STABLE (1.5 < delta T/ delta z <= 4.0)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL F
WIND SPEED (m/s) AT 10-m LEVEL

Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.01	0.08	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.16
NNE	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
NE	0.01	0.08	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
ENE	0.02	0.08	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
E	0.00	0.07	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
ESE	0.08	0.16	0.14	0.15	0.17	0.02	0.00	0.00	0.00	0.00	0.00	0.72
SE	0.15	0.18	0.19	0.31	0.50	0.07	0.01	0.00	0.00	0.00	0.00	1.43
SSE	0.06	0.21	0.13	0.08	0.18	0.06	0.00	0.00	0.00	0.00	0.00	0.76
S	0.06	0.16	0.07	0.03	0.15	0.13	0.05	0.02	0.02	0.00	0.00	0.68
SSW	0.06	0.10	0.03	0.00	0.08	0.05	0.05	0.01	0.00	0.00	0.00	0.38
SW	0.11	0.23	0.05	0.01	0.01	0.05	0.09	0.01	0.01	0.00	0.00	0.57
WSW	0.07	0.17	0.06	0.06	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.39
W	0.25	0.32	0.08	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.71
WNW	0.14	0.45	0.25	0.13	0.07	0.02	0.00	0.00	0.00	0.00	0.00	1.05
NW	0.05	0.08	0.05	0.06	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.25
NNW	0.02	0.07	0.01	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.16
Total	1.10	2.43	1.23	0.90	1.24	0.42	0.22	0.06	0.03	0.00	0.00	7.64

Percent of Calms 0.10
Percent of Invalid Hours 0.00
Percent of Valid Hours 7.74

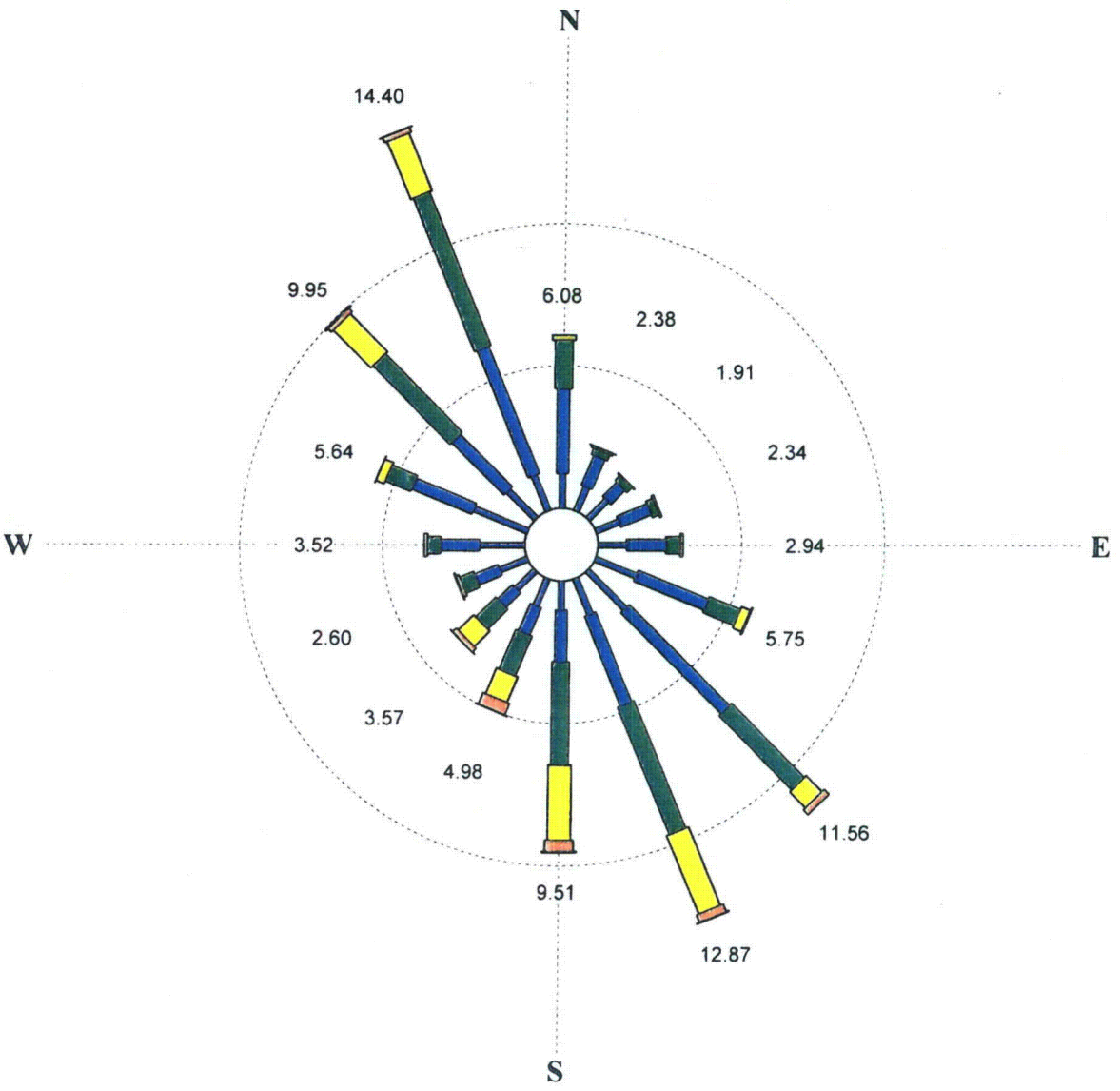
Omaha Public Power District
Fort Calhoun Nuclear Station
JOINT FREQUENCY DISTRIBUTION BY PERCENT
EXTREMELY STABLE (delta T/ delta z > 4.0)
PERIOD OF RECORD: JAN 2014 - DEC 2014
PASQUILL G
WIND SPEED (m/s) AT 10-m LEVEL

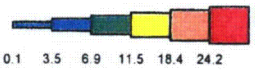
Wind Direct	< 0.5	0.5-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-8.0	8.1-10.0	> 10.0	Total
N	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
NNE	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
NE	0.02	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
ENE	0.05	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
E	0.02	0.10	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
ESE	0.10	0.19	0.07	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.48
SE	0.06	0.24	0.16	0.08	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.63
SSE	0.06	0.31	0.03	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.47
S	0.16	0.22	0.03	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.47
SSW	0.16	0.25	0.03	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.51
SW	0.07	0.18	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.29
WSW	0.06	0.13	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19
W	0.06	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
WNW	0.01	0.14	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
NW	0.05	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
NNW	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Total	0.92	2.12	0.47	0.24	0.19	0.07	0.00	0.00	0.00	0.00	0.00	4.02

Percent of Calms 0.03
Percent of Invalid Hours 0.00
Percent of Valid Hours 4.05

Percent of Hours Accounted For: 100.00

Joint Frequency Distribution
2014 FCS Meterological Tower





Wind Speed (Miles Per Hour)

Calms excluded.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.