INFORMATION ONLY

VIRGINIA POWER

Station Administrative Procedure

Title: Offsite Dose Calculation Manual		
Lead Department: Radiological Protection		
Procedure Number VPAP-2103	Revision Number 2	Effective Date 09/01/91

Revision Summary:

- Added a tab to Attachment 1, table step 1 (b) on page 43 between "(b)" and "Radwaste."
- Revised Attachment 23, item 3 on page 87 to read "Samples from 3 locations: a) 1 sample upstream, b) 1 sample downstream, c) 1sample from cooling lagoon." Delete "Sample off upstream, downstream and cooling lagoon" from the Collection Frequency column.
- Revise Attachment 23, on page 96 to change the Location, Station No., Distance, and Direction of the surface water and aquatic sediment sample points for the Lake Anna (upstream) sample location to change it to "North Anna River, Rt 669 Bridge (Brook's Bridge)", "WNW", and "12.9." This change is to resolve QA Audit 91-03-OBS 08N.

Surry Power Station	North Anna Power Station
Approved by: [signature] SNSOC Chairman, Date [illegible]	Approved by: [signature] SNSOC Chairman, Date 8/16/91
Approved by: [signature] Station Manager, Date 8/16/91	Approved by: [signature] Station Manager, Date 8/16/91

Approved by: RF Saul for, Vice President-Nuclear Operations, Date 8/20/91

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ATTACHMENTS (Continued)

1.0 PURPOSE

The Offsite Dose Calculation Manual (ODCM) establishes the requirements of the Radioactive Effluent and Radiological Environmental Monitoring Programs. Methodology and parameters are provided for calculation of offsite doses resulting from radioactive gaseous and liquid effluents, for gaseous and liquid effluent monitoring alarm/trip setpoints, and for conduct of the Environmental Monitoring Program. Requirements are established for the Annual Radiological Environmental Operating Report and the Semi-Annual Radioactive Effluent Release Report required by Station technical specifications. Calculation of offsite doses due to radioactive liquid and gaseous effluents are performed to assure that:

- Concentration of radioactive liquid effluents to the unrestricted area will be limited to the levels of 10 CFR 20, Appendix B, Table II, column 2 for radionuclides other than dissolved or entrained noble gases
- Exposure to the maximum exposed member of the public in the unrestricted area from radioactive liquid effluents will not result in doses greater than the liquid dose limits of 10 CFR 50, Appendix I
- Dose rate at and beyond the site boundary from radioactive gaseous effluents will be limited to the annual dose rate limits of 10 CFR 20
- Exposure from radioactive gaseous effluents to the maximum exposed member of the public in the unrestricted area will not result in doses greater than the gaseous dose limits of 10 CFR 50, Appendix I, and
- Exposure to the maximum exposed member of the public will not exceed 40 CFR 190 dose limits

2.0 SCOPE

This procedure applies to the Radioactive Effluent and Environmental Monitoring Programs at Surry and North Anna Stations.

3.0 REFERENCES/COMMITMENT DOCUMENTS

3.1 References

3.1.1 10 CFR 20, Standards for Protection Against Radiation

3.1.2 10 CFR 50, Domestic Licensing of Production and Utilization Facilities

3.1.3 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Operations

3.1.4 TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites

3.1.5 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, Rev. 1, U.S. NRC, June 1974

3.1.6 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 50, Appendix I, Rev. 1, U.S. NRC, October 1977

3.1.7 Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Rev. 1, U.S. NRC, July 1977

3.1.8 Surry and North Anna Technical Specifications (Units 1 and 2)

3.1.9 NUREG-0324, XOQDOQ, Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations, U.S. NRC, September 1977

3.1.10 NUREG/CR-1276, Users Manual for the LADTAP II Program, U.S. NRC, May, 1980

3.1.11 NUREG-0597, User's Guide to GASPAR Code, U.S. NRC, June, 1980

3.1.12 Radiological Assessment Branch Technical Position on Environmental Monitoring, November, 1979, Rev. 1

3.1.13 NUREG-0133, Preparation of Radiological Effluent Technical Specifications for Nuclear Power Stations, October, 1978

3.1.14 NUREG-0543, February 1980, Methods for Demonstrating LWR Compliance With the EPA Uranium Fuel Cycle Standard (40 CFR Part 190)

3.1.15 NUREG-0472, Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors, Rev. 3, March 1982

3.1.16 Environmental Measurements Laboratory, DOE HASL 300 Manual

3.1.17 NRC Generic Letter 89-01, Implementation of Programmatic Controls for Radiological Effluent Technical Specifications (RETS) in the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of RETS to the Offsite Dose Calculation Manual or to the Process Control Program

3.1.18 UFSAR (Surry and North Anna)

3.1.19 Nuclear Reactor Environmental Radiation Monitoring Quality Control Manual, IWL-0032-361

3.1.20 VPAP-2802, Notifications and Reports | Rev. 1

3.2 Commitment Documents

3.2.1 Quality Assurance Audit Report Number C 90-22, Management Safety Review Committee, Observation 03C, January 17, 1991 | Rev. 1

3.2.2 Quality Assurance Audit Report Number 91-03, Observation 08N

4.0 DEFINITIONS

Rev. 1

4.1 Channel Calibration

Adjustment, as necessary, of the channel output so it responds with the necessary range and accuracy to known values of the parameter the channel monitors. It encompasses the entire channel including the sensor and alarm and/or trip functions, and includes the Channel Functional Test. The Channel Calibration can be performed by any series of sequential, overlapping or total channel steps so the entire channel is calibrated.

4.2 Channel Check

A qualitative assessment, by observation, of channel behavior during operation. This assessment includes, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrumentation channels measuring the same parameter.

4.3 Channel Functional Test

There are two types of Channel Functional Tests.

4.3.1 Analog Channels

Injection of a simulated signal into a channel as close to the sensor as practicable to verify Operability, including alarm and/or trip functions.

4.3.2 Bistable Channels

Injection of a simulated signal into a sensor to verify Operability, including alarm and/or trip functions.

4.4 Dose Equivalent I-131

That concentration of I-131 (microcurie/gram) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134 and I-135, actually present. Thyroid dose conversion factors used for this calculation are listed in Table III of TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites. Thyroid dose conversion factors from NRC Regulatory Guide 1.109, Revision 1, may be used (**Surry**).

4.5 Frequency Notations

NOTE: Frequencies are allowed a maximum extension of 25 percent.

NOTATION	FREQUENCY
D - Daily	At least once per 24 hours
W - Weekly	At least once per 7 days
M - Monthly	At least once per 31 days
Q - Quarterly	At least once per 92 days
SA - Semi-annually	At least once per 184 days
R - Refueling	At least once per 18 months
S/U - Startup	Prior to each reactor startup
P - Prior to release	Completed prior to each release
N.A. - Not applicable	Not applicable

4.6 Gaseous Radwaste Treatment System

A system that reduces radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and provides delay or holdup to reduce total radioactivity prior to release to the environment. The system comprises the waste gas decay tanks, regenerative heat exchanger, waste gas charcoal filters, process vent blowers, waste gas surge tanks, and waste gas diaphragm compressor (**North Anna**).

4.7 General Nomenclature

χ = Chi: concentration at a point at a given instant (curies per cubic meter)

D = Deposition: quantity of deposited radioactive material per unit area (curies per square meter)

Q = Source strength (instantaneous; grams, curies)

= Emission rate (continuous; grams per second, curies per second)

= Emission rate (continuous line source; grams per second per meter)

4.8 Lower Limit of Detection (LLD)

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. Rev. 1

4.9 Members of the Public

Individuals who, by virtue of their occupational status, have no formal association with the Station. This category includes non-employees of Virginia Power who are permitted to use portions of the site for recreational, occupational, or other purposes not associated with Station functions. This category does not include non-employees such as vending machine servicemen or postmen who, as part of their formal job function, occasionally enter an area that is controlled by Virginia Power for purposes of protection of individuals from exposure to radiation and radioactive materials.

4.10 Operable - Operability

A system, subsystem, train, component or device is operable or has operability when it is capable of performing its specified functions and all necessary, attendant instrumentation, controls, normal and emergency electrical power sources, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its functions are also capable of performing their related support functions.

4.11 Purge - Purging

Controlled discharge of air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, so that replacement air or gas is required to purify the confinement.

4.12 Rated Thermal Power

Total reactor core heat transfer rate to reactor coolant.

- Surry: 2441 Megawatt Thermal (MWt)
- North Anna: 2893 MWt

4.13 Site Boundary

The line beyond which Virginia Power does not own, lease, or otherwise control the land.

4.14 Source Check

A qualitative assessment of channel response when the channel sensor is exposed to radiation. This applies to installed radiation monitoring systems.

4.15 Special Report

A report to the NRC to comply with Subsection 6.2, 6.3, or 6.4 of this procedure. | Rev. 1

4.16 Thermal Power

Total reactor core heat transfer rate to the reactor coolant.

4.17 Unrestricted Area

Any area at or beyond the site boundary where access is not controlled by Virginia Power 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 or recreational purposes.

4.18 Ventilation Exhaust Treatment System

A system that reduces gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and High Efficiency Particulate Adsorber (HEPA) filters to remove iodines and particulates from a gaseous exhaust stream prior to release to the environment (such a system is not considered to have any effect on noble gas effluents). Engineered Safety Feature (ESF) atmospheric cleanup systems are not Ventilation Exhaust Treatment System components.

5.0 RESPONSIBILITIES

5.1 Radiological Protection

Rev. 1

Radiological Protection is responsible for:

5.1.1 Establishing and maintaining procedures for surveying, sampling, and monitoring radioactive effluents and the environment

5.1.2 Surveying, sampling, and analyzing plant effluents and environmental monitoring, and documenting these activities.

5.1.3 Analyzing plant effluent trends and recommending actions to correct adverse trends.

5.1.4 Preparing Effluent and Environmental Monitoring Program records.

5.2 Operations Department

The Operations Department is responsible for requesting samples, analysis, and authorization to release effluents.

6.0 INSTRUCTIONS

NOTE: Meteorological, liquid and gaseous pathway analyses are presented in Attachments 28 and 29, Meteorological, Liquid and Gaseous Pathway Analysis.

6.1 Sampling and Monitoring Criteria

6.1.1 Surveys, sampling, and analyses shall use instruments calibrated for the type and range of radiation monitored and the type of discharge monitored.

6.1.2 Installed monitoring systems shall be calibrated for the type and range of radiation or parameter monitored.

6.1.3 A sufficient number of survey points shall be used or samples taken to adequately assess the status of the discharge monitored.

6.1.4 Samples shall be representative of the volume and type of discharge monitored.

6.1.5 Surveys, sampling, analyses, and monitoring records shall be accurately and legibly documented, and sufficiently detailed so that the meaning and intent of the records are clear.

6.1.6 Surveys, analyses, and monitoring records shall be reviewed for trends, completeness, and accuracy.

6.2 Liquid Radioactive Waste Effluents

6.2.1 Liquid Effluent Concentration Limitations

a. Liquid waste concentrations discharged from the Station shall not exceed the following limits:

1. For radionuclides (other than dissolved or entrained noble gases), liquid effluent concentrations released to unrestricted areas shall not exceed those specified in 10 CFR 20, Appendix B, Table II, Column 2.

2. For dissolved or entrained noble gases, concentrations shall not exceed 2E-4 µCi/ml.

b. If the concentration of liquid effluents exceed above limits in 6.2.1.a, promptly reduce concentrations to within limits.

c. Daily concentrations of radioactive materials in liquid waste released to unrestricted areas shall meet the following:

$$\frac{\text{Volume of Waste Discharged + Volume of Dilution Water}}{\text{Volume of Waste Discharged} \times \sum_i \frac{\mu Ci/ml_i}{MPC_i}} \geq 1 \qquad (1)$$

where:

$\mu Ci/ml_i$ = the concentration of nuclide i in the liquid effluent discharge;

MPC_i = the maximum permissible concentration in unrestricted areas of nuclide, i, expressed as µCi/ml from 10 CFR 20, Appendix B, Table II, for radionuclides other than noble gases, and 2E-4 µCi/ml for dissolved or entrained noble gases

6.2.2 Liquid Monitoring Instrumentation

a. **Radioactive Liquid Effluent Monitoring Instrumentation**

Radioactive liquid effluent monitoring instrumentation channels shown on Attachments 1 and 2, Radioactive Liquid Effluent Monitoring Instrumentation, shall be operable with their alarm/trip setpoints set to ensure that limits of 6.2.1.a are not exceeded.

1. Alarm/trip setpoints of these channels shall be determined and adjusted in accordance with 6.2.2.d, Setpoint Calculation.
2. If a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint is less conservative than required by 6.2.2.a, perform one of the following:

   - Promptly suspend release of radioactive liquid effluents monitored by the affected channel
   - Declare the channel inoperable
   - Change the setpoint to an acceptable, conservative value

b. **Radioactive Liquid Effluent Monitoring Instrumentation Operability**

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated operable by performing a Channel Check, Source Check, Channel Calibration and Channel Functional Test at the frequencies shown in Attachments 3 and 4, Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements.

1. If the number of operable channels is less than the minimum required by the tables in Attachment 1 or 2, perform the action shown in these tables.
2. Attempt to return the instruments to operable status within 30 days. If unsuccessful, explain in the next Semiannual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

c. **Applicable Monitors**

Liquid effluent monitors for which alarm/trip setpoints shall be determined are: Rev. 1

Release Point	Instrument Number		
	North Anna	Surry	
Liquid Radwaste Effluent Line	LW-111	LW-108	
Service Water System Effluent Line	SW-108	SW-107 A,B,C,D	Rev. 1
Condenser Circulating Water Line	SW-130, SW-230	SW-120, SW-220	
Radwaste Facility Effluent Line	N/A	RRM-131	Rev. 1

d. **Setpoint Calculation**

NOTE: This methodology does not preclude use of more conservative setpoints.

1. Maximum setpoint values shall be calculated by:

$$c = \frac{CF}{f} \qquad (2)$$

where:

c = the setpoint, in µCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution;

C = the effluent concentration limit for the monitor used to implement 10 CFR 20 for the Station, in µCi/ml;

f = the flow setpoint as measured at the radiation monitor location, GPM;

F = dilution water flow calculated as:

(Surry) F = f + (200,000 GPM x Number of Circ. Pumps in Service)

(N. Anna) F = f + (218,000 GPM x Number of Circ. Pumps in Service)

2. Each of the condenser circulating water channels (Surry: SW-120, SW-220) (North Anna: SW-130, SW-230) monitors the effluent (service water, including component cooling service water, circulating water, and liquid radwaste) in the circulating water discharge tunnel beyond the last point of possible radioactive material addition. No dilution is assumed for this pathway. Therefore, Equation (2) becomes:

$$c = C \qquad (3)$$

The setpoint for Station monitors used to implement 10 CFR 20 for the site becomes the effluent concentration limit.

3. In addition, for added conservatism, setpoints shall be calculated for the liquid radwaste effluent line (Surry: LW-108, North Anna: LW-111), the service water system effluent line (Surry: SW-107 A, B, C, and D , North Anna: SW-108), and the Radwaste Facility effluent line (Surry: RRM-131). Rev. 1

4. For the liquid radwaste effluent line, Equation (2) becomes:

$$c = \frac{CFK_{LW}}{f} \tag{4}$$

where:

K_{LW} = The fraction of the effluent concentration limit, used to implement 10 CFR 20 for the site, attributable to the liquid radwaste effluent line pathway.

5. For the service water system effluent line, Equation (2) becomes:

$$c = \frac{CFK_{SW}}{f} \tag{6}$$

where:

K_{SW} = The fraction of the effluent concentration limit, used to implement 10 CFR 20 for the Station, attributable to the service water effluent line pathway.

6. For the Radwaste Facility effluent line, Equation (2) becomes:

$$c = \frac{CFK_{RW}}{f} \tag{5}$$

where:

K_{RW} = The fraction of the effluent concentration limit, used to implement 10 CFR 20 attributable to the Radwaste Facility effluent line pathway. Rev. 1

7. The sum $K_{LW} + K_{SW} + K_{RW}$ shall not be greater than 1.0.

6.2.3 Liquid Effluent Dose Limit

a. **Requirement**

At least once per 31 days, perform the dose calculation in 6.2.3.c and 6.2.3.d to ensure the dose or dose commitment to the maximum exposed member of the public from radioactive materials in liquid releases (from each reactor unit) to unrestricted areas is limited to:

1. During any calendar quarter:
   - Less than or equal to 1.5 mrem to the total body
   - Less than or equal to 5 mrem to the critical organ

2. During any calendar year:
   - Less than or equal to 3 mrem to the total body
   - Less than or equal to 10 mrem to the critical organ

b. **Action**

If the calculated dose from release of radioactive materials in liquid effluents exceeds any of the above limits, prepare and submit to the NRC, within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that identifies causes for exceeding limits and defines corrective actions taken to reduce releases of radioactive materials in liquid effluents to ensure that subsequent releases will be in compliance with the above limits. Rev. 1

c. **Surry Dose Contribution Calculations**

NOTE: Thyroid and GI-LLI organ doses must be calculated to determine which is the critical organ for the period being considered.

Dose contributions shall be calculated for all radionuclides identified in liquid effluents released to unrestricted areas based on the equation:

$$D = t\,F\,M \sum_i C_i\,A_i \qquad (6)$$

where:

Subscripts = TB, refers to the total body dose (see Equation (10))
O, refers to the organ dose (see Equation (11)) Rev. 1
i, refers to individual radionuclide

D = the cumulative dose commitment to the total body or critical organ from the liquid effluents for the time period t, in mrem

t = the length of the time period over which C_i and F are averaged for all liquid releases, hours

M = the mixing ratio (reciprocal of the dilution factor) at the point of exposure, dimensionless, 0.2 from Appendix 11A, Surry UFSAR

F = the near field average dilution factor for C_i during any liquid effluent release; the ratio of the average undiluted liquid waste flow during release to the average flow from the site discharge structure to unrestricted areas

C_i = the average concentration of radionuclide, i, in undiluted liquid effluent during time period, t, from all liquid releases, in μCi/ml

A_i = the site related ingestion dose commitment factor to the total body or critical organ of an adult for each identified principal gamma and beta emitter in mrem-ml per hr-µCi. Values for A_i are given in Attachment 5, Liquid Ingestion Pathway Dose Factors For Surry Power Station.

$$A_i = 1.14\text{ E+05 } (21BF_i + 5BI_i)\, DF_i \qquad (7)$$

where:

1.14 E+05 = 1 E+06 pCi/µCi x 1 E+03 ml/kg ÷ 8760 hr/yr, units conversion factor

21 = adult fish consumption, kg/yr, from NUREG-0133

5 = adult invertebrate consumption, Kg/yr, from NUREG-0133

BI_i = the bioaccumulation factor for nuclide, i, in invertebrates, pCi/kg per pCi/l, from Table A-1 of Regulatory Guide 1.109, Rev. 1

BF_i = the bioaccumulation factor for nuclide, i, in fish, pCi/kg per pCi/l, from Table A-1 of Regulatory Guide 1.109, Rev. 1

DF_i = the critical organ dose conversion factor for nuclide, i, for adults, in mrem/pCi, from Table E-11 of Regulatory Guide 1.109, Rev. 1

d. **North Anna Dose Contribution Calculations**

NOTE: Attachment 6, North Anna Liquid Ingestion Pathway Dose Factor Calculation provides the derivation for Equation (8).

Dose contribution shall be calculated for all radionuclides identified in liquid effluents released to unrestricted areas based on:

$$D = \sum_i Q_i \times B_i \qquad (8)$$

Where:

Subscripts = TB, refers to the total body dose (see Equation (10))
O, refers to the organ dose (see Equation (11))
i, refers to individual radionuclide

Rev. 1

D = the cumulative dose commitment to the total body or critical organ from the liquid effluents for the time period t, in mrem

B_i = Dose Commitment Factors (mrem/Ci) for adults. Values for B_i are provided in Attachment 7, North Anna Liquid Ingestion Pathway Dose Commitment Factors for Adults

Q_i = Total released activity for the considered time period and the ith nuclide

$$Q_i = t \times C_i \times \text{Waste Flow} \qquad (9)$$

Where:

t = the length of time over which C_i and F are averaged for all liquid releases, hours

C_i = the average concentration of radionuclide, i, in undiluted liquid effluent during time period, t, from any liquid releases, in µCi/ml

e. **Quarterly Composite Analyses**

For radionuclides not determined in each batch or weekly composite, dose contribution to current monthly or calendar quarter cumulative summation may be approximated by assuming an average monthly concentration based on previous monthly or quarterly composite analyses. However, for reporting purposes calculated dose contribution shall be based on the actual composite analyses.

6.2.4 Liquid Radwaste Treatment

a. **Requirement**

1. The Liquid Radwaste Treatment System and/or the Surry Radwaste Facility Liquid Waste System shall be used to reduce the radioactive materials in liquid waste prior to discharge when projected dose due to liquid effluent, from each reactor unit, to unrestricted areas would exceed 0.06 mrem to total body or 0.2 mrem to the critical organ in a 31-day period. Rev. 1
2. Doses due to liquid releases shall be projected at least once per 31 days.

b. **Action**

If radioactive liquid waste is discharged without treatment and in excess of the above limits, within 30 days, prepare and submit to the NRC, a special report in accordance with VPAP-2802, Notifications and Reports, that includes the following: Rev. 1

1. An explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or sub-system, and the reason for the inoperability.
2. Actions taken to restore inoperable equipment to operable status.
3. Summary description of actions taken to prevent a recurrence.

c. **Projected Total Body Dose Calculation**

1. Determine D_{TB}, the total body dose from liquid effluents in the previous 31-day period, per Equation (6) or (8) (Surry and North Anna, respectively).
2. Estimate R_1, the ratio of the estimated volume of liquid effluent releases in the present 31-day period to the volume released in the previous 31-day period.
3. Estimate F_1, the ratio of the estimated liquid effluent radioactivity in the present 31-day period to liquid effluent activity in the previous 31-day period (µCi/ml).
4. Determine PD_{TB}, the projected total body dose in a 31-day period.

$$PD_{TB} = D_{TB} (R_1 F_1) \quad (10)$$

d. **Projected Critical Organ Dose Calculation**

Historical data pertaining to the volumes and radioactivity of liquid effluents released in connection with specific Station functions, such as maintenance or refueling outages, shall be used in projections as appropriate.

1. Determine D_o, the critical organ dose from liquid effluents in the previous 31-day period, per Equation (6) or (8) (Surry and North Anna, respectively).
2. Estimate R_1 as in 6.2.4.c.2.
3. Estimate F_1 as in 6.2.4.c.3.
4. Determine PD_o = projected critical organ dose in a 31-day period.

$$PD_o = D_o (R_1 F_1) \quad (11)$$

6.2.5 **Liquid Sampling**

Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis requirements shown in Attachments 8 and 9, Radioactive Liquid Waste Sampling and Analysis Program (Surry and North Anna, respectively).

6.3 Gaseous Radioactive Waste Effluents

6.3.1 Gaseous Effluent Dose Rate Limitation

a. **Requirement**

Dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to the following:

1. The dose rate limit for noble gases shall be ≤ 500 mrem/year to the total body and ≤ 3000 mrem/year to the skin.
2. The dose rate limit for I-131, for tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days shall be ≤ 1500 mrem/year to the critical organ.

b. **Action**

1. If dose rates exceed the above limits, promptly decrease the release rate to within the above limits.
2. Dose rates due to noble gases in gaseous effluents shall be determined, continuously, to be within the limits specified in 6.3.1.a.
3. Dose rates due to I-131, tritium, and all radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents shall be determined to be within the above limits by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified on Attachments 10 and 11, Radioactive Gaseous Waste Sampling and Analysis Program.

c. **Calculations of Gaseous Effluent Dose Rates**

1. The dose rate limit for noble gases shall be determined to be within the limit by limiting the release rate to the lessor of:

   - $\sum_i [K_{ivv} \dot{Q}_{ivv} + K_{ipv} \dot{Q}_{ipv}] \leq 500$ mrem/yr to the total body (12)

   or,

   - $\sum_i [(L_{ivv} + 1.1M_{ivv}) \dot{Q}_{ivv} + (L_{ipv} + 1.1M_{ipv}) \dot{Q}_{ipv}] \leq 3000$ mrem/yr to the skin (13)

   where:

   Subscripts = vv, refers to vent releases from the building ventilation vent including Radwaste Facility Ventilation Vent; Rev. 1
   pv, refers to the vent releases from the process vent;
   i, refers to individual radionuclide

   K_{ivv}, K_{ipv} = The total body dose factor for ventilation vents or process vent release due to gamma emissions for each identified noble gas radionuclide, i, in mrem/yr per Curie/sec. Factors are listed in Attachments 12 and 13, Gaseous Effluent Dose Factors (Surry and North Anna, respectively)

   L_{ivv}, L_{ipv} = The skin dose factor for ventilation vents or process vent release due to beta emissions for each identified noble gas radionuclide i, in mrem/yr per Curie/sec. Factors are listed in Attachments 12 and 13

   M_{ivv}, M_{ipv} = The air dose factor for ventilation vents or process vent release due to gamma emissions for each identified noble gas radionuclide, i, in mrad/yr per Curie/sec. Factors are listed in Attachments 12 and 13

   $\dot{Q}_{ivv}, \dot{Q}_{ipv}$ = The release rate for ventilation vents or process vent of noble gas radionuclide, i, in gaseous effluents in Curie/sec (per site)

   1.1 = The unit conversion factor that converts air dose to skin dose, in mrem/mrad

2. The dose rate limit for I-131, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days, shall be determined to be within the limit by restricting the release rate to:

$$\sum_i [P_{ivv} \dot{Q}_{ivv} + P_{ipv} \dot{Q}_{ipv}] \leq 1500 \text{ mrem/yr to the critical organ} \quad (14)$$

where:

P_{ivv}, P_{ipv} = The critical organ dose factor for ventilation vents or process vent for I-131, H-3, and all radionuclides in particulate form with half-lives greater than 8 days for the inhalation pathway, in mrem/yr per Curie/sec. Factors are listed in Attachments 12 and 13

$\dot{Q}_{ivv}$, $\dot{Q}_{ipv}$ = The release rate for ventilation vents or process vent of I-131, H-3, and all radionuclides, i, in particulate form with half-lives greater than 8 days in gaseous effluents in Curie/sec (per site)

3. All gaseous releases, not through the process vent, are considered ground level and shall be included in the determination of Q_{ivv}.

6.3.2 **Gaseous Monitoring Instrumentation**

a. **Requirement**

1. The radioactive gaseous effluent monitoring instrumentation channels shown in Attachment 14 or 15, Radioactive Gaseous Effluent Monitoring Instrumentation, shall be operable with alarm/trip setpoints set to ensure that limits specified for noble gases in 6.3.1.a are not exceeded. Alarm/trip setpoints of these channels shall be determined and adjusted in accordance with 6.3.2.d.
2. Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated operable by Channel Checks, Source Checks, Channel Calibrations, and Channel Functional Tests at the frequencies shown in Attachment 16 or 17, Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements.

b. **Action**

1. If a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint is less conservative than required by 6.2.2.a, promptly:
   - Suspend the release of radioactive gaseous effluents monitored by the affected channel **and** declare the channel inoperable; **or**
   - Change the setpoint so it is acceptably conservative
2. If the number of channels operable is less than the minimum channels required by tables shown in Attachment 14 and 15, take the action shown in those tables.
3. Return instruments to operable status within 30 days. If unsuccessful, explain in the next Semiannual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

c. **Applicable Monitors**

Radioactive gaseous effluent monitors for which alarm/trip setpoints shall be determined are:

Release Point	Instrument Number	
	North Anna	Surry
Process Vent	GW-102, GW-178-1	GW-102, GW-130-1
Condenser Air Ejector	SV-121, SV-221	SV-111, SV-211
Ventilation Vent A	VG-104, VG-179-1	N/A
Ventilation Vent B	VG-113, VG-180-1	N/A
Ventilation Vent No. 1	N/A	VG-104
Ventilation Vent No. 2	N/A	VG-110, VG-131-1
Radwaste Facility Vent	N/A	RRM-101

Rev. 1

d. **Setpoint Calculations**

1. Setpoint calculations for each monitor listed in 6.3.2.c shall maintain this relationship:

$$D \geq D_{pv} + D_{cae} + D_{vv} \quad (15)$$

where:

D = 6.3.1.a dose limits that implement 10 CFR 20 for the Station, mrem/yr

D_{pv} = The noble gas Station boundary dose rate from process vent gaseous effluent releases, mrem/yr

D_{cae} = The noble gas Station boundary dose rate from condenser air ejector gaseous effluent releases, mrem/yr

D_{vv} = The noble gas Station boundary dose rate from:

Surry: Summation of the Ventilation Vents 1, 2, and the Radwaste Facility vent gaseous effluent releases, mrem/yr | Rev. 1

North Anna: Summation of ventilation vent A plus B gaseous effluent releases, mrem/yr

2. Setpoint values shall be determined by:

$$C_m = \frac{R_m \times 2.12\ E\text{-}03}{F_m} \quad (16)$$

where:

m = The release pathway, process vent (pv), ventilation vent (vv) condenser air ejector (cae), or Radwaste Facility (rv) | Rev. 1

C_m = The effluent concentration limit implementing 6.3.1.a for the Station, µCi/ml

R_m = The release rate limit for pathway m determined from methodology in 6.3.1.c, using Xe-133 as nuclide to be released, µCi/sec

2.12E-03 = CFM per ml/sec

F_m = The maximum flow rate for pathway m, CFM

NOTE: According to NUREG-0133, the radioactive effluent radiation monitor alarm/trip setpoints should be based on the radioactive noble gases. It is not practicable to apply instantaneous alarm/trip setpoints to integrating monitors sensitive to radioiodines, radioactive materials in particulate form, and radionuclides other than noble gases.

6.3.3 **Noble Gas Effluent Air Dose Limit**

a. **Requirement**

1. The air dose in unrestricted areas due to noble gases released in gaseous effluents from each unit at or beyond the site boundary shall be limited to:
   - During any calendar quarter: ≤ 5 mrads for gamma radiation and ≤ 10 mrads for beta radiation
   - During any calendar year: ≤ 10 mrads for gamma radiation and ≤ 20 mrads for beta radiation
2. Cumulative dose contributions for noble gases for the current calendar quarter and current calendar year shall be determined in accordance with 6.3.3.c at least once per 31 days.

b. **Action**

If the calculated air dose from radioactive noble gases in gaseous effluents exceeds any of the above limits, prepare and submit to the NRC, within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that identifies the causes for exceeding the limits and defines corrective actions that have been taken to reduce releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the limits in 6.3.3.a. Rev. 1

c. **Noble Gas Effluent Air Dose Calculation**

Gaseous releases, not through the process vent, are considered ground level and shall be included in the determination of Q_{ivv}.

1. The air dose to areas at or beyond the site boundary due to noble gases shall be determined by the following:

For gamma radiation:

$$D_g = 3.17E\text{-}08 \sum_i [M_{ivv} \overline{Q}_{ivv} + M_{ipv} \overline{Q}_{ipv}] \quad (17)$$

For beta radiation:

$$D_b = 3.17E\text{-}08 \sum_i [N_{ivv} \overline{Q}_{ivv} + N_{ipv} \overline{Q}_{ipv}] \quad (18)$$

Where:

Subscripts = vv, refers to vent releases from the building ventilation vents, including the Radwaste Facility Ventilation Vent and air ejectors | Rev. 1
pv, refers to the vent releases from the process vent
i, refers to individual radionuclide

D_g = the air dose for gamma radiation, in mrad

D_b = the air dose for beta radiation, in mrad

M_{ivv}, M_{ipv} = the air dose factors for ventilation vents or process vent release due to gamma emissions for each identified noble gas radionuclide, i, in mrad/yr per Curie/sec. Factors are given in Attachments 12 and 13

N_{ivv}, N_{ipv} = the air dose factor for ventilation vents or process vent release due to beta emissions for each identified noble gas radionuclide, i, in mrad/yr per Curie/sec. Factors are listed in Attachments 12 and 13

$\overline{Q}_{ivv}$, $\overline{Q}_{ipv}$ = the release for ventilation vents or process vent of noble gas radionuclide, i, in gaseous effluents for 31 days, quarter, or year as appropriate in Curies (per site)

6.3.4 I-131, H-3, and Radionuclides In Particulate Form Effluent Dose Limit

a. **Requirement**

1. Methods shall be implemented to ensure that the dose to any organ of a member of the public from I-131, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from the site to unrestricted areas from each reactor unit shall be limited:
   - During any calendar quarter: ≤ 7.5 mrem to the critical organ
   - During any calendar year: ≤ 15 mrem to the critical organ

2. Cumulative dose contributions to a member of the public from I-131, tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released to unrestricted areas for the current calendar quarter and current calendar year shall be determined at least once per 31 days in accordance with 6.3.4.c or 6.3.4.d.

b. **Action**

If the calculated dose from the release of I-131, tritium, and radionuclides in particulate form, with half-lives greater than 8 days, in gaseous effluents exceeds any of the above limits, prepare and submit to the NRC within 30 days, a special report in accordance VPAP-2802, Notifications and Reports, that contains the: | Rev. 1

1. Causes for exceeding limits.
2. Corrective actions taken to reduce releases.
3. Proposed corrective actions to be taken to assure that subsequent releases will be in compliance with limits stated in 6.3.4.a.

c. **Surry Dose Calculations**

Gaseous releases, not through the process vent, are considered ground level and shall be included in the determination of $\tilde{Q}_{ivv}$. Historical data pertaining to the volumes and radioactive concentrations of gaseous effluents released in connection to specific Station functions, such as containment purges, shall be used in the estimates as appropriate. Rev. 1

1. The dose, attributable to gaseous effluents at and beyond the site boundary that contain I-131, tritium, and particulate-form radionuclides with half-lives greater than 8 days, to the maximum exposed member of the public shall be determined by:

$$D_r = 3.17E\text{-}08 \sum_i [(RM_{ivv}\ \tilde{Q}_{ivv} + RM_{ipv}\ \tilde{Q}_{ipv}) + (RI_{ivv}\ \tilde{Q}_{ivv} + RI_{ipv}\ \tilde{Q}_{ipv})] \quad (19)$$

Where:

Subscripts = vv, refers to vent releases from the building ventilation vents, including the Radwaste Facility Ventilation Vent and air ejectors; Rev. 1

pv, refers to the vent releases from the process vent

D_r = the dose to the critical organ of the maximum exposed member of the public in mrem

RM_{ivv}, RM_{ipv} = the milk pathway dose factor for ventilation vents or process vent release due to I-131, tritium, and from all particulate-form radionuclides with half-lives greater than 8 days, in mrem/yr per Curie/sec. Factors are listed in Attachment 18, Critical Organ and Inhalation Dose Factors For Surry

RI_{ivv}, RI_{ipv} = the inhalation pathway dose factor for ventilation vents or process vent release due to I-131, tritium, and from all particulate-form radionuclides with half-lives greater than 8 days, in mrem/yr per Curie/sec. Factors are listed in Attachment 18

$\tilde{Q}_{ivv}$, $\tilde{Q}_{ipv}$ = the release for ventilation vents or process vent of I-131, tritium, and from all particulate-form radionuclides with half-lives greater than 8 days in Curies

3.17 E-08 = the inverse of the number of seconds in a year

d. **North Anna Dose Calculations**

Gaseous releases, not through process vent, are considered ground level and shall be included in the determination of $\tilde{Q}_{ivv}$. Historical data pertaining to the volumes and radioactive concentrations of gaseous effluents released in connection to specific Station functions, such as containment p ges, shall be used in the estimates as appropriate. Rev. 1

1. The dose, attributable to gaseous effluents at and beyond the site boundary that contain I-131, tritium, and particulate-form radionuclides with half-lives greater than 8 days, to the maximum exposed member of the public shall be determined by:

$$D_r = 3.17E\text{-}08 \sum_i [R_{ivv} \tilde{Q}_{ivv} + R_{ipv} \tilde{Q}_{ipv}] \quad (20)$$

Where:

Subscripts = vv, refers to vent releases from the building ventilation vent; pv, refers to the vent releases from the process vent

D_r = the dose to the critical organ of the maximum exposed member of the public in mrem

R_{ivv}, R_{ipv} = the dose factor for ventilation vent or process vent release due to I-131, tritium, and from all particulate-form radionuclides with half-lives greater than 8 days, in mrem/yr per Curie/sec. Factors are listed in Attachment 19, Critical Organ and Inhalation Dose Factors for North Anna

$\tilde{Q}_{ivv}$, $\tilde{Q}_{ipv}$ = the release for ventilation vent or process vent of I-131, tritium, and from all particulate-form radionuclides with half-lives greater than 8 days in Curies Rev. 1

3.17 E-08 = the inverse of the number of seconds in a year

6.3.5 Gaseous Radwaste Treatment

Historical data pertaining to the volumes and radioactive concentrations of gaseous effluents released in connection to specific Station functions, such as containment purges, shall be used in projected doses, as appropriate.

a. **Requirement**

1. The Gaseous Radwaste Treatment System and the Ventilation Exhaust Treatment System shall be used to reduce radioactive material in gaseous waste prior to its discharge when projected gaseous effluent air doses due to gaseous effluent releases, from each unit to areas at and beyond the site boundary, would exceed 0.2 mrad for gamma radiation and 0.4 mrad for beta radiation averaged over 31 days. (**North Anna**) Rev. 1
2. The appropriate portions of the Gaseous Radwaste Treatment System shall be used to reduce radioactive materials in the gaseous waste prior to their discharge when the projected gaseous effluent air doses due to gaseous effluent releases, from each unit to areas at and beyond the site boundary, would exceed 0.2 mrad for gamma radiation and 0.4 mrad for beta radiation averaged over 31 days. (**Surry**)
3. The Ventilation Exhaust Treatment System shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the projected doses due to gaseous effluent releases, from each unit to areas at and beyond the site boundary, would exceed 0.3 mrem to the critical organ averaged over 31 days.
4. Doses due to gaseous releases from the site shall be projected at least once per 31 days based on the calculations in 6.3.5.c, d, and e.

b. **Action**

If gaseous waste that exceeds of the limits in 6.3.5.a is discharged without treatment, prepare and submit to the NRC within 30 days, a special report in accordance with VPAP-2802, Notifications and Reports, that includes: Rev. 1

1. An explanation why gaseous radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability.
2. Actions taken to restore the inoperable equipment to operable status.
3. Summary description of actions taken to prevent recurrence.

c. **Projected Gamma Dose**

1. Determine D_g, the 31-day gamma air dose in the previous 31-day period, per Equation (17).
2. Estimate R_g, the ratio of the estimated volume of gaseous effluent in the present 31-day period to the volume released during the previous 31-day period.
3. Estimate F_g, the ratio of the estimated noble gas effluent activity in the present 31-day period to the noble gas effluent activity during the previous 31-day period (μCi/ml).
4. Determine PD_g, the projected 31-day gamma air dose.

$$PD_g = D_g (R_g \times F_g) \tag{21}$$

d. **Projected Beta Dose**

1. Determine D_b, the 31-day beta air dose in the previous 31 days, per Equation (18).
2. Estimate R_g and F_g as in 6.3.5.c.2 and 3.
3. Determine PD_b, the projected 31 day beta air dose.

$$PD_b = D_b (R_g \times F_g) \tag{22}$$

e. **Projected Maximum Exposed Member of the Public Dose**

1. Determine D_{max}, the 31-day maximum exposed member of the public dose in the previous 31-day period, per Equation (19) or (20), where $D_r = D_{max}$.
2. Estimate F_i, the ratio of the estimated activity from I-131, radioactive materials in particulate form with half-lives greater than 8 days, and tritium in the present 31-day period to the activity of I-131, radioactive materials in particulate form with half-lives greater than 8 days, and tritium in the previous 31-day period (μC/ml).
3. Determine PD_{max}, the projected 31-day maximum exposed member of the public dose.

$$PD_{max} = D_{max} (R_g \times F_i) \tag{23}$$

6.4 Total Dose Limit to Public From Uranium Fuel Cycle Sources

6.4.1 Requirement

The annual (calender year) dose or dose commitment to the maximum exposed member of the public due to releases of radioactivity and radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrems to the total body or the critical organ (except the thyroid, which shall be limited to less than or equal to 75 mrems).

6.4.2 Action

a. If the calculated doses from release of radioactive materials in liquid or gaseous effluents exceed twice the limits in 6.2.3.a, 6.3.3.a, or 6.3.4.a, calculate, including direct radiation contribution from the units and from outside storage tanks, whether limits in 6.4.1 have been exceeded.

b. If the limits in 6.4.1 have been exceeded, prepare and submit to the NRC within 30 days a special report in accordance with VPAP-2802, Notifications and Reports, that defines the corrective action to be taken to reduce subsequent releases and to prevent recurrence, and includes a schedule for achieving conformance with the limits. Special reports, as defined in 10 CFR 20.405c, shall include: Rev. 1

1. An analysis that estimates the radiation exposure (dose) to the maximum exposed member of the public from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the releases covered by the report.
2. A description of the levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations.
3. If the estimated dose exceeds the limits in 6.4.1, and if the release condition that violates of 40 CFR 190 has not already been corrected, the special report shall include a request for a variance in accordance with the provisions of 40 CFR 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

6.5 Radiological Environmental Monitoring

6.5.1 Monitoring Program

a. **Requirement**

1. The Radiological Environmental Monitoring Program shall be conducted as specified in Attachments 20 or 21, Radiological Environmental Monitoring Program.
2. Samples shall be collected from specific locations specified in Attachment 22 or 23, Environmental Sample Locations.
3. Samples shall be analyzed in accordance with:
   - Attachment 20 or 21 requirements
   - Detection capabilities required by Attachment 24 or 25, Detection Capabilities for Environmental Sample Analysis
   - Guidance of the Radiological Assessment Branch Technical Position on Environmental Monitoring dated November, 1979, Revision No. 1

b. **Action**

1. If the Radiological Environmental Monitoring Program is not being conducted as required in 6.5.1.a, prepare and submit to the NRC, in the Annual Radiological Environmental Operating Report required by Technical Specification (Surry T.S. 6.6.B.2 and North Anna T.S. 6.9.1.8), a description of the reasons for not conducting the program as required, and the plan for precluding recurrence.
2. If, when averaged over any calendar quarter, radioactivity exceeds the reporting levels of Attachment 26 or 27, Reporting Levels for Radioactivity Concentrations in Environmental Samples, prepare and submit to the NRC within 30 days a special report that:
   - Identifies the causes for exceeding the limits, and
   - Defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a member of the public is less than the calendar year limits of 6.2.3, 6.3.3, and 6.3.4

When more than one of the radionuclides listed in Attachment 26 or 27 are detected in the sampling medium, the report shall be submitted if:

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

3. When radionuclides other than those listed in Attachment 26 and 27 are detected and are the result of plant effluents, the report shall be submitted if the potential annual dose to a member of the public is equal to or greater than the calendar year limits of 6.2.3, 6.3.3, and 6.3.4. The 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.
4. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Attachment 20 or 21, identify locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Identify the cause of the unavailability of samples and identify the new locations for obtaining replacement samples in the next Semiannual Radioactive Effluent Release Report. Include in the report a revised figure and table for the ODCM to reflect the new locations.

6.5.2 Land Use Census

a. **Requirement**

A land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the following:

- Nearest milk animal
- Nearest residence
- Nearest garden greater than 50 m^2 (500 ft^2) that produces broad leaf vegetation

1. The land use census shall be conducted during the growing season at least once per 12 months using information which will provide the best results (e.g., door-to-door survey, aerial survey, local agriculture authorities). Land use census results shall be included in the Annual Radiological Environmental Operating Report.

2. Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the site boundary in each of two different direction sectors with the highest predicted deposition source strength (D/Qs) in lieu of the garden census. Specifications for broad leaf vegetation sampling given in Attachment 20 or 21 shall be followed, including analysis of control samples. Rev. 1

b. **Action**

1. If a land use census identifies locations that yield a calculated dose or dose commitment greater than the values currently being calculated in 6.3.4.a.2, identify the new locations in the next Semiannual Radioactive Effluent Release Report.
2. If a land use census identifies locations that yield a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained, add the new locations to the Radiological Environmental Monitoring Program within 30 days. Sampling locations, excluding the control station location, having the lowest calculated dose or dose commitments (via the same exposure pathway) may be deleted from the monitoring program after October 31 of the year in which this land use census was conducted. Identify new locations in the next Semiannual Radioactive Effluent Release Report and include in the report revised figures and tables reflecting the new locations.

6.5.3 Interlaboratory Comparison Program

a. **Requirement**

Radioactive materials (which contain nuclides produced at the Stations) supplied as part of an Interlaboratory Comparison Program that has been approved by the NRC shall be analyzed.

b. **Action**

1. Analyses shall be performed as part of the Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparison Studies (Cross Check) Program and include:

Program	Cross-Check Of:
Milk	I-131, Gamma, K, Sr-89 and Sr-90
Water	Gross Beta, Gamma, I-131, H-3 (Tritium), Sr-89 and Sr-90 (Blind - any combinations of above radionuclides)
Air Filter	Gross Beta, Gamma, Sr-90

2. If analyses are not performed as required by 6.5.3.b, report the corrective actions taken to prevent a recurrence to the NRC in the Annual Radiological Environmental Operating Report.

c. **Methodology and Results**

1. Methodology and results of the cross-check program shall be maintained in the contractor-supplied Nuclear Reactor Environmental Radiation Monitoring Quality Control Manual, IWL-0032-361.
2. Results shall be reported in the Annual Radiological Environmental Monitoring Report.

6.6 Reporting Requirements

6.6.1 Annual Radiological Environmental Operating Report

Routine Radiological Environmental Operating Reports covering the operation of the units during the previous calendar year shall be submitted prior to May 1 of each year. A single submittal may be made for the Station. Radiological Environmental Operating Reports shall include:

a. Summaries, interpretations, and analysis of trends of results of radiological environmental surveillance activities for the report period, including:

- A comparison (as appropriate) with preoperational studies, operational controls, and previous environmental surveillance reports
- An assessment of the observed impacts of the plant operation on the environment
- Results of land use census per 6.5.2

b. Results of analysis of radiological environmental samples and of environmental radiation measurements taken per 6.5.1, Monitoring Program. Results shall be summarized and tabulated in the format of the table in the Radiological Assessment Branch Technical Position on Environmental Monitoring. Rev. 1

1. If some individual results are not available for inclusion with the report, the report shall be submitted, noting and explaining reasons for missing results.
2. Missing data shall be submitted in a supplementary report as soon as possible.

c. A summary description of the radiological environmental monitoring program.

d. At least two legible maps covering sampling locations, keyed to a table giving distances and directions from the centerline of one reactor. One map shall cover stations near the site boundary; a second shall include more distant stations.

e. Results of Station participation in the Interlaboratory Comparison Program, per 6.5.3.

f. Discussion of deviations from the Station's environmental sampling schedule per Attachment 20 or 21.

g. Discussion of analyses in which the lower limit of detection (LLD) required by Attachment 24 or 25 was not achievable.

6.6.2 **Semiannual Radioactive Effluent Release Report**

a. **Requirement**

Radioactive Effluent Release Reports covering operation of the units during the previous 6 months of operation shall be submitted within 60 days after January 1 and July 1 of each year. A single submittal may be made for the Station and should combine those sections that are common to both units. Radioactive Effluent Release Reports shall include:

1. A summary of quantities of radioactive liquid and gaseous effluents and solid waste released. Data shall be summarized on a quarterly basis following the format of Regulatory Guide 1.21, Appendix B.
2. An assessment of radiation doses to the maximum exposed members of the public due to the radioactive liquid and gaseous effluents released from the Station during the previous calendar year. This assessment shall be in accordance with 6.6.2.b and shall be included only in Radioactive Effluent Release Reports submitted within 60 days after January 1 of each year.
3. A list of unplanned releases from the site to unrestricted areas, during the reporting period, that exceeded the limits in 6.2.1 and 6.3.1.
4. Major changes to radioactive liquid, gaseous, and solid waste treatment systems during the reporting period.
5. Changes to VPAP-2103, Offsite Dose Calculation Manual (see 6.6.4).
6. A listing of new locations for dose calculations or environmental monitoring identified by the land use census (see 6.5.2).

b. **Dose Assessment**

1. Radiation dose to individuals due to radioactive liquid and gaseous effluents from the Station during the previous calendar year shall either be calculated in accordance with this procedure or in accordance with Regulatory Guide 1.109. Population doses shall not be included in dose assessments.

2. The dose to the maximum exposed member of the public due to radioactive liquid and gaseous effluents from the Station shal. oe incorporated with the dose assessment performed above. If the dose to the maximum exposed member of the public exceeds twice the limits of 6.2.3.a.1, 6.2.3.a.2, 6.3.3.a.1, or 6.3.4.a.1, the dose assessment shall include the contribution from direct radiation.

NOTE: NUREG-0543 states, "There is reasonable assurance that sites with up to four operating reactors that have releases within Appendix I design objective values are also in conformance with the EPA Uranium Fuel Cycle Standard, 40 CFR Part 190."

3. Meteorological conditions during the previous calendar year or historical annual average atmospheric dispersi n conditions shall be used for determining gaseous pathway doses.

6.6.3 Annual Meteorological Data

a. Meteorological data collected over the previous year shall be in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.

b. Meteorological data shall be retained in a file on site and shall be made available to the NRC upon request.

6.6.4 Changes to the ODCM

Changes to the ODCM shall be:

a. Reviewed and approved by Station Nuclear Safety and Operating Committee (SNSOC) and Station Manager prior to implementation. Rev. 1

b. Documented. Records of reviews shall be retained as Station records. Documentation shall include:

1. Sufficient information to support changes, together with appropriate analyses or evaluations justifying changes.

2. A determination that a change will not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations, and will maintain the level of radioactive effluent control required by:
   - 10 CFR 20.106
   - 40 CFR 190
   - 10 CFR 50.36a
   - 10 CFR 50, Appendix I

c. Submitted to the NRC in the form of a complete, legible copy of the entire ODCM as a part of, or concurrent with the Semiannual Radioactive Effluent Release Report for the period of the report in which any change was made. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.

d. Submitted to the Management Safety Review Committee (MSRC) Coordinator. **[Commitment 3.2.1]** Rev. 1

7.0 RECORDS

7.1 The following individual and packaged documents and copies of any related correspondence completed as a result of the performance or implementation of this procedure are records. They shall be submitted to Records Management in accordance with VPAP-1701, Records Management. Prior to transmittal to Records Management, the sender shall assure that:

- Each record is packaged when applicable,
- QA program requirements have been fulfilled for Quality Assurance records,
- Each record is legible, completely filled out, and adequately identifiable to the item or activity involved,
- Each record is stamped, initialed, signed, or otherwise authenticated and dated, as required by this procedure.

7.1.1 Individual Records

None Rev. 1

7.1.2 Record Packages

- Records of changes to the ODCM in accordance with 6.6.4
- Records of meteorological data in accordance with 6.6.3
- Records of sampling and analyses
- Records of radioactive materials and other effluents released to the environment
- Records of maintenance, surveillances, and calibrations

7.2 The following documents completed as a result of the implementation of this procedure are not records and are not required to be transmitted to Records Management.

None

ATTACHMENT 1

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SURRY RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM OPERABLE CHANNELS	ACTION	
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE			
(a) Liquid Radwaste Effluent Line	1	1	
(b) Radwaste Facility Liquid Effluent Line	1	1	Rev. 2 Rev. 1
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE			
(a) Circulating Water Discharge Line	1	2	
(b) Component Cooling Service Water Effluent Line	4	2	Rev. 1
3. FLOW RATE MEASUREMENT DEVICES			
(a) Liquid Radwaste Effluent Line	1	3	
(b) Radwaste Facility Liquid Effluent Line	1	3	Rev. 1

ACTION 1: If the number of operable channels is less than required, effluent releases shall be suspended.

ACTION 2: If the number of operable channels is less than required, effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for principal gamma emitters, as defined in Attachment 8, Surry Radioactive Liquid Waste Sampling and Analysis Program.

ACTION 3: If the number of operable channels is less than required, effluent releases via this pathway shall be suspended.

ATTACHMENT 2

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NORTH ANNA RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM OPERABLE CHANNELS	ACTION
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE		
Liquid Radwaste Effluent Line	1	1
2. GROSS BETA OR GAMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE		
(a) Service Water System Effluent Line	1	1
(b) Circulating Water System Effluent Line	1	4
3. FLOW RATE MEASUREMENT DEVICES		
Liquid Radwaste Effluent Line	1	2
4. CONTINUOUS COMPOSITE SAMPLERS AND SAMPLER FLOW MONITOR		
Clarifier Effluent Line	1	1
5. TANK LEVEL INDICATING DEVICES (Note 1)		
(a) Refueling Water Storage Tanks	1	3
(b) Casing Cooling Storage Tanks	1	3
(c) PG Water Storage Tanks (Note 2)	1	3
(d) Boron Recovery Test Tanks (Note 2)	1	3

ATTACHMENT 2

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NORTH ANNA RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

ACTION 1: If the number of operable channels is less than required, effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for gross radioactivity (beta or gamma) at a lower limit of detection of at least 1×10^{-7} μCi/g or an isotopic radioactivity at a lower limit of detection of at least 5×10^{-7} μCi/g.

ACTION 2: If the number of operable channels is less than required, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Design capacity performance curves generated in situ may be used to estimate flow.

ACTION 3: If the number of operable channels is less than required, liquid additions to this tank may continue provided the tank liquid level is estimated during all liquid additions to the tank.

ACTION 4: If the number of operable channels is less than required, make repairs as soon as possible. Grab samples cannot be obtained via this pathway.

NOTE 1: Tanks included in this requirement are those outdoor tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system.

NOTE 2: This is a shared system with Unit 2.

ATTACHMENT 3

(Page 1 of 1)

SURRY RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

CHANNEL DESCRIPTION	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
(a) Liquid Radwaste Effluent Line	D	PR	R	Q
(b) Radwaste Facility Liquid Effluent Line	D	PR	R	Q
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE				
(a) Circulating Water Discharge Line	D	M	R	Q
(b) Component Cooling Service Water System Effluent Line	D	M	R	Q
3. FLOW RATE MEASUREMENT DEVICES				
(a) Liquid Radwaste Effluent Line	D	N.A.	R	N.A.
(b) Radwaste Facility Liquid Effluent Line	D	N.A.	R	N.A

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ATTACHMENT 4

(Page 1 of 2)

NORTH ANNA RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

CHANNEL DESCRIPTION	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
Liquid Radwaste Effluent Line	D	D	R	Q (Note 1)
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE				
(a) Service Water System Effluent Line	D	M	R	Q (Note 2)
(b) Circulating Water System Effluent Line	D	M	R	Q (Note 2)
3. FLOW RATE MEASUREMENT DEVICES				
Liquid Radwaste Effluent Line	D (Note 3)	N.A.	R	Q
4. CONTINUOUS COMPOSITE SAMPLERS AND SAMPLER FLOW MONITOR				
Clarifier Effluent Line	N.A.	N.A.	R	N.A.
5. TANK LEVEL INDICATING DEVICES (Note 6)				
(a) Refueling Water Storage Tank	D (Note 4)	N.A.	R	Q
(b) Casing Cooling Storage Tank	D (Note 4)	N.A.	R	Q
(c) PG Water Storage Tanks (Note 5)	D (Note 4	N.A.	R	Q
(d) Boron Recovery Test Tanks (Note 5)	D (Note 4)	N.A.	R	Q

ATTACHMENT 4

(Page 2 of 2)

NORTH ANNA RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

NOTE 1: The Channel Functional Test shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

a. Instrument indicates measured levels above the alarm/trip setpoint.

b. Instrument controls not set in operate mode.

NOTE 2: The Channel Functional Test shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the alarm/trip setpoint.

b. Instrument cor[illegible]ls not set in operate mode.

NOTE 3: Channel Check sha[illegible]onsist of verifying indication of flow during periods of release. Channel Check sha[illegible]e make at least once per 24 hours on days on which continuous, periodic, or batch [illegible]ases are made.

NOTE 4: During liquid additions to the tank.

NOTE 5: This is a shared system with Unit 2.

NOTE 6: Tanks included in this requirement are those outdoor tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system.

ATTACHMENT 5

(Page 1 of 1)

LIQUID INGESTION PATHWAY DOSE FACTORS FOR SURRY STATION UNITS 1 AND 2

Radionuclide	Total Body A_i $\frac{mrem/hr}{\mu Ci/ml}$	Thyroid A_i $\frac{mrem/hr}{\mu Ci/ml}$	GI-LLI A_i $\frac{mrem/hr}{\mu Ci/ml}$
H-3	2.82E-01	2.82E-01	2.82E-01
Na-24	4.57E-01	4.57E-01	4.57E-01
Cr-51	5.58E+00	3.34E-01	1.40E+03
Mn-54	1.35E+03	-	2.16E+04
Fe-55	8.23E+03	-	2.03E+04
Fe-59	7.27E+04	-	6.32E+05
Co-58	1.35E+03	-	1.22E+04
Co-60	3.82E+03	-	3.25E+04
Zn-65	2.32E+05	-	3.23E+05
Rb-86	2.91E+02	-	1.23E+02
Sr-89	1.43E+02	-	8.00E+02
Sr-90	3.01E+04	-	3.55E+03
Y-91	2.37E+00	-	4.89E+04
Zr-95	3.46E+00	-	1.62E+04
Zr-97	8.13E-02	-	5.51E+04
Nb-95	1.34E+02	-	1.51E+06
Mo-99	2.43E+01	-	2.96E+02
Ru-103	4.60E+01	-	1.25E+04
Ru-106	2.01E+02	-	1.03E+05
Ag-110m	8.60E+02	-	5.97E+05
Sb-124	1.09E+02	6.70E-01	7.84E+03
Sb-125	4.20E+01	1.79E-01	1.94E+03
Te-125m	2.91E+01	6.52E+01	8.66E+02
Te-127m	6.68E+01	1.40E+02	1.84E+03
Te-129m	1.47E+02	3.20E+02	4.69E+03
Te-131m	5.71E+01	1.08E+02	6.80E+03
Te-132	1.24E+02	1.46E+02	6.24E+03
I-131	1.79E+02	1.02E+05	8.23E+01
I-132	9.96E+00	9.96E+02	5.35E+00
I-133	3.95E+01	1.90E+04	1.16E+02
I-134	5.40E+00	2.62E+02	1.32E-02
I-135	2.24E+01	4.01E+03	6.87E+01
Cs-134	1.33E+04	-	2.85E+02
Cs-136	2.04E+03	-	3.21E+02
Cs-137	7.85E+03	-	2.32E+02
Cs-138	5.94E+00	-	5.12E-05
Ba-140	1.08E+02	-	3.38E+03
La-140	2.10E-01	-	5.83E+04
Ce-141	2.63E-01	-	8.86E+03
Ce-143	4.94E-02	-	1.67E+04
Ce-144	9.59E+00	-	6.04E+04
Np-239	1.91E-03	-	7.11E+02

ATTACHMENT 6

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NORTH ANNA LIQUID INGESTION PATHWAY DOSE FACTOR CALCULATION UNITS 1 AND 2

1.0 EQUATION (6)

$$D = t F \sum_i f_i C_i A_i$$

where:

D = cumulative dose commitment to the total body or critical organ, from the liquid effluents for the time period t, in mrem

t = length of time period over which C_i and F are averaged for all liquid releases, hours

F = the near field average dilution factor for C_i during any liquid effluent release. Defined as the ratio of the average undiluted liquid waste flow during release to the average flow from the Station discharge structure to unrestricted areas

f_i = the individual dilution multiplication factor to account for increases in concentration of long-lived nuclides due to recirculation, listed on page 4 of 4 of this attachment. "f_i" is the ratio of the total dilution flow over the effective dilution flow

C_i = average concentration of radionuclide, i, in undiluted liquid effluent during time period, t, from any liquid releases, in µCi/ml

A_i = the site related ingestion dose commitment factor to the total body or critical organ of an adult for each identified principal gamma and beta emitter listed on page 4 of 4 of this attachment, in mrem-ml per hr-µCi

$$A_i = 1.14\ E{+}05\ (730/D_w\ +\ 21BF_i/D_a)\ DF_i$$

where:

1.14 E+05 = 1 E+06 pCi/µCi x 1 E+03 ml/kg ÷ 8760 hr/yr, units conversion factor

730 = adult water consumption, kg/yr, from NUREG-0133

ATTACHMENT 6

(Page 2 of 4)

NORTH ANNA LIQUID INGESTION PATHWAY DOSE FACTOR CALCULATION UNITS 1 AND 2

D_w = dilution factor from the near field area within one-quarter mile of the release point to the potable water intake for the adult water consumption. Dw includes the dilution contributions from the North Anna Dam to Doswell (0.73), the Waste Heat Treatment Facility (C_c/C_L), and Lake Anna (C_L/C_R). The potable water mixing ratio is calculated as:

$$1 / (C_c / C_L) (C_L / C_R \times 0.73) = C_R / (C_c \times 0.73)$$

where C_c / C_L and C_R are the respective concentrations for the considered nuclide in the Discharge Channel, Waste Heat Treatment Facility (Lagoon) and the Reservoir. Calculation is per expressions 11.2-5, 11.2-6, and 11.2-8 of the North Anna UFSAR

BF_i = the bioaccumulation factor for nuclide, i, in fish, pCi/kg per pCi/l, from Table A-1 of Regulatory Guide 1.109, Rev. 1

D_a = dilution factor for the fish pathway, calculated as C_L /C_c where C_L and C_c are the concentrations for the considered nuclide in the Discharge Channel and the Waste Heat Treatment Facility (Lagoon). Calculation is per Expressions 11.2-5, and 1'.2-6 of North Anna's UFSAR

DF_i = the critical organ dose conversion factor for nuclide, i, for adults, in mrem/pCi, from Table E-11 of Regulatory Guide 1.109, Rev. 1

ATTACHMENT 6

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NORTH ANNA LIQUID INGESTION PATHWAY DOSE FACTOR CALCULATION UNITS 1 AND 2

2.0 EQUATION (8)

Equation (6) is simplified for actual dose calculations by introducing:

$$F = \frac{\text{WASTE FLOW}}{\text{CIRC.(WATER) FLOW + WASTE FLOW}} = \frac{\text{WASTE FLOW}}{\text{CIRC. FLOW}}$$

and

$$f_i = \frac{\text{CIRC. FLOW}}{\text{EFFECTIVE DIL. FLOW}_i}$$

Effective dilution flow rates for individual nuclides "i" are listed on Attachment 7, North Anna Liquid Pathway Dose Commitment Factors for Adults. Then the total released activity (Q_i) for the considered time period and the ith nuclide is written as:

$$Q_i = t \times C_i \times \text{WASTE FLOW}$$

and Equation (6) reduces to:

$$D = \sum_i Q_i \frac{A_i}{\text{EFF. DIL. FLOW}_i}$$

For the long lived, dose controlling nuclides the effective dilution flow is essentially the over (dam) flow rate out of the North Anna Lake system (i.e., the liquid pathway dose is practically independent from the circulating water flow rate. However, to accurately assess long range average effects of reduced circulating water flow rates during outages or periods of low lake water temperatures, calculations are based on an average of 7 out of 8 circulating water pumps running at 218,000 gpm = 485.6 cft/sec per pump.

By defining $B_i = A_i / \text{EFF. DIL. FLOW}_i$, the dose calculation is reduced to a two factor formula:

$$D = \sum_i Q_i \times B_i$$

Values for B_i (mrem/Ci) and EFF. DIL. FLOW_i are listed in Attachment 7.

ATTACHMENT 6

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NORTH ANNA LIQUID INGESTION PATHWAY DOSE FACTOR CALCULATION UNITS 1 AND 2

Radionuclide	Individual Dilution Multiplication Factor (f_i)	Total Body A_i $\frac{mrem/hr}{\mu Ci/ml}$	Critical Organ A_i $\frac{mrem/hr}{\mu Ci/ml}$
H-3	14.9	6.18E+00	6.18E+00
Na-24	1.0	3.71E+01	3.71E+01
Cr-51	1.7	1.10E+00	-
Mn-54	7.0	8.62E+02	4.52E+03
Fe-55	11.3	1.30E+02	5.56E+02
Fe-59	2.2	9.47E+02	2.47E+03
Co-58	2.8	2.49E+02	1.11E+02
Co-60	13.3	8.27E+02	3.75E+02
Zn-65	6.1	3.28E+04	7.25E+04
Rb-86	1.5	3.53E+04	7.59E+04
Sr-89	2.3	8.70E+02	-
Sr-90	15.8	2.39E+05	-
Y-91	2.5	3.42E-01	-
Zr-95	2.7	2.98E-01	-
Zr-97	1.0	1.50E-04	3.27E-04
Nb-95	1.0	4.87E+01	9.07E+01
Mo-99	1.0	7.48E+00	3.93E+01
Ru-103	2.0	4.10E+00	-
Ru-106	7.6	2.65E+01	-
Ag-110m	6.2	4.94E+00	8.32E+00
Sb-124	2.6	4.37E+01	2.08E+00
Sb-125	11.4	2.46E+01	1.16E+00
Te-125m	2.5	3.23E+02	8.73E+02
Te-127m	3.7	7.82E+02	2.29E+03
Te-129m	1.9	1.52E+03	3.58E+03
Te-131m	1.0	1.12E+02	1.35E+02
Te-132	1.0	5.04E+02	5.37E+02
I-131	1.2	9.66E+01	1.69E+02
I-132	1.0	1.03E-01	2.95E-01
I-133	1.0	3.47E+00	1.14E+01
I-134	1.0	2.15E-02	6.00E-02
I-135	1.0	6.58E-01	1.78E+00
Cs-134	10.3	5.80E+05	7.09E+05
Cs-136	1.3	6.01E+04	8.35E+04
Cs-137	15.8	3.45E+05	5.26E+05
Cs-138	1.0	9.18E-01	1.85E+00
Ba-140	1.3	2.65E+01	5.08E-01
La-140	1.0	4.47E-03	1.69E-02
Ce-141	1.8	2.14E-02	1.89E-01
Ce-143	1.0	1.35E-04	1.22E+00
Ce-144	6.6	1.41E+00	1.10E+01
Np-239	1.0	5.13E-04	9.31E-04

ATTACHMENT 7

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NAPS LIQUID PATHWAY DOSE COMMITMENT FACTORS FOR ADULTS

(B_i = A_i Fi/CIRC FLOW = A_i/Effluent Dilution $Flow_i$)

Radionuclide	Effective Dilution Flow (cft/sec)	Total Body B_i (mrem/Ci)	Critical Organ B_i (mrem/Ci)
H-3	2.28E+02	2.66E-04	2.66E-04
Na-24	3.39E+03	1.07E-04	1.07E-04
Cr-51	1.99E+03	5.44E-06	N/A
Mn-54	4.88E+02	1.73E-02	9.08E-02
Fe-55	3.01E+02	4.23E-03	1.81E-02
Fe-59	1.57E+03	5.93E-03	1.55E-02
Co-58	1.20E+03	2.04E-03	9.10E-04
Co-60	2.55E+02	3.18E-02	1.44E-02
Zn-65	5.60E+02	5.74E-01	1.27E+00
Rb-86	2.34E+03	1.48E-01	3.18E-01
Sr-89	1.46E+03	5.84E-03	N/A
Sr-90	2.16E+02	1.09E+01	N/A
Y-91	1.34E+03	2.50E-06	N/A
Zr-95	1.27E+03	2.30E-06	1.31E-06
Zr-97	3.39E+03	4.33E-10	9.46E-10
Nb-95	3.25E+03	1.47E-04	2.74E-04
Mo-99	3.30E+03	2.22E-05	1.17E-04
Ru-103	1.68E+03	2.40E-05	N/A
Ru-106	4.48E+02	5.80E-04	N/A
Ag-110m	5.52E+02	8.78E-05	1.48E-04
Sb-124	1.32E+03	3.25E-04	1.55E-05
Sb-125	2.98E+02	8.10E-04	3.80E-05
Te-125m	1.35E+03	2.35E-03	6.35E-03
Te-127m	9.16E+02	8.37E-03	2.46E-02
Te-129m	1.82E+03	8.19E-03	1.93E-02
Te-131m	3.38E+03	3.27E-04	3.92E-04
Te-132	3.27E+03	1.51E-03	1.61E-03
I-131	2.94E+03	3.22E-04	5.62E-04
I-132	3.40E+03	2.98E-07	8.51E-07
I-133	3.39E+03	1.00E-05	3.2[illegible]E-05
I-134	3.40E+03	6.19E-08	1.73E-07
I-135	3.40E+03	1.90E-06	5.15E-06
Cs-134	3.29E+02	1.73E+01	2.11E+01
Cs-136	2.62E+03	2.25E-01	3.12E-01
Cs-137	2.15E+02	1.57E+01	2.40E+01
Cs-138	3.40E+03	2.65E-06	5.34E-06
Ba-140	2.65E+03	9.83E-05	1.88E-06
La-140	3.36E+03	1.31E-08	4.94E-08
Ce-141	1.85E+03	1.14E-07	1.00E-06
Ce-143	3.37E+03	3.93E-10	3.55E-06
Ce-144	5.14E+02	2.70E-05	2.10E-04
Np-239	3.32E+03	1.51E-09	2.75E-09

ATTACHMENT 8

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SURRY RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml), (Note 1)
A. Batch Releases (Note 2)	P (Each Batch)	P (Each Batch)	Principal Gamma Emitters (Note 3)	$5x10^{-7}$
			I-131	$1x10^{-6}$
	P (One Batch/M)	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	P (Each Batch)	M Composite (Note 4)	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	P (Each Batch)	Q Composite (Note 4)	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$
B. Continuous Releases (Note 5)	Continuous (Note 6)	W Composite (Note 6)	Principal Gamma Emitters (Note 6)	$5x10^{-7}$
			I-131	$1x10^{-6}$
	M Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	Continuous (Note 6)	M Composite (Note 6)	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	Continuous (Note 6)	Q Composite (Note 6)	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

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SU'.RY RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Note 1: For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E \bullet V \bullet 2.22 \times 10^6 \bullet Y \bullet e^{(-\lambda \Delta \tau)}}$$

Where:

LLD = the "a priori" (before the fact) Lower Limit of Detection (as microcuries per unit mass or volume) (see 4.8)

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, cpm)

E = the counting efficiency (as counts per disintegration)

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

2.22×10^6 = the number of disintegrations per minute (dpm) per microcurie

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

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

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not as an a "posteriori" (after the fact) limit for a particular measurement.

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SURRY RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Note 2: A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and appropriate methods will be used to obtain a representative sample for analysis.

Note 3: The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, at levels exceeding the LLD, together with the above nuclides, shall also be identified and reported.

Note 4: A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and for which the method of sampling employed results in a specimen that is representative of the liquids released.

Note 5: A continuous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

Note 6: To be representative of the quantities and concentrations of radioactive materials in liquid effluents, composite sampling shall employ appropriate methods which will result in a specimen representative of the effluent release.

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NORTH ANNA RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml), (Note 1)
Batch Releases (Notes 2 and 7)	P (Each Batch)	P (Each Batch)	Principal Gamma Emitters (Note 3)	5×10^{-7}
			I-131	1×10^{-6}
	P (One Batch/M)	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	P (Each Batch)	M Composite (Note 4)	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	P (Each Batch)	Q Composite (Note 4)	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}
Continuous Releases (Note 5)	Continuous (Note 6)	W Composite (Note 6)	Principal Gamma Emitters (Note 6)	5×10^{-7}
			I-131	1×10^{-6}
			Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	Continuous (Note 6)	M Composite (Note 6)	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	Continuous (Note 6)	Q Composite (Note 6)	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}

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NORTH ANNA RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Note 1: For a particular measurement system (which may include radiochemical separation):

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

Where:

LLD = the "a priori" (before the fact) Lower Limit of Detection as defined above (as microcuries per unit mass or volume) (see 4.8)

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, cpm)

E = the counting efficiency (as counts per disintegration)

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

2.22×10^6 = the number of disintegrations per minute (dpm) per microcurie

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

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

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not as an a "posteriori" (after the fact) limit for a particular measurement.

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NORTH ANNA RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

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

Note 3: The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, at levels exceeding the LLD, together with the above nuclides, shall also be identified and reported.

Note 4: A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and for which the method of sampling employed results in a specimen that is representative of the liquids released.

Note 5: A continuous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

Note 6: To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent releases.

Note 7: Whenever the secondary coolant activity exceeds 10^{-5} μCi/ml, the turbine building sump pumps shall be placed in manual operation and samples shall be taken and analyzed prior to release. Secondary coolant activity samples shall be collected and analyzed on a weekly basis. These samples are analyzed for gross activity or gamma isotopic activity within 24 hours.

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SURRY RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml), (Note 1)
A. Waste Gas Storage Tank	Prior to release. (Each Tank) (Grab Sample)	Prior to release. (Each Tank)	Principal Gamma Emitters (Note 2)	$1x10^{-4}$
B. Containment Purge	Prior to release. (Each PURGE) (Grab Sample)	Prior to release. (Each PURGE)	Principal Gamma Emitters (Note 2)	$1x10^{-4}$
			H-3	$1x10^{-6}$
C. Ventilation (1) Process Vent (2) Vent Vent #1 (3) Vent Vent #2 (4) SRF Vent	Weekly (Grab Sample) (Note 3)	Weekly (Note 3)	Principal Gamma Emitters (Note 2)	$1x10^{-4}$
			H-3	$1x10^{-6}$
D. All Release Types as listed in A, B, and C.	Continuous (Note 4)	Weekly (Note 5) (Charcoal Sample)	I-131	$1x10^{-12}$
	Continuous (Note 4)	Weekly (Note 5) Particulate Sample	Principal Gamma Emitters (Note 2)	$1x10^{-11}$
	Continuous (Note 4)	Weekly Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous (Note 4)	Quarterly Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$
	Continuous (Note 4)	Noble Gas Monitor	Noble Gases Gross Beta and Gamma	$1x10^{-6}$
E. Condenser Air Ejector	Weekly Grab Sample (Note 3)	Weekly (Note 3)	Principle Gamma Emitters (Note 2)	$1x10^{-4}$
			H-3	$1x10^{-6}$

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SURRY RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

	Prior to release. (Grab Sample)	Prior to release. (Each release	Principle Gamma Emitters	$1x10^{-4}$
			H-3	$1x10^{-6}$
F. Containment Hog Depressurization	Continuous (Note 4)	Charcoal Sample (Not[illegible]	I-131	$1x10^{-11}$
	Continuous (Note 4)	Particulat[illegible]e (Note 6)	Principle Gamma Emitters (Note 2)	$1x10^{-10}$
	Continuous (Note 4)	Composite Particulate Sample (Note 6)	Gross Alpha	$1x10^{-10}$
	Continuous (Note 4)	Composite Particulate Sample (Note 6)	Sr-89, Sr-90	$1x10^{-10}$

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SURRY RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Note 1: For a particular measurement system (which may include radiochemical separation):

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

Where:

LLD = the "a priori" (before the fact) Lower Limit of Detection as defined above (as microcuries per unit mass or volume) (see 4.8).

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, cpm).

E = the counting efficiency (as counts per disintegration). Rev. 1

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

2.22×10^6 = the number of disintegrations per minute (dpm) per microcurie.

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.

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

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not as an a "posteriori" (after the fact) limit for a particular measurement.

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SURRY RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Note 2: 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, Xe-135m, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other nuclides with half lives greater than 8 days, that are measurable and identifiable at levels exceeding the LLD, together with the above nuclides, shall also be identified and reported.

Note 3: Sampling and analysis shall also be performed following shutdown, startup, and whenever a thermal power change exceeding 15 percent of the rated thermal power occurs within a one hour period, when:

a. Analysis shows that the dose equivalent I-131 concentration in the primary coolant has increased more than a factor of 3; and

b. The noble gas activity monitor shows that effluent activity has increased by more than a factor of 3.

Note 4: The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with 6.3.1, 6.3.3, and 6.3.4.

Note 5: Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing (or after removal from sampler). Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or thermal power change exceeding 15 percent of rated thermal power in one hour and analyses shall be completed within 48 hours of charging. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement applies if:

a. Analysis shows that the dose equivalent I-131 concentration in the primary coolant has increased by a factor of 3; and

b. Noble gas monitor shows that effluent activity has increased more than a factor of 3.

Note 6: To be representative of the quantities and concentrations of radioactive materials in gaseous effluents, composite sampling shall employ appropriate methods which will result in a specimen representative of the effluent release.

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NORTH ANNA RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml), (Note 1)
A. Waste Gas Storage Tank	Prior to release. (Each Tank Grab Sample)	Prior to release. (Each Tank)	Principal Gamma Emitters (Note 2)	$1x10^{-4}$
B. Containment PURGE	Prior to release. (Each PURGE Grab Sample)	Prior to release. (Each PURGE)	Principal Gamma Emitters (Note 2)	$1x10^{-4}$
			H-3	$1x10^{-6}$
C. Ventilation (1) Process Vent (2) Vent. Vent A (3) Vent. Vent B	Monthly (Grab Sample) (Notes 3,4, and 5)	Monthly (Note 3)	Principal Gamma Emitters (Note 2)	$1x10^{-4}$
			H-3	$1x10^{-6}$
D. All Release Types as listed in A, B, and C.	Continuous (Note 4)	Weekly (Charcoal Sample)	I-131	$1x10^{-12}$
	Continuous (Note 4)	Weekly Particulate Sample	Principal Gamma Emitters (Note 2)	$1x10^{-11}$
	Continuous (Note 4)	Monthly Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous (Note 4)	Quarterly Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$
	Continuous (Note 4)	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	$1x10^{-6}$
E. Cond. Air Ejector Vent Steam Gen. Blowdown Vent	Weekly (Grab Sample)	Weekly	Principle Gamma Emitters (Note 7)	$1x10^{-4}$
			H-3	$1x10^{-6}$
F. Containment Vacuum Steam Ejector (Hogger)	Prior to release. (Grab Sample)	Prior to each release	Principle Gamma Emitters (Note 2)	$1x10^{-4}$
			H-3	$1x10^{-6}$

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NORTH ANNA RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Note 1: For a particular measurement system (which may include radiochemical separation): Rev. 1

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

Where:

LLD = the "a priori" (before the fact) Lower Limit of Detection as defined above (as microcuries per unit mass or volume) (see 4.8)

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, cpm)

E = the counting efficiency (as counts per disintegration)

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

2.22×10^6 = the number of disintegrations per minute (dpm) per microcurie

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

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

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not as an a "posteriori" (after the fact) limit for a particular measurement.

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NORTH ANNA RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Note 2: 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, Xe-135m, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, at levels exceeding the LLD, together with the above nuclides, shall also be identified and reported.

Note 3: Sampling and analysis shall also be performed following shutdown, startup, and whenever a thermal power change exceeding 15 percent of the rated thermal power occurs within a one hour period, if:

a. Analysis shows that the dose equivalent I-131 concentration in the primary coolant is greater than 1.0 μCi/gm; and

b. The noble gas activity monitor shows that effluent activity has increased by more than a factor of 3.

Note 4: The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with subsections 6.3.1, 6.3.3, and 6.3.4.

Note 5: Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing (or after removal from sampler). Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or thermal power change exceeding 15 percent of rated thermal power in one hour and analyses shall be completed within 48 hours of charging. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement applies if:

a. Analysis shows that the dose equivalent I-131 concentration in the primary coolant is greater than 1.0 μCi/gm and;

b. Noble gas monitor shows that effluent activity has increased more than a factor of 3.

Note 6: Whenever the secondary coolant activity exceeds 10^{-5} μCi/ml, samples shall be obtained and analyzed weekly. The turbine building sump pumps shall be placed in manual operation and samples shall be taken and analyzed prior to release. Secondary coolant activity samples shall be collected and analyzed on a weekly basis. These samples are analyzed for gross activity or gamma isotopic activity within 24 hours.

Note 7: 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, Xe-135m, and Xe-138 for gaseous emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, at levels exceeding the LLD together with the above nuclides, shall also be identified and reported.

ATTACHMENT 12

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GASEOUS EFFLUENT DOSE FACTORS FOR SURRY POWER STATION

(Gamma and Beta Dose Factors)

χ/Q = 6.0E-05 sec/m^3 at 499 meters N Direction

Dose Factors for Ventilation Vent

Noble Gas Radionuclide	K_{ivv} Total Body mrem/yr / Curie/Sec	L_{ivv} Skin mrem/yr / Curie/Sec	M_{ivv} Gamma Air mrad/yr / Curie/Sec	N_{ivv} Beta Air mrad/yr / Curie/Sec
Kr-83m	4.54E+00	*	1.16E+03	1.73E+04
Kr-85m	7.02E+04	8.76E+04	7.38E+04	1.18E+05
Kr-85	9.66E+02	8.04E+04	1.03E+03	1.17E+05
Kr-87	3.55E+05	5.84E+05	3.70E+05	6.18E+05
Kr-88	8.82E+05	1.42E+05	9.12E+05	1.76E+05
Kr-89	9.96E+05	6.06E+05	1.04E+06	6.36E+05
Kr-90	9.36E+05	4.37E+05	9.78E+05	4.70E+05
Xe-131m	5.49E+03	2.86E+04	9.36E+03	6.66E+04
Xe-133m	1.51E+04	5.96E+04	1.96E+04	8.88E+04
Xe-133	1.76E+04	1.84E+04	2.12E+04	6.30E+04
Xe-135m	1.87E+05	4.27E+04	2.02E+05	4.43E+04
Xe-135	1.09E+05	1.12E+05	1.15E+05	1.48E+05
Xe-137	8.52E+04	7.32E+05	9.06E+04	7.62E+05
Xe-138	5.30E+05	2.48E+05	5.53E+05	2.85E+05
Ar-41	5.30E+05	1.61E+05	5.58E+05	1.97E+05

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GASEOUS EFFLUENT DOSE FACTORS FOR SURRY POWER STATION

(Gamma and Beta Dose Factors)

χ/Q = 1.0E-06 sec/m^3 at 644 meters S Direction

Dose Factors for Process Vent

Noble Gas Radionuclide	K_{ipv} Total Body mrem/yr / Curie/Sec	L_{ipv} Skin mrem/yr / Curie/Sec	M_{ipv} Gamma Air mrad/yr / Curie/Sec	N_{ipv} Beta Air mrad/yr / Curie/Sec
Kr-83m	7.56E-02	·	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

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GASEOUS EFFLUENT DOSE FACTORS FOR SURRY POWER STATION

(Inhalation Pathway Dose Factors)

Ventilation Vent χ/Q = 6.0E-05 sec/m^3 at 499 meters N Direction

Process Vent χ/Q = 1.0E-06 sec/m^3 at 644 meters S Direction

Radionuclide	P_{ivv} mrem/yr / Curie/sec	Pipv mrem/yr / Curie/sec
H-3	6.75E+04	1.12E+03
Cr-51	5.13E+03	8.55E+01
Mn-54	ND	ND
Fe-59	ND	ND
Co-58	ND	ND
Co-60	ND	ND
Zn-65	ND	ND
Rb-86	ND	ND
Sr-90	ND	ND
Y-91	ND	ND
Zr-95	ND	ND
Nb-95	ND	ND
Ru-103	ND	ND
Ru-106	ND	ND
Ag-110m	ND	ND
Te-127m	3.64E+05	6.07E+03
Te-129m	3.80E+05	6.33E+03
Cs-134	ND	ND
Cs-136	ND	ND
Cs-137	ND	ND
Ba-140	ND	ND
Ce-141	ND	ND
Ce-144	ND	ND
I-131	9.75E+08	1.62E+07

ND - No data for dose factor according to Reg. Guide 1.109, Rev. 1.

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GASEOUS EFFLUENT DOSE FACTORS FOR NORTH ANNA POWER STATION

(Gamma and Beta Dose Factors)

χ/Q = 9.3E-06 sec/m^3 at 1416 meters SE Direction

Dose Factors for Ventilation Vent

Noble Gas Radionuclide	K_{ivv} Total Body mrem/yr / Curie/Sec	L_{ivv} Skin mrem/yr / Curie/Sec	M_{ivv} Gamma Air mrad/yr / Curie/Sec	N_{ivv} Beta Air mrad/yr / Curie/Sec
Kr-83m	7.03E-01	*	1.79E+02	2.68E+03
Kr-85m	1.09E+04	1.36E+04	1.14E+04	1.83E+04
Kr-85	1.50E+02	1.25E+04	1.60E+02	1.81E+04
Kr-87	5.51E+04	9.05E+04	5.74E+04	9.58E+04
Kr-88	1.37E+05	2.20E+04	1.41E+05	2.72E+04
Kr-89	1.54E+05	9.39E+04	1.61E+05	9.86E+04
Kr-90	1.45E+05	6.78E+04	1.52E+05	7.28E+04
Xe-131m	8.51E+02	4.43E+03	1.45E+03	1.03E+04
Xe-133m	2.33E+03	9.24E+03	3.04E+03	1.38E+04
Xe-133	2.73E+03	2.85E+03	3.28E+03	9.77E+03
Xe-135m	2.90E+04	6.61E+03	3.12E+04	6.87E+03
Xe-135	1.68E+04	1.73E+04	1.79E+04	2.29E+04
Xe-137	1.32E+04	1.13E+05	1.40E+04	1.18E+05
Xe-138	8.21E+04	3.84E+04	8.57E+04	4.42E+04
Ar-41	8.22E+04	2.50E+04	8.65E+04	3.05E+04

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GASEOUS EFFLUENT DOSE FACTORS FOR NORTH ANNA POWER STATION

(Gamma and Beta Dose Factors)

χ/Q = 1.2E-06 sec/m^3 at 1513 meters S Direction

Dose Factors for Process Vent

Noble Gas Radionuclide	K_{ipv} Total Body mrem/yr / Curie/Sec	L_{ipv} Skin mrem/yr / Curie/Sec	M_{ipv} Gamma Air mrad/yr / Curie/Sec	N_{ipv} Beta Air mrad/yr / Curie/Sec
Kr-83m	9.07E-02	-	2.32E+01	3.46E+02
Kr-85m	1.40E+03	1.75E+03	1.48E+03	2.36E+03
Kr-85	1.93E+01	1.61E+03	2.06E+01	2.34E+03
Kr-87	7.10E+03	1.17E+04	7.40E+03	1.24E+04
Kr-88	1.76E+04	2.84E+03	1.82E+04	3.52E+03
Kr-89	1.99E+04	1.21E+04	2.08E+04	1.27E+04
Kr-90	1.87E+04	8.75E+03	1.96E+04	9.40E+03
Xe-131m	1.10E+02	5.71E+02	1.87E+02	1.33E+03
Xe-133m	3.01E+02	1.19E+03	3.92E+02	1.78E+03
Xe-133	3.53E+02	3.67E+02	4.24E+02	1.26E+03
Xe-135m	3.74E+03	8.53E+02	4.03E+03	8.87E+02
Xe-135	2.17E+03	2.23E+03	2.30E+03	2.95E+03
Xe-137	1.70E+03	1.46E+04	1.81E+03	1.52E+04
Xe-138	1.06E+04	4.96E+03	1.11E+04	5.70E+03
Ar-41	1.06E+04	3.23E+03	1.12E+04	3.94E+03

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GASEOUS EFFLUENT DOSE FACTORS FOR NORTH ANNA POWER STATION

(Inhalation Pathway Dose Factors)

Ventilation Vent χ/Q = 9.3E-06 sec/m^3 at 1416 meters SE Direction

Process Vent χ/Q = 1.2E-06 sec/m^3 at 1513 meters S Direction

Radionuclide	P_{ivv} mrem/yr / Curie/sec	Pipv mrem/yr / Curie/sec
H-3	1.05E+04	1.35E+03
Cr-51	7.95E+02	1.02E+02
Mn-54	ND	ND
Fe-59	ND	ND
Co-58	ND	ND
Co-60	ND	ND
Zn-65	ND	ND
Rb-86	ND	ND
Sr-90	ND	ND
Y-91	ND	ND
Zr-95	ND	ND
Nb-95	ND	ND
Ru-103	ND	ND
Ru-106	ND	ND
Ag-110m	ND	ND
Te-127m	5.64E+04	7.28E+03
Te-129m	5.88E+04	7.59E+03
Cs-134	ND	ND
Cs-136	ND	ND
Cs-137	ND	ND
Ba-140	ND	ND
Ce-141	ND	ND
Ce-144	ND	ND
I-131	1.51E+08	1.95E+07

ND - No data for dose factor according to Reg. Guide 1.109, Rev. 1.

ATTACHMENT 14

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SURRY RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM OPERABLE CHANNELS	ACTION
1. PROCESS VENT SYSTEM		
(a) Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release	1	1
(b) Iodine Sampler	1	2
(c) Particulate Sampler	1	2
(d) Process Vent Flow Rate Monitor	1	3
(e) Sampler Flow Rate Measuring Device	1	3
2. CONDENSER AIR EJECTOR SYSTEM		
(a) Gross Activity Monitor	2 (one per unit)	1
(b) Air Ejector Flow Rate Measuring Device	2 (one per unit)	3
3. VENTILATION VENT SYSTEM (Note 1)		
(a) Noble Gas Activity Monitor	1	1
(b) Iodine Sampler	1	2
(c) Particulate Sampler	1	2
(d) Ventilation Vent Flow Rate Monitor	1	3
(e) Sampler Flow Rate Measuring Device	1	3

Rev. 1

Note 1: One each for the Ventilation Vent 1 & 2 and Radwaste Facility Ventilation Vent effluent points. Rev. 1

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SURRY RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

ACTION 1: If the number of operable channels is less than required, effluent releases via this path may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for gross activity within 24 hours.

ACTION 2: If the number of operable channels is less than required, effluent releases via the effected path may continue provided samples are continuously collected within one hour with auxiliary sampling equipment as required in Attachment 8.

ACTION 3: If the number of operable channels is less than required, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours.

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NORTH ANNA RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM OPERABLE CHANNELS	ACTION
1. PROCESS VENT SYSTEM		
(a) Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release	1	2, 4
(b) Iodine Sampler	1	2, 5
(c) Particulate Sampler	1	2, 5
(d) Process Vent Flow Rate Monitor	1	1
(e) Sampler Flow Rate Measuring Device	1	1
2. CONDENSER AIR EJECTOR SYSTEM		
(a) Gross Activity Monitor	1	3
(b) Flow Rate Measuring Device	1	1
3. VENTILATION VENT SYSTEM (Shared with Unit 2)		
(a) Noble Gas Activity Monitor	1 (Note 1)	2
(b) Iodine Sampler	1 (Note 1)	2
(c) Particulate Sampler	1 (Note 1)	2
(d) Flow Rate Monitor	1 (Note 1)	1
(e) Sampler Flow Rate Measuring Device	1 (Note 1)	1

Rev. 1

Rev. 1

Note 1: One per vent stack

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NORTH ANNA RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

ACTION 1: If the number of operable channels is less than required, effluent releases via this path may continue provided the flow rate is estimated at least once per 4 hours.

ACTION 2: If the number of operable channels is less than required, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for gross activity or gamma isotopic activity within 24 hours.

ACTION 3 If the number of operable channels is less than required, effluent releases via this pathway may continue provided the frequency of the grab samples required by Technical Specification requirement 4.4.6.3.b is increased to at least once per 4 hours and these samples are analyzed for gross activity or gamma isotopic activity within 8 hours.

ACTION 4: If the number of operable channels is less than required, the contents of the Waste Gas Decay Tanks may be released to the environment provided that prior to initiate the release:

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

b. At least two technically qualified members of the Station Staff independently verify the release rate calculations and discharge valve lineup;

Otherwise, suspend release of Waste Gas Decay Tank effluents.

ACTION 5: If the number of operable channels is less than required, effluent releases from the Waste Gas Decay Tanks may continue provided samples are continuously collected with auxiliary sampling equipment as required in Attachment 11.

ATTACHMENT 16

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SURRY RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Rev. 1CHANNEL DESCRIPTION	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. PROCESS VENT SYSTEM				
(a) Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release	D	M, *	R	Q
(b) Iodine Sampler	W	N.A.	N.A.	N.A.
(c) Particulate Sampler	W	N.A.	N.A.	N.A.
(d) Process Vent Flow Rate Monitor	D	N.A.	R	N.A.
(e) Sampler Flow Rate Measuring Device	D	N.A.	SA	Q
2. CONDENSER AIR EJECTOR SYSTEM				
(a) Gross Activity Monitor	D	M	R	Q
(b) Air Ejector Flow Rate Measuring Device	D	N.A.	R	N.A.
3. VENTILATION VENT SYSTEM				
(a) Noble Gas Activity Monitor	D	M	R	Q
(b) Iodine Sampler	W	N.A.	N.A.	N.A.
(c) Particulate Sampler	W	N.A.	N.A.	N.A.
(d) Ventilation Vent Flow Rate Monitor	D	N.A.	R	N.A.
(e) Sampler Flow Rate Measuring Device	D	N.A.	SA	Q

Rev. 1

* Prior to each Waste Gas Decay Tank release

ATTACHMENT 17

(Page 1 of 2)

NORTH ANNA RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

CHANNEL DESCRIPTION	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONA L TEST	
1. PROCESS VENT SYSTEM					
(a) Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release	D	P	R	Q (Note 1)	
(b) Iodine Sampler	W	N.A.	N.A.	N.A.	
(c) Particulate Sampler	W	N.A.	N.A.	N.A.	
(d) Process Vent Flow Rate Monitor	D	N.A.	R	Q	
(e) Sampler Flow Rate Measuring Device	D (Note 3)	N.A.	SA	N.A.	Rev. 1
2. CONDENSER AIR EJECTOR SYSTEM					
(a) Noble Gas Activity Monitor	D	M	R	Q (Note 2)	
(b) Flow Rate Measuring Device	D	N.A.	R	N.A.	Rev. 1
3. VENTILATION VENT SYSTEM (Shared with Unit 2)					
(a) Noble Gas Activity Monitor	D	M	R	Q (Note 2)	
(b) Iodine Sampler	W	N.A.	N.A.	N.A.	
(c) Particulate Sampler	W	N.A.	N.A.	N.A.	
(d) Flow Rate Monitor	D	N.A.	R	Q	
(e) Sampler Flow Rate Measuring Device	D (Note 3)	N.A.	SA	N.A.	Rev. 1

ATTACHMENT 17

(Page 2 of 2)

NORTH ANNA RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Note 1: The Channel Functional Test shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

a. Instrument indicates measured levels above the alarm/trip setpoint.

b. Instrument controls not set in operate mode.

Note 2: The Channel Functional Test shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the alarm setpoint.

b. Instrument controls not set in operate mode.

Note 3: Channel Checks shall consist of verifying indication of flow during periods of release. Channel Checks shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

ATTACHMENT 18

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CRITICAL ORGAN AND INHALATION DOSE FACTORS FOR SURRY

(Critical Pathway Dose Factors)

Ventilation Vent D/Q = 9.0E-10 m^{-2} at 5150 meters S Direction

Process Vent D/Q = 4.3E-10 m^{-2} at 5150 meters S Direction

Radionuclide	RM_{ivv} mrem/yr / Curie/sec	RMipv mrem/yr / Curie/sec
H-3	7.20E+02	3.12E+02
Mn-54	ND	ND
Fe-59	ND	ND
Co-58	ND	ND
Co-60	ND	ND
Zn-65	ND	ND
Rb-86	ND	ND
Sr-89	ND	ND
Sr-90	ND	ND
Y-91	ND	ND
Zr-95	ND	ND
Nb-95	ND	ND
Ru-103	ND	ND
Ru-106	ND	ND
Ag-110m	ND	ND
Te-127m	8.06E+04	3.85E+04
Te-129m	1.25E+05	5.98E+04
I-131	6.21E+08	2.97E+08
Cs-134	ND	ND
Cs-136	ND	ND
Cs-137	ND	ND
Ba-140	ND	ND
Ce-141	ND	ND
Ce-144	ND	ND

ND - No data for dose factor according to Reg. Guide 1.109, Rev. 1.

ATTACHMENT 18

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CRITICAL ORGAN AND INHALATION DOSE FACTORS FOR SURRY

(Inhalation Pathway Dose Factors)

Ventilation Vent χ/Q = 3.0E-07 sec/m^3 at 5150 meters S Direction

Process Vent χ/Q = 1.3E-07 sec/m^3 at 5150 meters S Direction

Radionuclide	[illegible] ivv m.. m/yr Curie/sec	RIipv mrem/yr Curie/sec
H-3	1.94E+02	8.41E+01
Cr-51	1.73E+01	7.48E+00
Mn-54	ND	ND
Fe-59	ND	ND
Co-58	ND	ND
Co-60	ND	ND
Zn-65	ND	ND
Rb-86	ND	ND
Sr-89	ND	ND
Sr-90	ND	ND
Y-91	ND	ND
Zr-95	ND	ND
Nb-95	ND	ND
Ru-103	ND	ND
Ru-106	ND	ND
Ag-110m	ND	ND
Te-127m	1.46E+03	6.33E+02
Te-129m	1.64E+03	7.12E+02
I-131	4.45E+06	1.93E+06
Cs-134	ND	ND
Cs-136	ND	ND
Cs-137	ND	ND
Ba-140	ND	ND
Ce-141	ND	ND
Ce-144	ND	ND

ND - No data for dose factor according to Reg. Guide 1.109, Rev. 1.

ATTACHMENT 19

(Page 1 of 1)

CRITICAL ORGAN DOSE FACTORS FOR NORTH ANNA

Rev. 1

(Critical Pathway Dose Factors)

Ventilation Vent D/Q = 2.4E-09 m^{-2} at 3250 meters N Direction

Process Vent D/Q = 1.1E-09 m^{-2} at 3250 meters N Direction

Radionuclide	R_{ivv} $\frac{mrem/yr}{Curie/sec}$	Ripv $\frac{mrem/yr}{Curie/sec}$
H-3	1.73E+03	9.36E+02
Mn-54	ND	ND
Fe-59	ND	ND
Co-58	ND	ND
Co-60	ND	ND
Zn-65	ND	ND
Rb-86	ND	ND
Sr-89	ND	ND
Sr-90	ND	ND
Y-91	ND	ND
Zr-95	ND	ND
Nb-95	ND	ND
Ru-103	ND	ND
Ru-106	ND	ND
Ag-110m	ND	ND
Te-127m	1.97E+05	9.04E+04
Te-129m	2.95E+05	1.35E+05
I-131	1.45E+09	6.72E+08
Cs-134	ND	ND
Cs-136	ND	ND
Cs-137	ND	ND
Ba-140	ND	ND
Ce-141	ND	ND
Ce-144	ND	ND

ND - No data for dose factor according to Reg. Guide 1.109, Rev. 1.

ATTACHMENT 20

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SURRY RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Sample and Sample Location	Collection Frequency	Type and Frequency of Analysis
1. DIRECT RADIATION			
	About 40 Routine Monitoring stations to be placed as follows: 1) Inner Ring in general area of site boundary with station in each sector. 2) Outer Ring 6 to 8 km from the site with a station in each sector 3)The balance of the 8 dosimeters should be placed in special interest areas such as population centers nearby residents, schools, and in 2 or 3 areas to serve as controls.	Quarterly	GAMMA DOSE Quarterly
2. AIRBORNE			
Radioiodines and Particulates	Samples from 7 locations: a) 1 sample from close to the site boundary location of the highest calculated annual average ground level D/Q. b) 5 sample locations 6-8 km distance located in a concentric ring around Station. c) 1 sample from a control location 15-30 km distant, providing valid background data.	Continuous Sampler operation with sample collection weekly.	Radioiodine Cannister I-131 Analysis Weekly Particulate Sampler Gross beta radioactivity analysis following filter change; Gamma isotopic analysis of composite (by location) quarterly

ATTACHMENT 20

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SURRY RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Sample and Sample Location	Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE			
a) Surface	a) 1 sample upstream b) 1 sample downstream	Monthly Sample	Gamma isotopic analysis monthly; Composite for tritium analysis quarterly.
b) Ground	Sample from 1 or 2 sources	Quarterly	Gamma isotopic and tritium analysis quarterly
c) Sediment from shoreline	1 sample from downstream area with existing or potential recreational value	Semi-Annually	Gamma isotopic analysis semi-annually
d) Silt	5 samples from vicinity of the Station	Semi-Annually	Gamma isotopic analysis semi-annually
4. INGESTION			
a) Milk	a) 4 samples from milking animals in the vicinity of Station. b) 1 sample from milking animals at a control location (15-30 km distant)	Monthly	Gamma isotopic and I-131 analysis monthly
b) Fish and Invertebrates	a) 3 sample of oysters in the vicinity of the Station	Bi-Monthly	Gamma isotopic on edibles
	b) 5 samples of clams in the vicinity of the Station.	Bi-Monthly	Gamma isotopic on edibles
	c) 1 sampling of crabs from the vicinity of the Station.	Annually	Gamma isotopic on edibles
	d) 2 samples of fish from the vicinity of the Station (catfish, white perch, eel)	Semi-Annually	Gamma isotopic on edibles
c) Food Products	a) 1 sample corn b) 1 sample soybean c) 1 sample peanuts	Annually	Gamma isotopic on edible portion

ATTACHMENT 21

(Page 1 of 4)

NORTH ANNA RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM(Note 1)

Exposure Pathway and/or Sample	Number of Sample and Sample Location(Note 2)	Collection Frequency	Type and Frequency of Analysis
1. DIRECT RADIATION (Note 3)	36 routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously to be placed as follows: 1) An inner ring of stations, one in each meteorological sector within the site boundary. 2) An outer ring of stations, one in each meteorological sector within 8 km range from the site 3) The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations.	Quarterly	GAMMA DOSE Quarterly

ATTACHMENT 21

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NORTH ANNA RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Sample and Sample Location (Note 2)	Collection Frequency	Type and Frequency of Analysis	
2. AIRBORNE				
Radioiodines and Particulates	Samples from 5 locations: a) 3 samples from close to the 3 site boundary locations (in different sectors) of the highest calculated historical annual average ground level D/Q. b) 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q. c) 1 sample from a control location 15-40 km distant and in the least prevalent wind direction	Continuous sampler, operation with sample collection weekly	Radioiodine Cannister I-131 analysis, weekly Particulate Sampler Gross beta radioactivity analysis following filter change; (Note 4) Gamma isotopic analysis of composite (by location) quarterly (Note 5)	Rev. 1
3. WATERBORNE				
a) Surface	Samples from 3 locations: a) 1 sample upstream b) 1 sample downstream c) 1 sample from cooling lagoon	Grab Monthly	Gamma isotopic analysis monthly; (Note 5) Composite for tritium analysis quarterly.	Rev. 2
b) Ground	Sample from 1 or 2 sources only if likely to be affected.	Grab Quarterly	Gamma isotopic and tritium analysis quarterly (Note 5)	
c) Sediment	1 sample from downstream area with existing or potential recreational value	Semi-Annually	Gamma isotopic analysis semi-annually (Note 5)	

ATTACHMENT 21

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NORTH ANNA RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Sample and Sample Location (Note 2)	Collection Frequency	Type and Frequency of Analysis
4. INGESTION			
a) Milk (Note 7)	a) Samples from milking animals in 3 locations within 5 km distance having the highest dose potential. If there are none, then, 1 sample from milking animals in each of 3 areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr. (Note 6) b) 1 sample from milking animals at a control location (15-30 km distant) and in the least prevalent wind direction).	Monthly at all times.	Gamma isotopic (Note 5) and I-131 analysis monthly.
b. Fish and Invertebrates	a) 1 sample of commercially and recreationally important species (bass, sunfish, catfish) in vicinity of plant discharge area. b) 1 sample of same species in areas not influenced by plant discharge	Semiannually	Gamma isotopic on edible portions.
c) Food Products	a) Samples of an edible broad leaf vegetation grown nearest each of two different offsite locations of highest predicted historical annual average ground level D/Q if milk sampling is not performed. b) 1 sample of broad leaf vegetation grown 15-30 km distant in the least prevalent wind direction if milk sampling is not performed	Monthly if available, or at harvest	Gamma isotopic (Note 5) and I-131 analysis.

ATTACHMENT 21

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NORTH ANNA RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Note 1: The number, media, frequency, and location of samples may vary from site to site. This table presents an acceptable minimum program for a site at which each entry is applicable. Local site characteristics must be examined to determine if pathways not covered by this table may significantly contribute to an individual's dose and be included in the sampling program.

Note 2: For each and every sample location in Attachment 21, specific parameters of distance and direction sector from the centerline of the reactor, and additional description where pertinent, shall be provided in Attachment 23. Refer to Radiological Assessment Branch Technical Positions and to NUREG-0133, Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plant. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to 6.6.1. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. In lieu of a Licensee Event Report and pursuant to 6.6.2, identify the cause of the unavailability of samples for that pathway and identify the new locations for obtaining replacement samples in the next Semiannual Radioactive Effluent Release Report and also include in the report revised figures and tables from the ODCM reflecting the new locations.

Note 3: One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The 36 stations are not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations, e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading. Rev. 1

Note 4: Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

Note 5: Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

Note 6: The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

Note 7: If milk sampling cannot be performed, use item 4.c (Pg. 3 of 4, Attachment 21)

ATTACHMENT 22

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SURRY ENVIRONMENTAL SAMPLING LOCATIONS

SAMPLE MEDIA	LOCATION	DISTANCE (MILES)	DIRECTION	REMARKS
Air Charcoal and Particulate	Surry Station (SS)	0.37	NNE	Site Boundary Location at Sector with Highest D/Q
	Hog Island Reserve (HIR)	2.0	NNE	
	Bacons Castle (BC)	4.5	SSW	
	Alliance (ALL)	5.1	WSW	
	Colonial Parkway (CP)	3.7	NNW	
	Dow Chemical (DOW)	5.1	ENE	
	Fort Eustis (FE)	4.8	ESE	
	Newport News (NN)	16.5	ESE	Control Location
Environmental TLDs	Control (00)			Onsite **
	West North West (02)	0.17	WNW	Site Boundary
	Surry Station Discharge (03)	0.6	NW	Site Boundary
	North North West (04)	0.4	NNW	Site Boundary
	North (05)	0.33	N	Site Boundary
	North North East (06)	0.28	NNE	Site Boundary
	North East (07)	0.31	NE	Site Boundary
	East North East (08)	0.43	ENE	Site Boundary
	East (Exclusion) (09)	0.31	E	Onsite
	West (10)	0.40	W	Site Boundary
	West South West (11)	0.45	WSW	Site Boundary
	South West (12)	0.30	SW	Site Boundary
	South South West (13)	0.43	SSW	Site Boundary
	South (14)	0.48	S	Site Boundary
	South South East (15)	0.74	SSE	Site Boundary
	South East (16)	1.00	SE	Site Boundary
	East (17)	0.57	E	Site Boundary
	Station Intake (18)	1.23	ESE	Site Boundary
	Hog Island Reserve (19)	1.94	NNE	Near Resident

ATTACHMENT 22

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SURRY ENVIRONMENTAL SAMPLING LOCATIONS

SAMPLE MEDIA	LOCATION		DISTANCE (MILES)	DIRECTION	REMARKS
Environmental TLDs	Bacons Castle	(20)	4.45	SSW	Approx. 5 miles
	Route 633	(21)	3.5	SW	Approx. 5 miles
	Alliance	(22)	5.1	WSW	Approx. 5 miles
	Surry	(23)	8.0	WSW	Population Center
	Route 636 and 637	(24)	4.0	W	Approx. 5 miles
	Scotland Wharf	(25)	5.0	WNW	Approx. 5 miles
	Jamestown	(26)	6.3	NW	Approx. 5 miles
	Colonial Parkway	(27)	3.7	NNW	Approx. 5 miles
	Route 617 and 618	(28)	5.2	NNW	Approx. 5 miles
	Kingsmill	(29)	4.8	N	Approx. 5 miles
	Williamsburg	(30)	7.8	N	Population Center
	Kingsmill North	(31)	5.6	NNE	Approx. 5 miles
	Budweiser	(32)	5.7	NNE	Population Center
	Water Plant	(33)	4.8	NE	Approx. 5 miles
	Dow	(34)	5.1	ENE	Approx. 5 miles
	Lee Hall	(35)	7.1	ENE	Population Center
	Goose Island	(36)	5.0	E	Approx. 5 miles
	Fort Eustis	(37)	4.8	ESE	Approx. 5 miles
	Newport News	(38)	16.5	ESE	Population Center
	James River Bridge	(39)	14.8	SSE	Control
	Benn's Church	(40)	14.5	S	Control
	Smithfield	(41)	11.5	S	Control
	Rushmere	(42)	5.2	SSE	Approx. 5 miles
	Route 628	(43)	5.0	S	Approx. 5 miles
Milk	Lee Hall		7.1	ENE	
	Epp's		4.8	SSW	
	Colonial Parkway		3.7	NNW	
	Judkin's		6.2	SSW	
	William's		22.5	S	Control Location

ATTACHMENT 22

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SURRY ENVIRONMENTAL SAMPLING LOCATIONS

SAMPLE MEDIA	LOCATION	DISTANCE (MILES)	DIRECTION	REMARKS
Well Water	Surry Station			Onsite***
	Hog Island Reserve	2.0	NNE	
	Bacons Castle	4.5	SSW	
	Jamestown	6.3	NW	
Crops (Corn, Peanuts, Soybeans)	Slade's Farm	2.4	S	State Split
	Brock's Farm	3.8	S	State Split
Crops (Cabbage, Kale)	Poole's Garden	2.3	S	State Split
	Carter's Grove Garden	4.8	NE	State Split
	Ryan's Garden			Control Location (Chester, Va.)
River Water (Bi-monthly)	Surry Station Intake	1.9	ESE	
	Hog Island Point	2.4	NE	
	Newport News	12.0	SE	
	Chicahominy River	11.2	WNW	Control Location
	Surry Station Discharge	0.17	NW	
River Water (Monthly)	Surry Discharge	0.17	NW	
	Scotland Wharf	5.0	WNW	Control Location
Sediment (Silt)	Chicahominy River	11.2	WNW	Control Location
	Surry Station Intake	1.9	ESE	
	Surry Station Discharge	1.0	NNW	
	Hog Island Point	2.4	NE	
	Point of Shoals	6.4	SSE	
	Newport News	12.0	SE	

ATTACHMENT 22

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SURRY ENVIRONMENTAL SAMPLING LOCATIONS

SAMPLE MEDIA	LOCATION	DISTANCE (MILES)	DIRECTION	REMARKS
Clams	Chicahominy River	11.2	WNW	Control Location
	Surry Station Discharge	1.3	NNW	
	Hog Island Point	2.4	NE	
	Jamestown	5.1	WNW	
	Lawne's Creek	2.4	SE	
Oysters	Deep Water Shoals	3.9	ESE	
	Point of Shoals	6.4	SSE	
	Newport News	12.0	SE	
Crabs	Surry Station Discharge	0.6	NW	
Fish	Surry Station Discharge	0.6	NW	
Shoreline Sediment	Hog Island Reserve	0.8	N	
	Burwell's Bay	7.76	SSE	

** Onsite Location - in Lead Shield

*** Onsite sample of Well Water - taken from tap-water at Surry Environmental Building.

ATTACHMENT 23

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NORTH ANNA ENVIRONMENTAL SAMPLING LOCATIONS

Distance and Direction From Unit No. 1

Sample Media	Location	Station No.	Distance (Miles)	Direction	Collection Frequency	REMARKS
Environmental TLDs	NAPS Sewage Treatment Plant	01	0.20	NE	Quarterly & Annually	On-Site
	Frederick's Hall	02	5.30	SSW	Quarterly & Annually	
	Mineral,VA	03	7.10	WSW	Quarterly & Annually	
	Wares Crossroads	04	5.10	WSW	Quarterly & Annually	
	Route 752	05	4.20	NNE	Quarterly & Annually	
	Sturgeon's Creek Marina	05A	3.20	N	Quarterly & Annually	
	Levy, VA	06	4.70	ESE	Quarterly & Annually	
	Bumpass, VA	07	7.30	SSE	Quarterly & Annually	
	End of Route 685	21	1.00	WNW	Quarterly & Annually	Exclusion Boundary
	Route 700	22	1.00	WSW	Quarterly & Annually	Exclusion Boundary
	"Aspen Hills"	23	0.93	SSE	Quarterly & Annually	Exclusion Boundary
	Orange, VA	24	22.00	NW	Quarterly & Annually	Control
	Bearing Cooling Tower	N-1/33	0.06	N	Quarterly	On-Site
	Sturgeon's Creek Marina	N-2/34	3.20	N	Quarterly	
	Parking Lot "C"	NNE-3/35	0.25	NNE	Quarterly	On-Site
	Good Hope Church	NNE-4/36	4.96	NNE	Quarterly	
	Parking Lot "B"	NE-5/37	0.20	NE	Quarterly	On-Site
	Lake Anna Marina	NE-6/38	1.49	NE	Quarterly	
	Weather Tower Fence	ENE-7/39	0.36	ENE	Quarterly	On-Site
	Route 689	ENE-8/40	2.43	ENE	Quarterly	
	Near Training Facility	E-9/41	0.30	E	Quarterly	On-Site

ATTACHMENT 23
(Page 2 of 4)
NORTH ANNA ENVIRONMENTAL SAMPLING LOCATIONS

Distance and Direction From Unit No. 1

Sample Media	Location	Station No.	Distance (Miles)	Direction	Collection Frequency	REMARKS	
Environmental TLDs (cont.)	"Morning Glory Hill"	E-10/42	2.85	E	Quarterly		
	Island Dike	ESE-11/43	0.12	ESE	Quarterly	On-Site	
	Route 622	ESE-12/44	4.70	ESE	Quarterly		
	Biology Lab	SE-13/45	0.75	SE	Quarterly	On-Site	
	Route 701 (Dam Entrance)	SE-14/46	5.88	SE	Quarterly		
	"Aspen Hills"	SSE-15/47	0.93	SSE	Quarterly	Exclusion Boundary	
	Elk Creek	SSE-16/48	2.33	SSE	Quarterly		Rev. 1
	Warehouse Compound Gate	S-17/49	0.22	S	Quarterly	On-Site	
	Elk Creek Church	S-18/50	1.55	S	Quarterly		
	NAPS Access Road	SSW-19/51	0.36	SSW	Quarterly	On-Site	
	Route 618	SSW-20/52	5.30	SSW	Quarterly		Rev. 1
	NAPS Access Road	SW-21/53	0.30	SW	Quarterly	On-Site	
	Route 700	SW-22/54	4.36	SW	Quarterly		
	500 KV Tower	WSW-23/55	0.40	WSW	Quarterly	On-Site	
	Route 700	WSW-24/56	1.00	WSW	Quarterly	Exclusion Boundary	
	NAPS Radio Tower	W-25/57	0.31	W	Quarterly	On-Site	
	Route 685	W-26/58	1.55	W	Quarterly		
	End of Route 685	WNW-27/59	1.00	WNW	Quarterly	Exclusion Boundary	
	H. Purcell's Private Road	WNW-28/60	1.52	WNW	Quarterly		Rev. 1
	End of #1/#2 Intake	NW-29/61	0.15	NW	Quarterly	On-Site	
	Lake Anna Campground	NW-30/62	2.54	NW	Quarterly		
	#1/#2 Intake	NNW-31/63	0.07	NNW	Quarterly	On-Site	
	Route 208	NNW-32/64	3.43	NNW	Quarterly		
	Bumpass Post Office	C-1/2	7.30	SSE	Quarterly	Control	
	Orange, VA	C-3/4	22.00	NW	Quarterly	Control	
	Mineral, VA	C-5/6	7.10	WSW	Quarterly	Control	
	Louisa, VA	C-7/8	11.54	WSW	Quarterly	Control	

ATTACHMENT 23
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NORTH ANNA ENVIRONMENTAL SAMPLING LOCATIONS

Distance and Direction From Unit No. 1

Sample Media	Location	Station No.	Distance (Miles)	Direction	Collection Frequency	REMARKS	
Airborne Particulate and Radioiodine	NAPS Sewage Treatment Plant	01	0.20	NE	Weekly	On-Site	
	Frederick's Hall	02	5.30	SSW	Weekly		
	Mineral, VA	03	7.10	WSW	Weekly		
	Wares Crossroads	04	5.10	WNW	Weekly		
	Route 752	05	4.20	NNE	Weekly		
	Sturgeon's Creek Marina	05A	3.20	N	Weekly		
	Levy, VA	06	4.70	ESE	Weekly		
	Bumpass, VA	07	7.30	SSE	Weekly		
	End of Route 685	21	1.00	WNW	Weekly	Exclusion Boundary	
	Route 700	22	1.00	WSW	Weekly	Exclusion Boundary	
	"Aspen Hills"	23	0.93	SSE	Weekly	Exclusion Boundary	
	Orange, VA	24	22.00	NW	Weekly	Control	
Surface Water	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	Monthly		
	North Anna River (upstream) Rt 669 Bridge (Brook's Bridge)	09A	12.9	WNW	Monthly	Control	Rev. 2
	North Anna River (downstream)	11	5.80	SE	Monthly		Rev. 1
Ground Water (well water)	Biology Lab	01A	0.75	SE	Quarterly		
Aquatic Sediment	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	Semi-Annually		
	North Anna River (upstream) Rt 669 Bridge (Brook's Bridge)	09A	12.9	WNW	Semi-Annually	Control	Rev. 2
	North Anna River (downstream)	11	5.80	SE	Semi-Annually		
Shoreline Soil	Lake Anna (upstream)	09	2.20	NW	Semi-Annually		
Soil	NAPS Sewage Treatment Plant	01	0.20	NE	Once per 3 yrs	On-Site	

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NORTH ANNA ENVIRONMENTAL SAMPLING LOCATIONS

Distance and Direction From Unit No. 1

Sample Media	Location	Station No.	Distance (Miles)	Direction	Collection Frequency	REMARKS	
Soil (cont.)	Fredericks Hall	02	5.30	SSW	Once per 3 yrs		Rev. 1
	Mineral, VA	03	7.10	WSW	Once per 3 yrs		
	Wares Crossroads	04	5.10	WNW	Once per 3 yrs		
	Route 752	05	4.20	NNE	Once per 3 yrs		
	Sturgeon's Creek Marina	05A	3.20	N	Once per 3 yrs		Rev. 1
	Levy, VA	06	4.70	ESE	Once per 3 yrs		
	Bumpass, VA	07	7.30	SSE	Once per 3 yrs		
	End of Route 685	21	1.00	WNW	Once per 3 yrs	Exclusion Boundary	
	Route 700	22	1.00	WSW	Once per 3 yrs	Exclusion Boundary	
	"Aspen Hills"	23	0.93	SSE	Once per 3 yrs	Exclusion Boundary	
	Orange, VA	24	22.00	NW	Once per 3 yrs	Control	
Milk	Holladay Dairy (R.C. Goodwin)	12	8.30	NW	Monthly		
	Terrell's Dairy (Frederick's Hall)	13	5.60	SSE	Monthly		
Fish	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	Semiannually		Rev. 1
	Lake Orange	25	16.50	NW	Semiannually	Control	
Food Products (Broad Leaf vegetation)	Route 713	14	varies	NE	Monthly if available, or at harvest		
	Route 614	15	varies	SE			
	Route 629/522	16	varies	NW		Control	
	Route 685	21	varies	WNW			
	"Aspen Hills" Area	23	varies	SSE			

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DETECTION CAPABILITIES FOR SURRY STATION ENVIRONMENTAL SAMPLE ANALYSIS(Note 1)

LOWER LIMIT OF DETECTION (LLD)

Analysis (Note 2)	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg) (wet)	Milk (pCi/l)	Food Products (pCi/kg) (wet)	Sediment (pCi/kg) (wet)
Gross beta	4	0.01				
H-3	2,000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-95	30					
Nb-95	15					
I-131	(Note 3) 1	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60			60		
La-140	15			15		

Note 1: Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

Note 2: This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

Note 3: LLD for the Ground (drinking) Water Samples. The LLD for the Surface (non-drinking Water Samples is 10 pCi/l.

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DETECTION CAPABILITIES FOR SURRY STATION ENVIRONMENTAL SAMPLE ANALYSIS(Note 1)

LOWER LIMIT OF DETECTION (LLD)

Note 1: For a particular measurement system (which may include radiochemical separation):

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

Where:

LLD = the "a priori" (before the fact) Lower Limit of Detection as defined above (as microcuries per unit mass or volume) (see 4.8)

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, cpm)

E = the counting efficiency (as counts per disintegration) Rev. 1

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

2.22×10^6 = the number of disintegrations per minute (dpm) per microcurie

Y = the fractional radiochemical yield (when applicable)

λ = the radioactive decay constant for the particular radionuclide

Δt = the elapsed time between sample collection (or end of the sample collection period) and time of counting (for environmental samples, not plant effluent samples)

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

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not as an "posteriori" (after the fact) limit for a particular measurement.

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DETECTION CAPABILITIES FOR NORTH ANNA STATION ENVIRONMENTAL SAMPLE ANALYSIS(Note 1)

LOWER LIMIT OF DETECTION (LLD)

Analysis (Note 2)	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg) (wet)	Milk (pCi/l)	Food Products (pCi/kg) (wet)	Sediment (pCi/kg) (wet)
Gross beta	4	0.01				
H-3	2,000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	(Note 2) 1	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		

Rev. 1

Note 1: This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Specification 6.9.1.8.

Note 2: This LLD value is for drinking water samples.

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DETECTION CAPABILITIES FOR NORTH ANNA STATION ENVIRONMENTAL SAMPLE ANALYSIS(Note 1)

LOWER LIMIT OF DETECTION (LLD)(Note 3)

Note 3: For a particular measurement system (which may include radiochemical separation):

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

Where:

LLD = the "a priori" (before the fact) Lower Limit of Detection as defined above (as microcuries per unit mass or volume) (see 4.8)

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, cpm)

E = the counting efficiency (as counts per disintegration) Rev. 1

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

2.22×10^6 = the number of disintegrations per minute (dpm) per microcurie

Y = the fractional radiochemical yield (when applicable)

λ = the radioactive decay constant for the particular radionuclide

Δt = the elapsed time between sample collection (or end of the sample collection period) and time of counting (for environmental samples, not plant effluent samples)

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

The LLD is an "a priori" (before the fact) limit representing the capability of a measurement system and not as an a "posteriori" (after the fact) limit for a particular measurement.

ATTACHMENT 26

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REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES AT SURRY STATION

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)
H-3	30,000				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	(Note 1) 2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

Note 1: Reporting level for the ground (drinking) water samples required by Attachment 20. The reporting level for the surface (non-drinking) water samples required by Attachment 20 is 20 pCi/l.

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REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES AT NORTH ANNA STATION

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)
H-3	20,000(1)				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

Note 1: For drinking water samples.

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SURRY METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

1.0 METEOROLOGICAL ANALYSIS

1.1 Purpose

The purpose of the meteorological analysis was to determine the annual average χ/Q and D/Q values at critical locations around the Station for ventilation vent (ground level) and process vent (mixed mode) releases. The annual average χ/Q and D/Q values were used in a dose pathway analysis to determine both the maximum exposed individual at site boundary and member of the public. The χ/Q and D/Q values resulting in the maximum exposures were incorporated into the dose factors in Attachments 12 and 18.

1.2 Meteorological Data, Parameters, and Methodology

Onsite meteorological data for the period January 1, 1979, through December 31, 1981, was used in calculations. These data included wind speed, wind direction, and differential temperature for the purpose of determining joint frequency distributions for those releases characterized as ground level (i.e., ventilation vent), and those characterized as mixed mode (i.e., process vent). The portions of release characterized as ground level were based on $\Delta T_{158.9ft-28.2ft}$ and 28.2 foot wind data, and the portions characterized as mixed mode were based on $\Delta T_{158.9ft-28.2ft}$ and 158.9 ft wind data.

χ/Q's and D/Q's were calculated using the NRC computer code "XOQDOQ - Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations", September, 1977. The code is based upon a straight line airflow model implementing the assumptions outlined in Section C (excluding C1a and C1b) of Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light - Water - Cooled Reactors".

The open terrain adjustment factors were applied to the χ/Q values as recommended in Regulatory Guide 1.111. The site region is characterized flat terrain such that open terrain correction factors are considered appropriate. The ground level ventilation vent release calculations included a building wake correction based on a [illegible]16 m^2 containment minimum cross-sectional area. The effective release height used in mixed mode release calculations was based on a process vent release height of 131 ft, and plume rise due to momentum for a vent diameter of 3 in. with plume exit velocity of 100 ft/sec.

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SURRY METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

Ventilation vent, and vent releases other than from the process vent, are considered ground level as specified in Regulatory Guide 1.111 for release points less than the height of adjacent solid structures, terrain elevations were obtained from Surry Power Station Units 1 and 2 Virginia Electric and Power Company Updated Final Safety Analysis Report Table 11A-11.

χ/Q and D/Q values were calculated for the nearest site boundary, resident, milk cow, and vegetable garden by sector for process vent and ventilation vent releases. χ/Q values were also calculated for the nearest discharge canal bank for process and ventilation vent releases.

According to the definition for short term in NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Stations," October, 1978, some gaseous releases may fit this category, primarily waste gas decay tank releases and containment purges. However, these releases are considered long term for dose calculations as past releases were both random in time of day and duration as evidenced by reviewing past release reports. Therefore, the use of annual average concentrations is appropriate according to NUREG-0133.

1.3 Results

The χ/Q value that resulted in the maximum total body, skin, and inhalation exposure for ventilation vent releases was 6.0E-05 sec/m^3 at a site boundary location 499 meters N sector. For process vent releases, the site boundary χ/Q value was 1.0E-06 sec/m^3 at a location 644 meters S sector. The discharge canal bank χ/Q value that resulted in the maximum inhalation exposure for ventilation vent releases was 7.8E-05 sec/m^3 at a location 290 meters NW sector. The discharge canal bank χ/Q value for process vent was 1.6E-06 sec/m^3 at a location 290 meters NW sector.

Pathway analysis indicated that the maximum exposure from I-131, and from all radionuclides in particulate form with half-lives greater than 8 days was through the grass-cow-milk pathway. The D/Q value from ventilation vent releases resulting in the maximum exposure was 9.0E-10 per m^2 at a location 5150 meters S sector. For process vent releases, the D/Q value was 4.3E-10 per m^2 at a location 5150 meters S sector. For tritium, the χ/Q value from ventilation vent releases resulting in the maximum exposure for the milk pathway was 3.0E-07 sec/m^3, and 1.3E-07 sec/m^3 for process vent releases at a location 5150 meters S sector. The inhalation pathway is the only other pathway existing at this location. Therefore, the χ/Q values given for tritium also apply for the inhalation pathway.

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SURRY METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

2.0 LIQUID PATHWAY ANALYSIS

2.1 Purpose

The purpose of the liquid pathway analysis was to determine the maximum exposed member of the public in unrestricted areas as a result of radioactive liquid effluent releases. The analysis included a determination of most restrictive liquid pathway, most restrictive age group, and critical organ. This analysis is required for subsection 6.2, Liquid Radioactive Waste Effluents.

2.2 Data, Parameters, and Methodology

Radioactive liquid effluent release data for the years 1976, 1977, 1978, 1979, 1980, and 1981 was compiled from the Surry Power Station effluent release reports. The data for each year, along with appropriate site specific parameters and default selected parameters, were entered into the NRC computer code LADTAP as described in NUREG-0133.

Liquid radioactive effluents from both units are released to the James River via the discharge canal. Possible pathways of exposure for release from the Station include ingestion of fish and invertebrates and shoreline activities. The irrigated food pathway and potable water pathway do not exist at this location. Access to the discharge canal by the general public is gained two ways: access for bank fishing is controlled by the Station and is limited to Virginia Power employees or guests of employees, and boating access is open to the public as far upstream as the inshore end of the discharge canal groin. It has been estimated that boat sport fishing would be performed a maximum of 800 hours per year, and that bank fishing would be performed a maximum of 160 hours per year.

For an individual fishing in the discharge canal, no river dilution was assumed for the fish pathway. For an individual located beyond the discharge canal groins, a river dilution factor of 5 was assumed as appropriate according to Regulatory Guide 1.109, Rev. 1, and the fish, invertebrate, and shoreline pathways were considered to exist. Dose factors, bioaccumulation factors, and shore width factors given in Regulatory Guide 1.109, Rev. 1, and in LADTAP were used, as were usage terms for shoreline activities and ingestion of fish and invertebrates. Dose to an individual fishing on the discharge bank was determined by multiplying the annual dose calculated with LADTAP by the fractional year the individual spent fishing in the canal.

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SURRY METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

2.3 Results

For the years 1976, 1977, 1979, 1980, and 1981, the invertebrate pathway resulted in the largest dose. In 1978 the fish pathway resulted in the largest dose. The maximum exposed member of the public was determined to utilize the James River. The critical age group was the adult and the critical organ was either the thyroid or GI-LLI. The ingestion dose factor, A_i, in 6.2.3 includes the fish and invertebrate pathways. A_i dose factors were calculated for the total body, thyroid, and GI-LLI organs.

3.0 GASEOUS PATHWAY ANALYSIS

3.1 Purpose

A gaseous effluent pathway analysis was performed to determine the location that would result in the maximum doses due to noble gases for use in demonstrating compliance with 6.3.1.a and 6.3.3.a. The analysis also included a determination of the location, pathway, and critical organ, of the maximum exposed member of the public, as a result of the release of I-131, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days for use in demonstrating compliance with 6.3.4.a. In addition, the analysis included a determination of the critical organ, maximum age group, and sector location of an exposed individual through the inhalation pathway from I-131, tritium, and particulates to demonstrate compliance with 6.3.1.a.

3.2 Data, Parameters, and Methodology

Annual average χ/Q values were calculated, as described in Section 1 of this attachment, for the nearest site boundary in each directional sector and at other critical locations accessible to the public inside site boundary. The largest χ/Q value was determined to be 6.0E-05 sec/m^3 at site boundary for ventilation vent releases at a location 499 meters N direction, and 1.0E-06 sec/m^3 at site boundary for process vent releases at a location 644 meters S direction. The maximum doses to total body and skin, and air doses for gamma and beta radiation due to noble gases would be at these site boundary locations. The doses from both release points are summed in calculations to calculate total maximum dose.

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SURRY METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

6.3.1.a.2 dose limits apply specifically to the inhalation pathway. Therefore, the locations and χ/Q values determined for maximum noble gas doses can be used to determine the maximum dose form I-131, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days for the inhalation pathway.

The NRC computer code GASPAR, "Evaluation of Atmospheric Releases", Revised 8/19/77, was run using 1976, 1977, 1978, 1979, 1980 and 1981 Surry Power Station gaseous effluent release report data. Doses from I-131, tritium, and particulates for the inhalation pathway were calculated using the 6.0E-05 sec/m^3 site boundary χ/Q. Except for the source term data and the χ/Q value, computer code default parameters were used. Results for each year indicated that the critical age group was the child and the critical organ was the thyroid for the inhalation pathway. In 1979, the teen was the critical age group. However, the dose calculated for the teen was only slightly greater than for the child and the doses could be considered equivalent.

The gamma and beta dose factors K_{ivv}, L_{ivv}, M_{ivv}, and N_{ivv} in Attachment 12 were obtained by performing a units conversion of the appropriate dose factors from Table B-1, Regulatory Guide 1.109, Rev. 1, to mrem/yr per Ci/m^3 or mrad/yr per Ci/m^3, and multiplying by the ventilation vent site boundary χ/Q value of 6.0E-05 sec/m^3. The same approach was used to calculate the gamma and beta dose factors K_{ipv}, L_{ipv}, M_{ipv}, and N_{ipv} in Attachment 12 using the process vent site boundary χ/Q value of 1.0E-06 sec/m^3.

Inhalation pathway dose factors P_{ivv} and P_{ipv} in Attachment 12 were calculated using the equation:

$$P_i = K' \text{ (BR) } DFA_i \text{ (}\chi/Q \text{ (mrem/yr per Curie/sec)}$$

where:

- K' = a constant of unit conversion, 1E+12 pCi/Ci
- BR = the breathing rate of the child age group, 3700 m3/yr, from Table E-5, Regulatory Guide 1.109, Rev.1
- DFA_i = the thyroid organ inhalation dose factor for child age group for the ith radionuclide, in mrem/pCi, from Table E-9, Regulatory Guide 1.109, Rev. 1
- χ/Q = the ventilation vent site boundary χ/Q, 6.0E-5 sec/m^3, or the process vent site boundary χ/Q, 1.0E-06 sec/m^3 as appropriate

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SURRY METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

6.3.4.a, requires that the dose to the maximum exposed member of the public from I-131, tritium, and from all radionuclides in particulate form with half-lives greater than 8 days be less than or equal to the specified limits. Dose calculations were performed for an exposed member of the public within site boundary unrestricted areas, discharge canal bank, and to an exposed member of the public beyond site boundary at real residences with the largest χ/Q values using the NRC computer code GASPAR. Doses to Members of the Public were also calculated for the vegetable garden, meat animal, and milk-cow pathways with the largest D/Q values using the NRC computer code GASPAR.

It was determined that the member of the public within site boundary would be using the discharge canal bank for fishing a maximum of 160 hours per year. The maximum annual χ/Q at this location was determined to be 7.8E-05 sec/m^3 at 290 meters NW direction. After applying a correction for the fractional part of year an individual would be fishing at this location, the dose was calculated to be less than an individual would receive at site boundary.

The member of the public receiving the largest dose beyond site boundary was determined to be located 5150 meters S sector. The critical pathway was the grass-cow-milk, the maximum age group was the infant, and the critical organ the thyroid. For each year 1976, 1977, 1978, 1979, 1980 and 1981 the dose to the infant from the grass-cow-mild pathway was greater than the dose to the member of the public within site boundary, nearest residence, vegetable or meat pathways. Therefore, the maximum exposed member of the public was determined to be the infant, exposed through the grass-cow-milk pathway, critical organ thyroid, at a location 5150 meters S sector. The only other pathway existing at this location for the infant is the inhalation.

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SURRY METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

The RM_{ivv} and RM_{ipv} dose factors, except for tritium, in Attachment 18 were calculated by multiplying the appropriate D/Q value with the following equation:

$$RM_i = K' \frac{Q_F\ (U_{ap})}{\lambda_i + \lambda_w} F_m\ (r)\ (DFL_i) \left[\frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)\ e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

where:

K' = a constant of unit conversion, 1E+12 pCi/Ci

Q_F = cow's consumption rate, 50, in Kg/day (wet weight)

U_{ap} = infant milk consumption rate, 330, liters/yr

Y_p = agricultural productivity by unit area of pasture feed grass, 0.7 Kg/m^2

Y_s = agricultural productivity by unit area of stored feed, 2.0, in Kg/m^2

F_m = stable element transfer coefficients, from Table E-1, Regulatory Guide 1.109, Rev. 1

r = fraction of deposited activity retained on cow's feed grass, 1.0 for radioiodine, and 0.2 for particulates

DFL_i = thyroid ingestion dose factor for the ith radionuclide for the infant, in mrem/pCi, from Table E-14, Regulatory Guide 1.109, Rev.1

λ_i = decay constant for the ith radionuclide, in sec^{-1}

λ_w = decay constant for removal of activity of leaf and plant surfaces by weathering, 5.73E-07 sec^{-1} (corresponding to a 14 day half-life)

t_f = transport time from pasture to cow, to milk, to receptor, 1.73+05, in seconds

t_h = transport time from pasture, to harvest, to cow, to milk, to receptor, 7.78E+06, in seconds

f_p = fraction of year that cow is on pasture, 0.67 (dimensionless), 7.78E+06 in seconds

f_s = fraction of cow feed that is pasture grass while cow is on pasture, 1.0, dimensionless

Parameters used above were obtained from NUREG-0133 and Regulatory Guide 1.109, Rev.1.

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SURRY METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

Since the concentration of tritium in milk is based on the airborne concentration rather than the deposition, the following equation is used:

$$R_{H-3} = K' \; K''' \; F_m \; Q_F \; U_{ap} \; (DFL_{H-3}) \; [0.75 \; (0.5/H)] \times \chi/Q$$

where:

- K''' = a constant of unit conversion 1E+03 gm/kg
- H = absolute humidity of the atmosphere, 8.0, gm/m^3
- 0.75 = the fraction of total feed that is water
- 0.5 = the ratio of the specific activity of the feed grass to the atmospheric water
- χ/Q = the annual average concentration at a location 5150 meters S sector, 3.0E-07 sec/m^3 for ventilation vent releases, and 1.3E-07 sec/m^3 for the process vent releases

Other parameters have been previously defined.

The inhalation pathway dose factors RI_{ivv} and RI_{ipv} in Attachment 18 were calculated using the following equation:

$$RI_i = K' \; (BR) \; DFA_i \; (\chi/Q) \; \text{(mrem/yr per Curie/sec)}$$

where:

- K' = a constant of unit conversion, 1E+12 pCi/Ci
- BR = breathing rate of the infant age group, 1400 m^3/yr, from Table E-5, Regulatory Guide 1.109, Rev.1
- DFA_i = thyriod organ inhalation dose factor for infant age group for the ith radionuclide, in mrem/pCi, from Table E-10, Regulatory Guide 1.109, Rev.1
- χ/Q = ventilation vent χ/Q, 3.0E-07 sec/m^3, or the process vent site boundary χ/Q, 1.3E-07 sec/m^3, at a location 5150 meters S sector.

The GASPAR computer runs using 1976, 1977, 1978, 1979, 1980 and 1981 Surry effluent release data were reviewed to determine the percent of total dose from the cow milk and inhalation pathways for I-133. I-133 contributed less than 1 percent of the total dose to an infant's thyroid except for the year 1977 when the percent I-133 was 1.77. The calculations indicate that I-133 is a negligible dose contributor and its inclusion in a sampling and analysis program and dose calculation is unnecessary.

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NORTH ANNA METEOROLOGICAL, LIQUID AND GASEOUS PATHWAY ANALYSIS

1.0 METEOROLOGICAL ANALYSIS

1.1 Purpose

The purpose of the meteorological analysis was to determine the annual average χ/Q and D/Q values at critical locations around the Station for ventilation vent (ground level) and process vent (mixed mode) releases. The annual average χ/Q and D/Q values were used to perform a dose pathway analysis to determine both the maximum exposed individual at site boundary and member of the public. The χ/Q and D/Q values resulting in the maximum exposures were incorporated into the dose factors in Attachments 13 and 19.

1.2 Meteorological Data, Parameters, and Methodology

Onsite meteorological data for the period January 1, 1981, through December 31, 1981, were used in calculations. This data included wind speed, wind direction, and differential temperature for the purpose of determining joint frequency distributions for those releases characterized as ground level (e.g., ventilation vent), and those characterized as mixed mode (i.e., process vent). The portions of release characterized as ground level were based on $\Delta T_{158.9ft-28.2ft}$ and 28.2 foot wind data, and the portions characterized as mixed mode were based on $\Delta T_{158.9ft-28.2ft}$ and 158.9 ft wind data.

χ/Q's and D/Q's were calculated using the NRC computer code "XOQDOQ - Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations", September, 1977. The code is based upon a straight line airflow model implementing the assumptions outlined in Section C (excluding C1a and C1b) of Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light - Water - Cooled Reactors".

The open terrain adjustment factors were applied to the χ/Q values as recommended in Regulatory Guide 1.111. The site region is characterized by gently rolling terrain so open terrain correction factors were considered appropriate. The ground level ventilation vent release calculations included a building wake correction based on a 1516 m^2 containment minimum cross-sectional area.

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The effective release height used in mixed mode release calculations was based on a process vent release height of 157.5 ft, and plume rise due to momentum for a vent diameter of 3 in. with plume exit velocity of 100 ft/sec. Ventilation vent, and vent releases other than from the process vent, are considered ground level as specified in Regulatory Guide 1.111 for release points less than the height of adjacent solid structures, terrain elevations were obtained from North Anna Power Station Units 1 and 2, Virginia Electric and Power Company Final Safety Analysis Report Table 11C.2-8.

χ/Q and D/Q values were calculated for the nearest site boundary, resident, milk cow, and vegetable garden by sector for process vent and ventilation vent releases at distances specified from North Anna Power Station Annual Environmental Survey Data for 1981. χ/Q values were also calculated for the nearest lake shoreline by sector for the process vent and ventilation vent releases.

According to the definition for short term in NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Stations," October, 1978, some gaseous releases may fit this category, primarily waste gas decay tank releases and containment purges. However, these releases are considered long term for dose calculations as past releases were both random in time of day and duration as evidenced by reviewing past release reports. Therefore, the use of annual average concentrations is appropriate according to NUREG-0133.

The χ/Q and D/Q values calculated from 1981 meteorological data are comparable to the values presented in the North Anna Power Station UFSAR.

1.3 Results

The χ/Q value that resulted in the maximum total body, skin and inhalation exposure for ventilation vent releases was 9.3E-06 sec/m^3 at a site boundary location 1416 meters SE sector. For process vent releases, the site boundary χ/Q value was 1.2E-06 sec/m^3 at a location 1513 meters S sector. The shoreline χ/Q value that resulted in the maximum inhalation exposure for ventilation vent releases was 1.0E-04 sec/m^3 at a location 241 meters NNE sector. The shoreline χ/Q value for process vent was 3.7E-06 sec/m^3 at a location 241 meters NNE sector.

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Pathway analysis indicated that the maximum exposure from I-131, and from all radionuclides in particulate form with half-lives greater than 8 days was through the grass-cow-milk pathway. The D/Q value from ventilation vent releases resulting in the maximum exposure was 2.4E-09 per m^2 at a location 3250 meters N sector. F(process vent releases, the D/Q value was 1.1E-09 per m^2 at a location 3250 meters N sector. For tritium, the χ/Q value from ventilation vent releases resulting in the maximum exposure for the milk pathway was 7.2E-07 sec/m^3, and 3.9E-07 sec/m^3 for process vent releases at a location 3250 meters N sector.

2.0 LIQUID PATHWAY ANALYSIS

2.1 Purpose

The purpose of the liquid pathway analysis was to determine the maximum exposed member of the public in unrestricted areas as a result of radioactive liquid effluent releases. The analysis includes a determination of most restrictive liquid pathway, most restrictive age group, and critical organ. This analysis is required for 6.2.

2.2 Data, Parameters, and Methodology

Radioactive liquid effluent release data for the years 1979, 1980, and 1981 was compiled from the North Anna Power Station semi-annual effluent release reports. The data for each year, along with appropriate site specific parameters and default selected parameters, was entered into the NRC computer code LADTAP as described in NUREG-0133.

Reconcentration of effluents using the small lake connected to larger water body model was selected with the appropriate parameters determined from Table 3.5.3.5, Design Data for Reservoir and Waste Heat Treatment Facility from Virginia Electric and Power Company, Applicant's Environmental Report Supplement, North Anna Power Station, Units 1 and 2, March 15, 1972. Dilution factors for aquatic foods, shoreline, and drinking water were set to one. Transit time calculations were based on average flow rates. All other parameters were defaults selected by the LADTAP computer code.

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2.3 Results

For each year, the fish pathway resulted in the largest dose. The critical organ each year was the liver, and the adult and teenage age groups received the same organ dose. However, since th. adult total body dose was greater than the teen total body dose for each year, the adult was selected as the most restrictive age group. Dose factors in Attachment 7 are for the maximum exposed member of the public, an adult, with the critical organ being the liver.

3.0 GASEOUS PATHWAY ANALYSIS

3.1 Purpose

A gaseous effluent pathway analysis was performed to determine the location that would result in the maximum doses due to noble gases for use in demonstrating compliance with 6.3.1.a and 6.3.3.a. The analysis also included a determination of the critical pathway, location of maximum exposed member of the public, and the critical organ for the maximum dose due to I-131, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days for use in demonstrating compliance with requirements in 6.3.1.a.1 and 6.3.3.a. The Analysis also included a determination of the critical pathway, location of maximum exposed member of the public, and the critical organ for the maximum dose due to I-131, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days for use in demonstrating compliance with 6.3.1.a.2 and 6.3.4.a.

3.2 Data, Parameters, and Methodology

Annual average χ/Q values were calculated, as described in Section 1 of this attachment, for the nearest site boundary in each directional sector and at other critical locations beyond the site boundary. The largest χ/Q value was determined to be 9.3E-06 sec/m^3 at site boundary for ventilation vent releases at a location 1416 meters SE direction, and 1.2E-06 sec/m^3 at site boundary for process vent releases at a location 1513 meters S direction. The maximum doses to total body and skin, and air doses for gamma and beta radiation due to noble gases would be at these site boundary locations. The doses from both release points are summed in calculations to calculate total maximum dose.

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6.3.1.a.2 dose limits apply specifically to the inhalation pathway. Therefore, the locations and χ/Q values determined for maximum noble gas doses can be used to determine the maximum dose form I-131, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days for the inhalation pathway.

The NRC computer code GASPAR, "Evaluation of Atmospheric Releases," Revised 8/19/77, was run using 1979, 1980 and 1981 North Anna Power Station Gaseous Effluent Release Report data. Doses from I-131, tritium, and particulates for the inhalation pathway were calculated using the 9.3E-06 sec/m^3 site boundary χ/Q. Except for the source term data and the χ/Q value, computer code default parameters were used. Results for each year indicated that the critical age group was the child and the critical organ was the thyroid for the inhalation pathway.

The gamma and beta dose factors K_{ivv}, L_{ivv}, M_{ivv}, and N_{ivv} in Attachment 12 were obtained by performing a units conversion of the appropriate dose factors from Table B-1, Regulatory Guide 1.109, Rev. 1, to mrem/yr per Ci/m^3 or mrad/yr per Ci/m^3, and multiplying by the ventilation vent site boundary χ/Q value of 9.3E-06 sec/m^3. The same approach was used in calculating the gamma and beta dose factors K_{ipv}, L_{ipv}, M_{ipv}, and N_{ipv} in Attachment 13 using the process vent site boundary χ/Q value of 1.2E-06 sec/m^3.

The inhalation pathway dose factors P_{ivv} and P_{ipv} in Attachment 13 were calculated using the following equation:

$$P_i = K' (BR) DFA_i (\chi/Q) \text{ (mrem/yr per Curie/sec)}$$

where:

K' = a constant of unit conversion, 1E+12 pCi/Ci

BR = the breathing rate of the child age group, 3700 m^3/yr, from Table E-5, Regulatory Guide 1.109, Rev.1

DFA_i = the thyroid organ inhalation dose factor for child age group for the ith radionuclide, in mrem/pCi, from Table E-9, Regulatory Guide 1.109, Rev. 1

χ/Q = the ventilation vent site boundary χ/Q, 9.3E-06 sec/m^3, or the process vent site boundary χ/Q, 1.2E-06 sec/m^3 as appropriate.

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6.3.4.a, requires that the dose to the maximum exposed member of the public from I-131, tritium, and from all radionuclides in particulate form with half-lives greater than 8 days be less than or equal to the specified limits. Dose calculations were performed for an exposed member of the public within site boundary unrestricted areas, and to an exposed member of the public beyond site boundary at locations identified in the North Anna Power Station Annual Environmental Survey Data for 1981.

It was determined that the member of the public within site boundary would be using Lake Anna for recreational purposes a maximum of 2232 hours per year. It is assumed that this member of the public would be located the entire 2232 hours at the lake shoreline with the largest annual χ/Q of 1.0E-04 at a location 241 meters NNE sector. The NRC computer code GASPAR was run to calculate the inhalation dose to this individual. The GASPAR results were corrected for the fractional year the member of the public would be using the lake.

Using the NRC computer code GASPAR and annual average χ/Q and D/Q values obtained as described in Section 1 of this attachment the member of the public receiving the largest dose beyond site boundary was determined to be located 3250 meters N sector. The critical pathway was the grass-cow-milk, the maximum age group was the infant, and the critical organ the thyroid.

For each year 1979, 1980 and 1981 the dose to the infant from the grass-cow-milk pathway was greater than the dose to the member of the public within site boundary. Therefore, the maximum exposed member of the public was determined to be the infant, exposed through the grass-cow-milk pathway, critical organ thyroid, at a location 3250 meters N sector.

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The R_{ivv} and R_{ipv} dose factors, except for tritium, in Attachment 19 were calculated by multiplying the appropriate D/Q value with the following equation:

$$R_i = K' \frac{Q_F \ (U_{ap})}{\lambda_i + \lambda_w} F_m \ (r) \ (DFL_i) \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) \ e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

where:

K' = a constant of unit conversion, 1E+12 pCi/Ci

Q_F = cow's consumption rate, 50, in Kg/day (wet weight)

U_{ap} = infant milk consumption rate, 330, liters/yr

Y_p = agricultural productivity by unit area of pasture feed grass, 0.7 Kg/m^2

Y_s = agricultural productivity by unit area of stored feed, 2.0, in Kg/m^2

F_m = stable element transfer coefficients, from Table E-1, Regulatory Guide 1.109, Rev. 1

r = fraction of deposited activity retained on cow's feed grass, 1.0 for radioiodine, and 0.2 for particulates

DFL_i = thyroid ingestion dose factor for the ith radionuclide for the infant, in mrem/pCi, from Table E-14, Regulatory Guide 1.109, Rev.1

λ_i = decay constant for the ith radionuclide, in sec^{-1}

λ_w = decay constant for removal of activity of leaf and plant surfaces by weathering, 5.73E-07 sec^{-1} (corresponding to a 14 day half-life)

t_f = transport time from pasture to cow, to milk, to receptor, 1.73E+05, in seconds

t_h = transport time from pasture, to harvest, to cow, to milk, to receptor, 7.78E+06, in seconds

f_p = fraction of year that cow is on pasture, 0.58 (dimensionless), 7 months per year from NUREG-0597

f_s = fraction of cow feed that is pasture grass while cow is on pasture, 1.0, dimensionless

Parameters used in the above equation were obtained from NUREG-0133 and Regulatory Guide 1.109, Rev.1.

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Since the concentration of tritium in milk is based on the airborne concentration rather than the deposition, the following equation is used:

$$R_{H-3} = K' \; K''' \; F_m \; Q_F \; U_{ap} \; (DFL_{H-3}) \; [0.75 \; (0.5/H)] \; \times \; \chi/Q$$

where:

K''' = a constant of unit conversion 1E+03 gm/kg

H = absolute humidity of the atmosphere, 8.0, gm/m^3

0.75 = the fraction of total feed that is water

0.5 = the ratio of the specific activity of the feed grass to the atmospheric water

χ/Q = the annual average concentration at a location 3250 meters N sector, 7.2E-07 sec/m^3 for ventilation vent releases, and 3.9E-07 sec/m^3 for the process vent releases

Other parameters have been previously defined.