North Anna Power Station
Updated Final Safety Analysis Report

Chapter 11

Intentionally Blank

Chapter 11: Radioactive Waste Management
Table of Contents

Chapter 11: Radioactive Waste Management
Table of Contents (continued)

Chapter 11: Radioactive Waste Management
Table of Contents (continued)

Chapter 11: Radioactive Waste Management
Table of Contents (continued)

Chapter 11: Radioactive Waste Management
Table of Contents (continued)

Chapter 11: Radioactive Waste Management
Table of Contents (continued)

Chapter 11: Radioactive Waste Management

List of Tables

Chapter 11: Radioactive Waste Management

List of Tables (continued)

Chapter 11: Radioactive Waste Management

List of Tables (continued)

Chapter 11: Radioactive Waste Management

List of Tables (continued)

Chapter 11: Radioactive Waste Management

List of Figures

Intentionally Blank

CHAPTER 11 RADIOACTIVE WASTE MANAGEMENT

Note: As required by the Renewed Operating Licenses for North Anna Units 1 and 2, issued March 20, 2003, various systems, structures, and components discussed within this chapter are subject to aging management. The programs and activities necessary to manage the aging of these systems, structures, and components are discussed in Chapter 18.

The waste disposal systems separate, treat, hold for decay, and dispose of radioactive liquid, gaseous, and solid waste materials. Each of the liquid, solid, and gaseous waste disposal systems is designed to serve both reactor units. These systems incorporate one or more of the following basic processes:

1. Demineralization, for removal of dissolved ionized material.
2. Dilution, for reduction of concentration.
3. Filtration, for removal of suspended particulate matter.
4. Natural decay of radioactive isotopes.
5. Packaging for shipment to an offsite vendor, for volume reduction.

Waste originating in the reactor coolant system is collected via the vent and drain system and processed in the waste disposal system. Other waste includes laundry and sample waste and solid waste generated during operation and maintenance.

Adequate sampling, analysis, and monitoring of the waste disposal systems are provided to comply with the operation requirements. Radiation monitoring and volumetric measuring equipment are provided for surveillance of gaseous waste and process stream effluent to ensure compliance with applicable regulations and to provide early indication of possible malfunctions or out-of-specification conditions.

Sufficient shielding is provided to reduce personnel exposure to acceptable levels as discussed in Chapter 12.

Area radiation monitoring equipment, portable radiation survey instruments, health physics facilities, environmental programs, and administrative controls are provided for surveillance and control of radiation and personnel exposure levels to ensure compliance with applicable regulations.

Soon after the plant began operation, it became evident that the 6 gpm capacity of the evaporator was seriously inadequate. Consequently, in July of 1978, a portable filter demineralizer unit was added. This is described in Section 11.2. The original evaporator, clarifier, and flatbed filter are not used. The limits given by the discharge activity tables will not be exceeded.

Similarly, as numerous plants obtained experience with the urea formaldehyde solidification system, various system shortcomings became evident, particularly the unexpectedly large amount of free liquid. Consequently, the North Anna plant no longer uses that system but now uses contractor supplied waste solidification and/or dewater systems. This change is discussed in Section 11.5.

For both of these system changes, written operating procedures were prepared and approved to assure safe and reliable processing of all radioactive waste.

11.1 SOURCE TERMS

The fission product inventory in the reactor core and the diffusion to the fuel pellet cladding gap for a core using 15 x 15 fuel assemblies are presented in Table 11.1-1. Source term data is based on NRC models and assumptions described in NUREG-0017.

11.1.1 Radioactivity

This section presents the quantities of radioactive isotopes present in the core, fuel rod gap, coolant, and volume control tank for a core with 15 x 15 fuel assemblies. A brief discussion of the derivation is also provided.

11.1.1.1 Activities in the Core

The total core activity calculation is consistent with TID 14844 (Reference 1) and data from APED-5398 (Reference 2). Numerical values for isotopes that are important as health hazards are given in Table 11.1-1. The source term used in design basis accident analysis is based on the Alternative Source Term as described in Section 15.4.

11.1.1.2 Activities in the Fuel Rod Gap

The computed gap activities are given for both the 15 x 15 (Table 11.1-1) and 17 x 17 (Table 15.1-5) fuel assemblies. A comparison of the gap activities for these two fuel assemblies shows that the gap activities for the 17 x 17 fuel assembly are only about one-half of those of the 15 x 15 fuel assembly. This is a result of the lower operating temperatures and therefore the slower diffusion rate in the 17 x 17 fuel. For this reason, the calculations in Chapter 11 have not been recalculated for the 17 x 17 fuel assembly, since the results would have only been less.

The computed gap activities (15 x 15) are based on buildup in the fuel from the fission process and diffusion to the fuel rod gap at rates dependent on the operating temperature. For the purposes of this analysis, the fuel pellets were divided into five concentric rings each with release rate dependent on the mean fuel temperature within that ring. The diffusing isotope is assumed present in the gas gap when it has diffused to the boundary of its ring.

The diffusion coefficient, D', for Xe and Kr in UO_2,varies with temperature through the following expression:

$$D'(T) = D'(1673)\exp\left[-\frac{E}{R}\left(\frac{1}{T} - \frac{1}{1673}\right)\right] \qquad (11.1\text{-}1)$$

where:

E = activation energy
D' (1673) = diffusion coefficient at 1673 K = 1×10^{-11} sec^{-1}
T = temperature, K
R = gas constant

The above expression is valid for temperatures above 1100°C. Below 1100°C fission gas release occurs mainly by two temperature-independent phenomena, recoil and knock-out, and is predicted by using D' at 1100°C. The value used for D' (1673 K), based on data at burnups greater than 10^{19} fission/cc, accounts for possible fission gas release by other mechanisms and pellet cracking during irradiation.

The diffusion coefficient for iodine isotopes is assumed to be the same as for Xe and Kr. Toner and Scott (Reference 3) observed that iodine diffused in UO at about the same rate as Xe and Kr and has about the same activation energy.

Data surveyed and reported by Belle (Reference 4) indicate that iodine diffuses at slightly slower rates than do Xe and Kr.

For a full core cycle at 2900 MWt core power, the above analysis results in a pellet-clad gap activity of less than 3% of the dose equivalent equilibrium core iodine inventory. The noble gas activity present in the pellet-clad gap is about 2.5% of the core inventory.

The percentage of the total core activity present in the gap for each isotope is also listed in Table 11.1-1.

The core temperature distribution used in this analysis is presented in Table 11.1-2.

The inventory of fission products in a fuel assembly is dependent on the rating of the assembly. The parameters used for the calculations of the highest rated assembly in the core to be discharged are summarized in Table 11.1-3, while the associated activities at the time of shutdown are given in Table 11.1-4.

The expected end-of-life temperature and power distributions were calculated by using radial and axial power peaking factors of 1.27 and 1.37 respectively. The conservative end-of-life temperature and power distributions were calculated by using the same radial power peaking factor as in the expected case, but with a higher axial power peaking factor of 1.72. Thus, the temperature/volume distribution in the fuel is changed and the maximum temperature is increased (Table 11.1-3), resulting in an increased fraction of fission products in the fuel-cladding gap (Table 11.1-4).

While the full core cycle was based on 2900 MWt, the gap activity of 15 x 15 fuel is approximately twice that of the 17 x 17 fuel used in the North Anna cores given the same operating conditions. This source term is normalized to the Technical Specifications dose equivalent I-131 limit in the primary coolant, which essentially removes the power dependence from the analyses. For the measurement uncertainty recapture power uprate to 2940 MWt, the existing fuel rod gap activities were determined to be conservative.

11.1.1.3 **Activities in the Reactor Coolant**

The parameters used in the calculation of the design case reactor coolant fission product inventories, together with the pertinent information concerning the expected coolant cleanup flow rate and demineralizer effectiveness, are summarized in Table 11.1-5. The results of the calculations are presented in Table 11.1-6. In these calculations the defective fuel rods were assumed to be present at the initial core loading and were uniformly distributed throughout the core. Thus, the fission product escape rate coefficients were based upon the average fuel temperature. The calculations were performed for the average temperature of the reactor coolant system. The coolant density correction of 1.35 was made in order to obtain the correct activities downstream of the regenerative heat exchanger.

The expected case activities are those calculated for the 10 CFR 50 Appendix I analysis using NUREG-0017 methodology. The Appendix I evaluation presented in Section 11C.1 is based on radioactive release rates for Units 1 and 2 expected at the time of initial licensing of the units. The following discussion pertains to the calculation of new expected source terms for Units 1 and 2 based on revised calculational models and related guidance as contained in NUREG-0017. The source terms (primary coolant and secondary-side liquid and steam radioactivities) and the resulting radioactive releases are calculated using the basic assumptions and approaches contained in NUREG-0017.

The PWR-GALE code used by the NRC staff is not used in these analyses. However, the procedures that are used provide essentially the same mathematical treatments. Values of parameters, such as flow rates, are based on the North Anna Units 1 and 2 design. In some instances, standard NRC staff assumptions are used in lieu of the design values in order to fit the NUREG-0017 analysis for North Anna Units 1 and 2 as closely as possible to the NRC staff's analytical approach. The staff's model is inflexible in some respects and is expected to lead necessarily to slightly different results than those from this analysis. The data described herein represent an attempt to analyze the releases using the NRC model and assumptions as closely as Virginia Power could configure them.

Table 11.1-9 contains the parameters used in determining source terms. Table 11.1-10 lists the source terms.

For fuel failure and burnup experience see Chapter 4.

The fission product activities in the reactor coolant during operation with small cladding defects (fuel rods containing pinholes or fine cracks) are computed using the following differential equations:

For parent nuclides in the coolant:

$$\frac{dN_{wi}}{dt} = D\upsilon_j N_{ci} - \left(\lambda_i + R\eta_i + \frac{B'}{B_o - tB'}\right) N_{wi} \qquad (11.1\text{-}2)$$

For daughter nuclides in the coolant:

$$\frac{dN_{wj}}{dt} = D\upsilon_j N_{cj} - \left(\lambda_j + R\eta_j + \frac{B'}{B_o - tB'}\right) N_{wj} + \lambda_i N_{wi} \quad (11.1\text{-}3)$$

where:

N = nuclide concentration

D = clad effects, as a fraction of rated core thermal power being generated by rods with clad defects

R = purification flow, coolant system volumes per sec

B = initial boron concentration, ppm

B' = boron concentration reduction rate by feed and bleed, ppm/sec

η = removal efficiency of purification cycle for nuclide

λ = radioactive decay constant

υ = escape rate coefficient for diffusion into coolant

t = time

c = core

w = coolant

i = parent nuclide

j = daughter nuclide

11.1.1.4 **Activities in Secondary Side**

The concentrations of principal fission products in the secondary side liquid of the steam generator are given for both design and expected failed fuel conditions in Tables 11.1-7 and 11.1-10, respectively. Concentrations of principal noble gases and halogens in the secondary side steam are given in Tables 11.1-8 and 11.1-10.

11.1.1.5 **Activities in the Volume Control Tank**

The 300-ft^3 volume control tank is assumed to contain 96 ft^3 of liquid and 204 ft^3 of vapor, for dose analysis. Table 11.1-11 lists the activities in the volume control tank with clad defects in 1% of the fuel rods.

11.1.1.6 **Activities in the Pressurizer**

The activities in the pressurizer are separated between the liquid and the steam phase and the results obtained are given in Table 11.1-12 using the assumptions summarized in Table 11.1-5.

11.1.1.7 **Activities in the Demineralizer Resin**

Saturation activities for demineralizer resins (specific source strength) are given in Table 11.1-13 using the assumptions summarized in Table 11.1-5.

11.1.2 Leakage Rates

As a necessary part of the effort to reduce effluent of radioactive liquid wastes, Westinghouse has been surveying various pressurized water reactor (PWR) facilities that are in operation, to identify design and operating problems influencing reactor coolant and nonreactor-grade leakage and hence the load on the waste disposal system.

Leakage sources have been identified as pump shaft seals and valve stem leakage.

Where packed glands are provided, a leakage problem may be anticipated, while mechanical shaft seals provide essentially zero leakage. Valve stem leakage has been experienced, however. A combination of a graphite filament yarn packing sandwiched with asbestos sheet packing is used with improved results.

The station waste disposal systems, as designed, will accommodate the leakages listed in Table 11.1-14. The values given assume cladding defects in fuel rods that generated 1% of the rated core thermal power.

Section 11.3.5 gives conservatively estimated leakages from the gaseous waste system with corresponding activity discharges.

11.1 REFERENCES

1. J. J. Di Nunno et al., *Calculation of Distance Factors for Power and Test Reactor Sites*, TID 14844, March 1962.
2. M. E. Meek and B. F. Rider, *Summary of Fission Product Yields for U235, U238, Pu239 and Pu241 at Thermal Fission Spectrum and 14 MeV Neutron Energies*, APED-5398, General Electric Company, March 1, 1968
3. D. F. Toner and J. L. Scott, “Fission Product Release for UO_2,” *Nuclear Safety*, Vol. III, No. 2, December 1961.
4. J. Belle, *Uranium Dioxide: Properties and Nuclear Application*, Naval Reactors Division of Reactor Development, USAEC, 1961.

Table 11.1-1
CORE AND GAP ACTIVITIES 15 X 15 FUEL ASSEMBLY ARRAY [a]

Isotope	Curies in the Core, ($\times 10^7$)	Percent of Core Activity in the Gap	Curies in the Gap ($\times 10^5$)
I-131	7.17	1.88	13.5
I-132	10.9	0.21	2.29
I-133	16.1	0.63	10.1
I-134	18.9	0.13	2.46
I-135	14.6	0.36	5.26
Xe-133	16.6	1.53	25.4
Xe-133m	0.422	1.01	0.426
Xe-135	4.54	0.42	1.91
Xe-135m	4.45	0.071	0.316
Kr-85	0.0814	25.5	2.08
Kr-85m	3.22	0.29	0.935
Kr-87	6.19	0.16	0.990
Kr-88	8.82	0.23	2.03

a. Assume operation at 2900 MWt for 650 days. Temperature distribution is specified in Table 11.1-2.

Table 11.1-2
CORE TEMPERATURE DISTRIBUTION 15 X 15 FUEL ASSEMBLY ARRAY

Core Fuel Volume Above the Given Temperature, % [a]	Power (MWt)	Local Temperature (°F)
0	0	4100
0.2	6.8	3700
1.8	90	3300
7.0	317	2900
15.5	704	2500

a. Remainder of core fuel volume is assumed at or below 2,500°F.

Table 11.1-3
NUCLEAR CHARACTERISTICS OF HIGHEST RATED DISCHARGED FUEL ASSEMBLY

Reactor	Expected Case	Conservative Case
Power Rating	2900 MWt	2900 MWt
Number of assemblies	157	157
Array	15 x 15	15 x 15
Core average assembly power	18.5	18.5
Discharged assembly (highest power)		
Axial peak to average ratio	1.37	1.72
Peak power	13.4 kW/ft	13.4 kW/ft
Maximum temperature	3500°F	3900°F
Radial peak to average ratio	1.27	1.27

Temperature/Power Distribution

Local Temperature	Fuel Volume (%)	Power in Volume (MWt)	Fuel Volume (%)	Power in Volume (MWt)
>3900	0	0	0	0
3700 - 3900	0	0	1.33	0.32
3500 - 3700	0	0	2.67	0.64
3300 - 3500	1.33	0.32	4.00	0.96
3100 - 3300	2.67	0.64	5.33	1.28
2900 - 3100	4.00	0.96	6.67	1.60
2700 - 2900	5.33	1.28	8.00	1.92
2500 - 2700	6.67	1.60	9.33	2.24
<2500	80.00	19.18	62.67	15.02
Total	100.00	23.98	100.00	23.98

Table 11.1-4
ACTIVITIES IN HIGHEST RATED DISCHARGED ASSEMBLY
AT TIME OF REACTOR SHUTDOWN (Ci)

Isotope	Total Curies
I-131	5.91×10^5
I-132	8.98×10^5
I-133	1.32×10^6
I-134	1.55×10^6
I-135	1.21×10^6
Kr-85m	2.66×10^5
Kr-85	6.53×10^3
Kr-87	5.10×10^5
Kr-88	7.27×10^5
Xe-133m	3.47×10^4
Xe-133	1.36×10^6
Xe-135	3.74×10^5

Table 11.1-5
PARAMETERS USED IN THE CALCULATION OF REACTOR COOLANT FISSION PRODUCT ACTIVITIES (15 x 15 FUEL ASSEMBLY)

Parameter	Value
Core thermal power, max. calculated	2900 MWt
Fraction of fuel containing clad defects design	0.01
Reactor coolant liquid volume, including pressurizer	9380 ft^3
Reactor coolant average temperature	577°F
Purification flow rate (normal/maximum design)	60 gpm/120 gpm
Effective cation demineralizer flow	6.0 gpm
Volume control tank volumes	
Vapor	204 ft^3
Liquid	96 ft^3
Fission product escape rate coefficients	
Noble gas isotopes	6.5×10^{-8} sec^{-1}
Br, I, and Cs isotopes	1.3×10^{-8} sec^{-1}
Te isotopes	1.0×10^{-9} sec^{-1}
Mo isotopes	2.0×10^{-9} sec^{-1}
Sr and Ba isotopes	1.0×10^{-11} sec^{-1}
Y, La, Ce, and Pr isotopes	1.6×10^{-12} sec^{-1}
Mixed bed demineralizer decontamination factors	
Noble gases and Cs-134, Cs-136, Cs-137, Y-90, Y-91, and Mo-99	1.0
All other isotopes	10.0
Cation bed demineralizer decontamination factor for Cs-134, Cs-136, Cs-127, Y-90, Y-91, and Mo-99	10.0

Table 11.1-5 (continued)
PARAMETERS USED IN THE CALCULATION OF REACTOR COOLANT FISSION PRODUCT ACTIVITIES (15 x 15 FUEL ASSEMBLY)

Volume control tank noble gas stripping fraction (closed system)

Isotope	Stripping Fraction
Kr-85	2.3×10^{-5}
Kr-85m	2.7×10^{-1}
Kr-87	6.0×10^{-1}
Kr-88	4.3×10^{-1}
Xe-133	1.6×10^{-2}
Xe-133m	3.7×10^{-2}
Xe-135	1.8×10^{-1}
Xe-135m	8.0×10^{-1}
Xe-138	1.0×10^{0}

Table 11.1-6
CONCENTRATION OF PRINCIPAL FISSION PRODUCTS
IN PRIMARY COOLANT WITH 1.0% FAILED FUEL (μCi/cm^3) [a]

Isotope	Activity	Isotope	Activity
Br-84	3.18×10^{-2}	Cs-136	1.10×10^{-1}
Rb-88	2.77×10^{0}	Cs-137	9.92×10^{-1}
Rb-89	7.55×10^{-2}	Cs-138	6.99×10^{-1}
Sr-89	2.82×10^{-3}	Ba-140	3.19×10^{-3}
Sr-90	1.04×10^{-4}	La-140	1.10×10^{-3}
Sr-91	1.44×10^{-3}	Ce-144	2.42×10^{-4}
Sr-92	5.52×10^{-4}	Pr-144	2.41×10^{-4}
Y-90	1.26×10^{-4}	Kr-85	3.86 (peak)
Y-91	4.55×10^{-3}	Kr-85m	1.59×10^{0}
Y-92	5.38×10^{-4}	Kr-87	9.20×10^{-1}
Zr-95	5.24×10^{-4}	Kr-88	2.78×10^{0}
Nb-95	5.18×10^{-4}	Xe-133	$2.13 \times 10^{+2}$
Mo-99	4.01×10^{0}	Xe-133m	2.36×10^{0}
I-131	1.85×10^{0}	Xe-135	4.62×10^{0}
I-132	6.74×10^{-1}	Xe-135m	1.43×10^{-1}
I-133	2.99×10^{0}	Xe-138	5.08×10^{-1}
I-134	4.17×10^{-1}	Mn-54	5.6×10^{-4}
I-135	1.61×10^{0}	Mn-56	2.1×10^{-2}
Te-132	1.97×10^{-1}	Co-58	1.8×10^{-2}
Te-134	2.18×10^{-2}	Co-60	5.4×10^{-4}
Cs-134	1.98×10^{-1}	Fe-59	7.5×10^{-4}
		Cr-51	6.8×10^{-4}

a. Based on parameters of Table 11.1-5.

Table 11.1-7
CONCENTRATION OF PRINCIPAL PRODUCTS IN
STEAM GENERATOR LIQUID WITH 1.0% FAILED FUEL (μCi/cm^3) [a]

Isotope	Activity	Isotope	Activity
I-131	4.44×10^{-3}	Mo-99	8.71×10^{-3}
I-132	6.47×10^{-4}	Tc-99m	7.59×10^{-3}
I-133	4.89×10^{-3}	Te-132	4.36×10^{-4}
I-134	7.73×10^{-5}	Te-134	3.28×10^{-6}
I-135	1.15×10^{-5}	Cs-134	5.03×10^{-4}
Br-84	3.65×10^{-6}	Cs-136	2.04×10^{-4}
Rb-88	1.77×10^{-4}	Cs-137	2.52×10^{-3}
Rb-89	4.04×10^{-6}	Cs-138	7.79×10^{-5}
Sr-89	7.14×10^{-6}	Ba-137m	2.31×10^{-3}
Sr-90	2.64×10^{-7}	Ba-140	7.81×10^{-6}
Sr-91	1.67×10^{-6}	La-140	3.92×10^{-6}
Sr-92	2.64×10^{-7}	Ce-144	6.14×10^{-7}
Y-90	3.12×10^{-7}	Pr-144	6.14×10^{-7}
Y-91m	6.22×10^{-7}	Cr-51	1.70×10^{-6}
Y-91	1.15×10^{-5}	Mn-54	1.42×10^{-6}
Y-92	5.25×10^{-7}	Mn-56	9.70×10^{-6}
Zr-95	1.32×10^{-6}	Fe-59	1.89×10^{-6}
Nb-95m	3.03×10^{-9}	Co-58	4.54×10^{-5}
Nb	1.32×10^{-6}	Co-60	1.37×10^{-6}

a. Based on a 100 gallon/day primary/secondary leak rate and a 37.5 gpm total steam generator blowdown per unit.

Table 11.1-8
CONCENTRATION OF PRINCIPAL NOBLE GASES AND HALOGENS IN SECONDARY SIDE STEAM WITH 1.0% FAILED FUEL (μCi/lb)

Isotope	Steam Generator Steam Activity
Kr-85m	8.86×10^{-3}
Kr-85	2.16×10^{-2}
Kr-87	5.15×10^{-3}
Kr-88	1.56×10^{-2}
Xe-133m	1.32×10^{-2}
Xe-133	1.20×10^{0}
Xe-135m	8.01×10^{-4}
Xe-135	2.59×10^{-2}
Xe-138	2.84×10^{-3}
I-131	2.51×10^{-1}
I-132	3.66×10^{-2}
I-133	2.77×10^{-1}
I-134	4.38×10^{-3}
I-135	8.49×10^{-2}

Table 11.1-9
PARAMETERS USED TO DESCRIBE THE PRESSURIZED WATER REACTOR WITH U-TUBE STEAM GENERATORS (VOLATILE CHEMISTRY)

Parameters	Value
Thermal power	2.9E+03 MWt
Steam flow rate	1.22E+07 lb/hr
Weight of water in reactor coolant system	4.34E+05 lb
Weight of water in all steam generators	5.02E+05 lb
Reactor coolant letdown flow (purification)	2.23E+04 lb/hr
Reactor coolant letdown flow (yearly average for boron control)	3.40+03 lb/hr
Steam generator blowdown flow (total)	4.50E+04 lb/hr
Fraction of radioactivity in blowdown stream which is not returned to the secondary coolant system	
Halogens	1.00
Cs, Rb	1.00
Others	1.00
Flow through the purification system cation demineralizer	2.23E+03 lb/hr
Ratio of condensate demineralizer flow rate to the total steam flow rate	0.0
Ratio of the total amount of noble gases routed to gaseous radwaste from the purification system to the total amount of noble gases routed from the primary coolant system to the purification system (not including the boron recovery system)	0.0

Notes:

1. The reactor coolant concentrations given are for reactor coolant entering the letdown line.
2. The secondary coolant concentrations are based on a primary-to-secondary leakage of 100 lb/day.
3. The steam generator steam concentrations given are for steam leaving the steam generator.
4. Values used in determining coolant activities are given in Section 2.2.3 of NUREG-0017.
5. These coolant activities are calculated according to NUREG-0017 (April 1976) methods.

Table 11.1-10
SOURCE TERMS FOR PWR WITH U-TUBE STEAM GENERATORS

	Reactor Coolant		Steam Generator Liquids		Steam Generator Steam	Decay Constant
Isotope	(μCi/g)	(Ci)	(μCi/g)	(Ci)	(μCi/g)	(1/sec)
			Noble Gases			
KR-83M	2.3E-02	4.5E+00	0.0	0.0	7.7E-09	1.04E-04
KR-85M	1.2E-01	2.3E+01	0.0	0.0	4.0E-08	4.30E-05
KR-85	1.9E-02	38.E+00	0.0	0.0	6.6E-09	2.05E-09
KR-87	6.5E-02	1.3E+01	0.0	0.0	2.1E-08	1.52E-04
KR-88	2.1E-01	4.2E+01	0.0	0.0	7.3E-08	6.88E-05
KR-89	5.5E-03	1.1E+00	0.0	0.0	1.9E-09	3.66E-03
XE-131M	3.9E-02	7.7E+00	0.0	0.0	1.4E-08	6.69E-07
XE-133M	1.6E-01	3.2E+01	0.0	0.0	5.6E-08	3.60E-06
XE-133	9.5E+00	1.9E+03	0.0	0.0	3.3E-06	1.52E-06
XE-135M	1.4E-02	2.8E+00	0.0	0.0	4.9E-09	7.55E-04
XE-135	3.5E-01	7.0E+01	0.0	0.0	1.2E-07	2.10E-05
XE-137	9.9E-03	2.0E+00	0.0	0.0	3.4E-09	3.01E-03
XE-138	4.8E-02	9.5E+00	0.0	0.0	1.6E-08	8.14E-04
			Halogens			
BR-83	5.5E-03	1.1E+00	1.2E-07	2.8E-05	1.2E-09	8.02E-05
BR-84	2.9E-03	5.7E-01	1.8E-08	4.1E-06	1.8E-10	3.66E-04
BR-85	3.3E-04	6.5E-02	2.0E-10	4.6E-08	2.0E-12	4.03E-03
I-130	2.6E-03	5.1E-01	1.5E-07	3.3E-05	1.5E-09	1.55E-05
I-131	3.7E-01	7.4E+01	3.3E-05	7.5E-03	3.3E-07	9.98E-07

Table 11.1-10 (continued)
SOURCE TERMS FOR PWR WITH U-TUBE STEAM GENERATORS

Isotope	Reactor Coolant (µCi/g)	Reactor Coolant (Ci)	Steam Generator Liquids (µCi/g)	Steam Generator Liquids (Ci)	Steam Generator Steam (µCi/g)	Decay Constant (1/sec)
Halogens (continued)						
I-132	1.1E-01	2.3E+01	3.3E-06	7.5E-04	3.3E-08	8.43E-05
I-133	4.9E-01	9.6E+01	3.3E-05	7.5E-03	3.3E-09	9.26E-06
I-134	5.3E-02	1.0E+01	5.0E-07	1.1E-04	5.0E-09	2.20E-04
I-135	2.3E-01	4.5E+01	9.7E-06	2.2E-03	9.7E-08	2.92E-05
Cs, Rb						
Rb-86	1.1E-04	2.1E-02	1.0E-08	2.3E-06	1.0E-11	4.30E-07
Rb-88	2.2E-01	4.4E+01	7.6E-07	1.7E-04	7.6E-10	6.53E-04
Cs-134	3.2E-02	6.3E+00	3.0E-06	6.8E-04	3.0E-09	1.07E-08
Cs-136	1.6E-02	3.2E+00	1.5E-06	3.4E-04	1.5E-09	6.17E-07
Cs-137	2.3E-02	4.5E+00	2.2E-06	4.9E-04	2.2E-09	7.30E-10
Water Activation Products						
N-16	4.0E+01	7.9E+03	9.0E-07	2.0E-04	9.0E-08	9.75E-02
Tritium						
H-3	1.0E+00	2.0E+02	1.0E-03	2.3E-01	1.0E-03	1.79E-09
Other Nuclides						
Cr-51	2.6E-03	5.2E-01	2.4E-07	5.4E-05	2.4E-10	2.88E-07
MN-54	4.3E-04	8.5E-02	5.3E-08	1.2E-05	5.3E-11	2.56E-08
FE-55	2.2E-03	4.4E-01	2.1E-07	4.8E-05	2.1E-10	8.14E-09

Table 11.1-10 (continued)
SOURCE TERMS FOR PWR WITH U-TUBE STEAM GENERATORS

Isotope	Reactor Coolant (µCi/g)	Reactor Coolant (Ci)	Steam Generator Liquids (µCi/g)	Steam Generator Liquids (Ci)	Steam Generator Steam (µCi/g)	Decay Constant (1/sec)
Other Nuclides (continued)						
FE-59	1.4E-03	2.7E-01	1.6E-07	3.6E-05	1.6E-10	1.78E-07
CO-58	2.2E-02	4.4E+00	2.1E-06	4.8E-04	2.1E-09	1.12E-07
CO-60	2.8E-03	5.5E-01	2.4E-07	5.4E-05	2.4E-10	4.18E-09
SR-89	4.9E-04	9.6E-02	5.3E-08	1.2E-05	5.3E-12	1.59E-07
SR-90	1.4E-05	2.7E-02	1.1E-09	2.4E-07	1.1E-12	7.58E-10
SR-91	7.9E-04	1.6E-01	3.5E-08	8.1E-04	3.5E-11	2.03E-05
Y-90	1.6E-06	3.2E-04	1.9E-10	4.4E-08	1.9E-13	3.1E-06
Y-91M	4.0E-04	7.9E-02	1.1E-08	2.5E-06	1.1E-11	2.32E-04
Y-91	8.9E-05	1.8E-02	7.9E-09	1.8E-06	7.9E-12	1.37E-07
Y-93	4.2E-05	8.2E-03	1.8E-09	4.1E-07	1.8E-12	1.89E-05
ZR-95	8.4E-05	1.6E-02	1.1E-08	2.4E-06	1.1E-11	1.23E-07
NB-95	7.0E-05	1.4E-02	1.1E-08	2.4E-06	1.1E-11	2.29E-07
MO-99	1.1E-01	2.2E+01	9.6E-06	2.2E-03	9.6E-09	2.92E-06
TC-99M	5.7E-02	1.1E+01	4.8E-06	1.1E-03	4.8E-09	3.20E-05
RU-103	6.3E-05	1.2E-02	5.3E-09	1.2E-06	5.3E-12	2.03E-07
RU-106	1.4E-05	2.7E-03	1.1E-09	2.4E-07	1.1E-12	2.17E-08
RH-103M	5.0E-05	9.9E-03	2.3E-09	5.1E-07	2.3E-12	2.06E-04
RH-106	1.1E-05	2.2E-03	4.0E-10	9.0E-07	4.0E-13	2.32E-02
TE-125M	4.0E-05	8.0E-03	2.6E-09	6.0E-07	2.6E-12	1.38E-07
TE-127M	3.9E-04	7.7E-02	2.6E-08	6.0E-06	2.6E-11	2.36E-08

Table 11.1-10 (continued)
SOURCE TERMS FOR PWR WITH U-TUBE STEAM GENERATORS

Isotope	Reactor Coolant (µCi/g)	Reactor Coolant (Ci)	Steam Generator Liquids (µCi/g)	Steam Generator Liquids (Ci)	Steam Generator Steam (µCi/g)	Decay Constant (1/sec)
Other Nuclides (continued)						
TE-127	1.0E-03	2.0E-01	5.3E-08	1.2E-05	5.3E-11	2.05E-05
TE-129M	1.9E-03	3.8E-01	1.6E-07	3.6E-05	1.6E-10	2.40E-07
TE-129	1.8E-03	3.5E-01	6.9E-08	1.6E-05	6.9E-11	1.65E-04
TE-131M	3.2E-03	6.4E-01	2.2E-07	5.0E-05	2.2E-10	6.42E-06
TE-131	1.2E-03	2.4E-01	2.1E-08	4.8E-06	2.1E-11	4.62E-04
TE-132	3.6E-02	7.2E+00	2.4E-06	5.6E-04	2.4E-09	2.47E-06
BA-137	1.8E-02	3.5E+00	9.0E-07	2.0E-04	9.0E-10	4.53E-03
BA-140	3.0E-04	6.0E-02	2.6E-08	5.9E-06	2.6E-11	6.27E-07
LA-140	2.0E-04	3.9E-02	1.6E-08	3.7E-06	1.6E-11	4.79E-06
CE-141	9.7E-05	1.9E-02	1.1E-08	2.4E-06	1.1E-11	2.47E-07
CE-143	5.2E-05	1.0E-02	2.2E-09	5.1E-07	2.2E-12	5.83E-06
CE-144	4.6E-05	9.1E-03	5.3E-09	1.2E-06	5.3E-12	2.82E-08
PR-143	6.9E-05	1.4E-02	5.3E-09	1.2E-06	5.2E-12	5.91E-07
PR-144	3.1E-05	7.2E-03	2.1E-09	4.7E-07	2.1E-12	6.69E-04
NP-239	1.6E-03	3.2E-01	1.4E-07	3.2E-05	1.4E-10	3.41E-06

Table 11.1-11
VOLUME CONTROL TANK ACTIVITIES

Isotope	Vapor Activity (μCi/cc)
Kr-85	1.11×10^{2}
Kr-85m	2.72×10^{1}
Kr-87	4.22×10^{0}
Kr-88	3.54×10^{1}
Xe-133	4.09×10^{3}
Xe-133m	4.45×10^{1}
Xe-135	7.54×10^{1}
Xe-135m	6.15×10^{-3}
Xe-138	1.15×10^{-2}

Table 11.1-12
PRESSURIZER ACTIVITIES [a]

Isotope	Vapor Activity (μCi/cm^3)
Kr-85	6.2×10^{-1}
Kr-85m	1.4×10^{-1}
Kr-87	2.3×10^{-2}
Kr-88	1.5×10^{-1}
Xe-131m	1.2×10^{-1}
Xe-133	5.3×10^{1}
Xe-133m	2.5×10^{0}
Xe-135	8.4×10^{-1}
Xe-135m	7.2×10^{-4}
Xe-138	2.9×10^{-3}
Isotope	**Liquid Activity (μCi/gm)**
N-16 (max)	1.5×10^{0}
Rb-88	1.6×10^{-2}
Mo-99	0.50×10^{0}
I-131	1.7×10^{0}
I-132	2.9×10^{-2}
I-133	0.90×10^{0}
I-134	7.2×10^{-3}
I-135	0.17×10^{0}
Cs-137	1.3×10^{0}
Cs-138	7.4×10^{-3}

a. Based on parameters of Table 11.1-5 with 1% clad defects.

Table 11.1-13
SPECIFIC SOURCE STRENGTH

MeV	Specific Activity (MeV/cm^3-sec)
Mixed Bed Demineralizer	
0.4	1.1×10^8
0.8	6.0×10^8
1.3	1.5×10^7
1.7	1.7×10^7
2.5	5.1×10^7
Cation Bed Demineralizer	
0.4	9.6×10^5
0.8	8.4×10^8
1.3	1.5×10^7
1.7	1.9×10^4
2.5	1.6×10^4
Spent Fuel Pit Ion Exchanger	
0.4	1.3×10^4
0.8	1.4×10^6
1.3	1.5×10^4
1.7	6.0×10^2
2.5	3.2×10^3

Table 11.1-14
LEAKAGE RATES

Primary To Secondary Leakage
Design - Shall be limited to: a. Total leakage from all steam generators of 300 gpd. b. Leakage from an individual steam generator of 100 gpd. c. Total leakage increase of 60 gpd between surveillance intervals. d. An increasing trend based on the latest surveillance that indicates 100 gpd would not be exceeded on an individual steam generator within 90 minutes.
Primary Coolant Leakage
Design - 0.024 gpm per unit in the containment and 0.006 gpm per unit in the auxiliary building.
Condensate Leakage to Turbine Building Sumps
Design - 1,670,000 gallon per year for two units. This number was developed from manufacturers' data on the pump seals for the condensate and heater drain pumps plus estimated valve leakage.
Steam Leakage to the Turbine and Auxiliary Buildings
Main steam leakage to the turbine building (design) - 100 lb/hr per unit. Reflashed auxiliary steam Building heating drain receivers - 300 lb/hr for two units over the 6-month heating season. Auxiliary steam drain receiver - 4000 lb/hr for two units. Auxiliary steam Main condenser air ejector - 12.5 scfm per unit of air and noncondensables and 41.5 lb/hr per unit of steam. Gland steam condenser air ejector - 2200 lb/hr per unit of air and noncondensables and 230 lb/hr per unit of steam. Chilled water unit air ejector condenser - 2.5 scfm per unit of air and noncondensables and 8.3 lb/hr per unit of steam.

11.2 LIQUID WASTE DISPOSAL SYSTEM

11.2.1 Design Objectives

The liquid waste disposal system was designed to satisfy the applicable sections of the general design criteria of Section 3.1. In addition, this system was designed to meet the criteria of 10 CFR 20, 10 CFR 50, and 10 CFR 100 so as not to endanger the health of station operating personnel or the general public. Transportation of radioactive materials from the station will be carried out in a manner that will conform with all applicable Federal, state, and local ordinances. Liquid radioactive waste system components have been designed according to Section VIII of the ASME Boiler and Pressure Vessel Code.

The liquid waste disposal system is common to both reactor units and accommodates the radioactive wastes produced during simultaneous operation of the two units.

Section 11.2.5 presents design and expected liquid activity releases by nuclide from North Anna Units 1 and 2. These estimated liquid releases are based on a set of assumptions, discussed in Sections 11.1 and 11.2.2, regarding the operation of the plant, various process system radioactive liquid flowrates, and the liquid waste disposal system. These assumptions and original estimates of design and expected releases represented the basis for compliance to the NRC requirements in the original licensing basis. These assumptions were intended to be representative of the plant operation. In some instances, this is not the case since various system process parameters have proven to be different from the initial estimated values. Ultimately, adherence to the liquid waste effluent requirements is monitored by procedures in accordance with the Offsite Dose Calculation Manual (ODCM), as discussed in Section 11.4.4.1.

Monitoring liquid effluent releases in accordance with the ODCM ensures that the composite results of the variations in the liquid waste inputs and processing on the actual releases are within the accepted current licensing basis for the liquid waste disposal system as specified in the acceptance criteria of the ODCM. In addition, this monitoring has demonstrated that the released liquid waste activities are typically significantly less than the expected case releases from Section 11.2.5.

Virginia Power implemented the revised 10 CFR 20 January 1, 1994. The occupational MPC values are replaced by Derived Air Concentration (DAC) values and the non-occupational MPC values are replaced by Effluent Concentration Values. The calculational methodology for the design and expected liquid activity releases, which are based on the criteria of the old 10 CFR 20, are valid design analyses and does not need to be redone under the revised 10 CFR 20. (Reference: Seventh Set of NRC Q/A, #456.) The exposures received by the general public as a result of these releases are presented in Section 11.2.8.

11.2.2 System Description

The liquid waste disposal system was designed to receive, process, and discharge potentially radioactive liquids from a variety of sources, including the Chemical and Volume Control System, the boron recovery system, the steam generator blowdown system, the vent and drain system sumps described in Section 9.3.3, laboratory drains, personnel decontamination area (PDA) drains, the decontamination system, the sampling system, laundry drains, and spent resin flush water. The system design considers potential personnel exposure and ensures that radioactive releases to the environment are as low as reasonably achievable (ALARA). During normal plant operation, the total activity from radionuclides leaving the discharge canal does not exceed the limits of applicable regulations. Sources of radioactivity are identified in Section 11.1. Flow diagrams indicating principal flow paths and bypasses are given in Reference Drawings 1 through 4. Design data for permanently installed equipment are given in Table 11.2-1. Several components have been abandoned in place and are identified as such. Their description is for reference only. Dilution factors used in evaluating the release of radioactive effluents are given in Section 11.2.7. Section 11.2.5 and Figure 11.2-1 and Figure 11.2-2 describe the expected average volumes and activities of outlet streams. Section 11.2.5 also gives the plant releases by isotope and concentration.

All pipes containing significant radioactivity are routed within appropriately shielded areas, as specified on design drawings. Pipes are field run only to the extent that the pipe lengths necessary to allow the pipes to fit in the appropriate shielded areas are determined in the field.

With the exception of the ion exchanger filtration system (IEFS), waste disposal building, demineralizer, and spent resin transfer equipment, liquid waste processing equipment is located below grade in the auxiliary building or decontamination building. These portions of the auxiliary building and decontamination building are designed according to Seismic Class I criteria.

Offsite dose calculations consider only liquid waste treatment by ion exchange and filtration. NUREG-0017 was used to estimate equipment performance.

11.2.2.1 **Condensate Polishing System Resin Waste Disposal**

The condensate polishers could generate radioactive waste in the form of spent powdered resin in a slurry with water. The slurry is accumulated in the secondary phase separator in the turbine building. If the resin slurry in the secondary phase separator is nonradioactive, the resin slurry is treated as non-hazardous chemical waste. If the slurry is radioactive, it is pumped to an appropriate container and disposed of as radioactive waste.

11.2.2.2 **Ion Exchange Filtration System (IEFS)**

Liquid radioactive waste may be treated prior to release by the ion exchange filtration system (IEFS) as the sole method of treatment, or by using the IEFS in conjunction with other components of the liquid waste disposal system (typically the demineralizers in the Waste

Disposal Bldg.). The IEFS consists of filtration and demineralizer vessels each of which have a volume of 30 ft^3.

The IEFS processes up to 35 gpm of liquid waste.

The demineralization system is hose-connected into the in-plant source of waste water (Reference Drawing 2, 2"-LW-372-152), while the effluent side of the system is hose-connected into the in-plant systems for hold-up, monitoring and discharge (Reference Drawing 2, 2"-LW-373-152). Influent and effluent lines are hard-piped.

The piping, which leads from the basement of the decontamination building to level 271, is the same size and grade as existing piping (NAS-28). Pipe runs use existing pipe chases and lead to an area adjacent to the waste solidification cubicle. Hose attachment will be secure and tight, and will have appropriate isolation valves.

The Ion Exchange Filtration system is a portable unit containing the sluicable filtration and demineralizer pressure vessels.

Waste water is pumped to the IEFS by the high-level waste drain tank pumps 1-LW-P-2A and 1-LW-P-2B. A self-priming booster pump is provided at the inlet to provide satisfactory flow rates through the filtration and demineralizer pressure vessels. Also, a pressure relief valve is mounted on the inlet header to prevent overpressurization of the system. The relief valve complies with ASME, Section I and paragraph 67 through 72 of the ASME Boiler and Pressure Vessel Codes. The relief valve is vented to the radwaste collection floor drain.

The filtration and demineralizer vessels are designed, fabricated and tested in accordance with ASME, Section VIII. Each filter vessel contains media for removal of suspended solids and activated corrosion products. The demineralizer vessels are loaded with ion-exchange media for removal of dissolved impurities.

The treated water is discharged through control and monitoring devices. The effluent of the system is transferred to the low level waste tanks for hold up and monitoring. The contents of the low level waste tanks can receive additional treatment by the demineralizers in the Waste Disposal Bldg., can be transferred back to the High Level Waste Tanks, or can be discharged into the Circulating Water System.

Local control and monitoring devices are provided for pressure indicating flow monitoring, and conductivity monitoring within the demineralizer unit. Grab samples are taken for chemical and isotopic analysis. Low discharge pressure on the upstream booster pump to the IEFS stops the pump to reduce flow through the IEFS.

The influent and effluent connections necessary for the connection of the ion exchange filtration system, along with all supplemental service connections necessary for the operation of the system (i.e., service air, electrical, primary grade water supply and contaminated drains), are provided by Virginia Power, within this area so that any unnecessary penetrations into this potentially contaminated area are minimized.

The initial setup, installation, and testing of the ion exchange filtration system was done by qualified personnel under the direction of Virginia Power.

The replacement of the expended filtration and demineralizer media and preparation of the expended media for transport and burial will be performed by qualified personnel.

The installation and operation of the liquid waste demineralizer system complies fully with Appendix I of 10 CFR 50.

The spent resin shipping liner, demineralizers, and charcoal vessels are located behind the shield walls in the waste solidification area. The pump and controls are located outside the shield walls. Health Physics provides radiological controls for the decontamination building where the system is located.

The Ion Exchange Filtration System (IEFS) has no adverse effect on station operations or the operation of safety-related equipment. The design specifications meet the specifications of the previously existing system and all additional piping is located in areas previously designated for liquid waste processing.

Limitation of personnel exposure is achieved by the site location and installed shielding of the demineralizer system. The system is designated to be located within a protected, shielded area normally used for the handling and solidification of radioactive waste.

The control panel, with all the functions and indications necessary for the safe operation or shutdown of the system, is located outside the walled-in area. Personnel entry into the walled-in area will be for short duration for minor manual adjustment and control of the system.

11.2.3 Operating Procedures

System influents from the vent and drain system, which include the effluent from various building sumps, are directed by valve lineup to either the high-level or low-level waste drain tanks, according to influent activity level.

Laundry waste and cold laboratory drainage, personnel decontamination area (PDA) shower drainage, and PDA sink drainage are discharge into the contaminated drain tanks.

Hot laboratory drainage and spent resin flush water are discharged directly into the high-level waste drain tanks.

High-level liquid waste from the vent and drain, liquid waste disposal, chemical and volume control, and boron recovery systems is discharged to the high-level waste drain tanks. The contents of the high-level waste drain tanks, which may have activity levels of up to 10^{-1} µCi/ml, are processed by the ion exchanger filtration system. The contents of these tanks may be transferred to the low-level waste drain tanks by means of a line under administrative control in the event that the high-level waste drain tank contents do not require further treatment. The decontamination system fluid waste treating tank (Section 9.5.9) in the decontamination building can be used for additional storage of high-level wastes. The influent to the high-level drain tanks also may include the contents of the low-level drain tanks and the contaminated drain tanks should the activity level of the liquids in these tanks require further processing. The high-level tanks afford a holdup period for sampling the liquid before it is processed.

The low-level waste drain tanks accumulate low-level waste liquid from the IEFS, vent and drain, and boron recovery systems as well as from the fluid waste treating tank, and boron recovery test tanks. The contents of the low level waste drain tanks are pumped to the waste header, through the clarifier, and are discharged to the circulating water system or are processed through the Liquid Waste Demineralizer, if needed prior to discharge.

The demineralizers in the Waste Disposal Bldg. also could receive liquids from the contaminated drain tank, the steam generator blowdown tank, and the blowdown from the Service Water Reservoir. These liquids are monitored prior to release to ensure that the limits of 10 CFR 20 will not be exceeded. Offsite dose calculations, based on effluent samples obtained at this release point, are performed to ensure the limits of 10 CFR 50, Appendix I are not exceeded.

All liquid waste discharges to the circulating water system are monitored as described in Section 11.4.2.12 to ensure radiological control. Periodic sampling of the liquid waste effluent is conducted as described in Section 11.4.4.1. Liquid waste discharges are automatically isolated downstream of the clarifier demineralizer filter on a signal from the radiation monitor. This valve is also operated remotely from the main control room or automatically by a signal from the clarifier surge tank level switches. High activity detected by the radiation monitor overrides the valve control and stops all discharge flow. The discharge flow from the liquid waste disposal system is combined and mixed with the water in the circulating-water discharge tunnel so that the concentration of activity of the combined effluent is maintained ALARA and well within the limits established by applicable regulations.

11.2.4 Performance Tests

All effluent is monitored for radioactivity prior to release, a sample is taken for detailed radiological analysis, and a record of flow rate and total is made. Periodic testing is performed to ensure function and calibration of the final radiation monitor and the flow recorder on the effluent line.

11.2.5 Estimated Releases

The design objective of the liquid waste disposal system is to maintain releases ALARA and within the limits of 10 CFR 20, 10 CFR 50, and 10 CFR 100. Releases due to accidents are discussed in Chapter 15. To demonstrate how this objective is accomplished in other cases, this section presents estimates of liquid releases for two cases, expected and design. These estimated releases are based on the original plant configuration and liquid waste processing options assumed at the time of initial plant licensing. The expected releases are based on circumstances and equipment parameters that could occur during normal station operation and anticipated operational occurrences. The design releases are representative only of short-term releases that could occur only if all systems in both units degraded to the conditions stated in the assumptions. Such degradation is extremely unrealistic. Even with the high degree of conservatism inherent in the analysis for the design case, the results indicate that operation of Units 1 and 2 and the associated radioactive liquid waste released does not exceed the limits of 10 CFR 20 and therefore does not represent a hazard to the health and safety of the general public. The doses associated with the expected releases are discussed in Section 11.2.8.

Flow charts of the liquid waste disposal system (Units 1 and 2) are shown in Figure 11.2-3 (design) and Figure 11.2-4 (expected). The liquid waste disposal system is designed to minimize the discharge of radioactivity contained in liquid effluent from the station. To accomplish this, extensive use is made of demineralization and filtration.

These estimated activities are based upon the conservative assumptions listed in Section 11.1, an operating time of 365 days (100% capacity factor) in the design case and 300 days in the expected case (80% capacity factor).

Figure 11.2-3 lists, for the design case, the estimated quantities and activities of radioactive waste liquid from various sources and the waste treatment that each undergoes before being released from Units 1 and 2. Figure 11.2-4 does the same for the expected case. Tables 11.2-2 through 11.2-6 and Tables 11.2-7 through 11.2-11 expanded this information on a nuclide-by-nuclide basis for the design and expected cases, respectively. Tables 11.2-12 and 11.2-13 list the estimated activity and discharge rate of each radionuclide at the point of discharge for the design and expected cases, respectively.

The concentrations by nuclide in the liquid waste disposal system, the discharge canal, the Waste Heat Treatment Facility, and the North Anna Reservoir are presented in Tables 11.2-12 and 11.2-14 through 11.2-16 for the design case and Tables 11.2-13 and 11.2-17 through 11.2-19 for the expected case.

The activities in Table 11.2-7 are considered an extremely conservative upper bound for short-term releases. The total nontritium activity discharged from Units 1 and 2, assuming that Units 1 and 2 operate continuously at full power with system degradations expressed in the assumptions for the design case, is 332 Ci/yr.

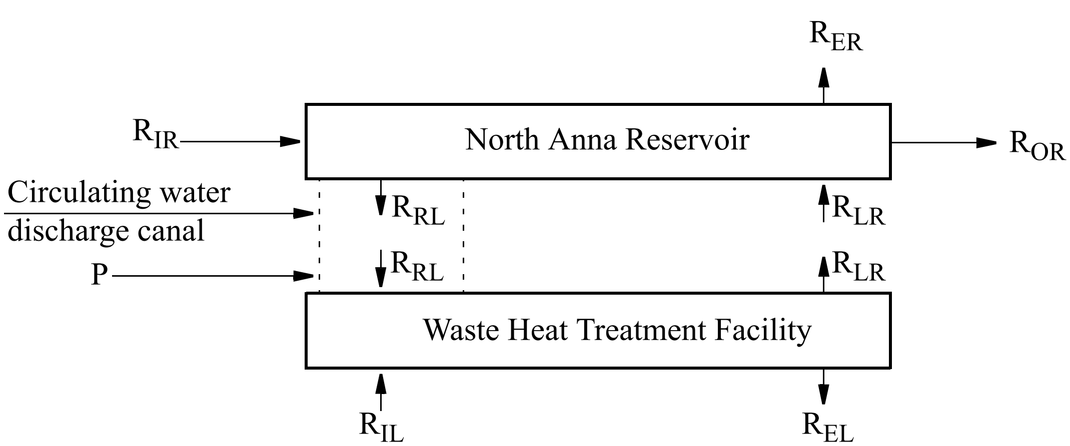
A significant amount of tritium may be accumulated in the reactor coolant system. Tritium is considered separately because it is relatively insensitive to waste treatment. It is usually in the form of tritiated water and during normal operation is found in the reactor coolant, boron recovery, sampling, vent and drain, liquid waste, and refueling water storage systems. Tritiated water behaves in the liquid waste disposal system essentially the same as ordinary water. Assuming one unit on its equilibrium fuel cycle, one unit on its initial fuel cycle and 1% ternary fission release, it is estimated that 1183 Ci/yr. of tritium are available for release from the station for both the design and expected cases.

Appendix 11A discusses tritium control by use of Zircaloy clad fuel and silver-indium-cadmium control rods. The appendix details possible tritium sources, and evaluates plant design factors and potential for discharge.

The fraction of the primary coolant tritium that actually is discharged from the station depends upon the primary-grade water management at the station. However, the conservative assumption is made for this analysis that all of the 1183 Ci are discharged from the station.

11.2.5.1 Estimated Activities in North Anna Reservoir and Waste Heat Treatment Facility

Effluent from the liquid waste disposal system is the source of radionuclides in the North Anna Reservoir and Waste Heat Treatment Facility. This effluent is discharged from the station into the discharge canal, where it is diluted by the circulating water supplied from the reservoir and is then discharged into the Waste Heat Treatment Facility. Radionuclides that enter the Waste Heat Treatment Facility via this route can eventually pass into the reservoir at the skimmer wall structure, which is the outlet from the Waste Heat Treatment Facility to the reservoir. From the reservoir, the radionuclides either flow over the dam and spillway or are recirculated to the circulating-water intake. The following model and differential equations were developed to calculate the concentration of any radionuclide in the reservoir and in the Waste Heat Treatment Facility:



$$\frac{dN_R}{dt} = \frac{R_{LR}}{V_L}N_L - \left[\frac{R_{ER} + R_{OR} + R_{RL}}{V_R} + \lambda\right]N_R \qquad (11.2\text{-}1)$$

$$\frac{dN_L}{dt} = P + \frac{R_{RL}}{V_R}N_R - \left[\frac{R_{EL} + R_{LR}}{V_L} + \lambda\right]N_L \qquad (11.2\text{-}2)$$

where, for any radionuclide:

N_R= curies in the reservoir at time t

N_L = curies in the Waste Heat Treatment Facility at time t

V_R = volume of the reservoir, cm^3

V_L = volume of the Waste Heat Treatment Facility, cm^3

P = Ci/sec discharged from the plant to the circulating water

t = time, sec

λ = decay constant, sec^{-1}

R_{IR} = inlet flow rate to the reservoir from the environment, cm^3/sec

R_{EL} = evaporation rate from the Waste Heat Treatment Facility, cm^3/sec [1]

R_{IL} = inlet flow rate to the Waste Heat Treatment Facility from the environment, cm^3/sec

R_{OR} = (R_{IR} + R_{IL} - R_{ER} - R_{EL}) = overflow rate from the reservoir, cm^3/sec

R_{RL} = recirculation flow rate from the reservoir to the Waste Heat Treatment Facility, cm^3/sec

R_{ER} = evaporation rate from the reservoir, cm^3/sec [2]

R_{LR} = (R_{LR} + R_{IL} -R_{EL}) = return flow from the Waste Heat Treatment Facility to the reservoir, cm^3/sec

Let:

$$\lambda_R = \frac{R_{ER} + R_{OR} + R_{RL}}{V_R} + \lambda \qquad (11.2\text{-}3)$$

$$\lambda_L = \frac{R_{EL} + R_{LR}}{V_L} + \lambda \qquad (11.2\text{-}4)$$

1. Evaporation rates are removal terms for tritium only. For all other radionuclides, R_{EL} and R_{ER} are set equal to zero in the differential equations and no credit is taken for the removal of the other radionuclides by evaporation.
2. Evaporation rates are removal terms for tritium only. For all other radionuclides, R_{EL} and R_{ER} are set equal to zero in the differential equations and no credit is taken for the removal of the other radionuclides by evaporation.

At equilibrium, the concentration (µCi/cm^3) in the North Anna Reservoir and Waste Heat Treatment Facility is:

$$C_R = \frac{N_R}{V_R} = \frac{P \text{ x } R_{LR}}{\lambda_L \lambda_R V_L V_R - R_{RL} R_{LR}} \tag{11.2-5}$$

$$C_L = \frac{N_L}{V_L} = \frac{P \text{ x } \lambda_R V_R}{\lambda_L \lambda_R V_L V_R - R_{RL} R_{LR}} \tag{11.2-6}$$

The concentration in the discharge canal is:

$$C_C = \frac{P}{R_{RL}} + C_R \tag{11.2-7}$$

$$C_C = \frac{P}{R_{RL}}\left[\frac{\lambda_L \lambda_R V_L V_R}{\lambda_L \lambda_R V_L V_R - R_{RL} R_{LR}}\right] \tag{11.2-8}$$

The maximum permissible concentrations (MPC) of radionuclides set forth in 10 CFR 20 are not to be exceeded in the North Anna Reservoir, Waste Heat Treatment Facility, or discharge canal for the design case. Because of recirculation effects, and because the discharge point from the station is at the discharge canal, the point of maximum concentration for any radionuclide is in the discharge canal. Thus, the concentration in the discharge canal is limiting in this analysis.

For a single radionuclide, i, the concentration in the discharge canal must be less than MPC, so that the maximum allowable discharge rate, P_i, for that radionuclide, if it alone were discharged from the station, would be:

$$P_i \le MPC_i - R_{RL}\left[\frac{\lambda_{Li} \lambda_{Ri} V_L V_R - R_{RL} R_{LR}}{\lambda_{Li} \lambda_{Ri} V_L V_R}\right] \tag{11.2-9}$$

For a mixture of radionuclides of known concentrations, 10 CFR 20 requires that:

$$\frac{C_1}{MPC_1} + \frac{C_2}{MPC_2} + \frac{C_3}{MPC_3} + \ldots \le 1 \tag{11.2-10}$$

Let:

X = gross activity discharge rate from the waste disposal system, excluding tritium, Ci/sec

f_i = fraction of nuclide i in the nontritium mixture

Then Xf_i = discharge rate of nuclide i in the mixture of known concentrations, Ci/sec

The concentration in the discharge canal of nuclide i is:

$$C_{Ci} = \frac{Xf_i}{R_{RL}}\left[\frac{\lambda_{Li}\lambda_{Ri}V_LV_R}{\lambda_{Li}\lambda_{Ri}V_LR_R - R_{RL}R_{LR}}\right] \quad (11.2\text{-}11)$$

Let:

$$R_{RL_i} = \frac{1}{R_{RL}}\left[\frac{\lambda_{Li}\lambda_{Ri}V_LV_R}{\lambda_{Li}\lambda_{Ri}V_LV_R - R_{RL}R_{LR}}\right] \quad (11.2\text{-}12)$$

Substituting into Equation 11.2-10 gives:

$$\frac{P_{H3}R_{RLH3}}{MPC_{H3}} + \sum\frac{Xf_iR_{RLi}}{MPC_i} \le 1 \quad (11.2\text{-}13)$$

and:

$$X \le \frac{\left[1 - \frac{P_{H3}R_{RLH3}}{MPC_{H3}}\right]}{\sum\frac{f_iR_{RLi}}{MPC_i}} \quad (11.2\text{-}14)$$

Equation 11.2-14 gives the maximum gross activity discharge rate for a mixture of known concentration, so that 10 CFR 20 is not exceeded in the discharge canal, and Xf_i gives the maximum discharge rate of an individual radionuclide in that mixture.

The radionuclides that could be discharge from the waste disposal system are listed in Table 11.2-12 for the design case and Table 11.2-13 for the expected case.

From Table 11.2-12 and Table 11.2-13, it is estimated that 332 Ci/yr. are discharged from the station for the design case and 3.50 Ci/yr. for the expected case. These values do not include tritium, of which there are 1183 Ci/yr. available for release. Based on the expected release rates for tritium and nontritium activity, the following equilibrium concentrations may be expected at the station:

Location	Concentrations (pCi/1)	
	Gross Beta[a]	Tritium
Discharge canal	4.78	5470
Waste Heat Treatment Facility	1.38	5270
North Anna Reservoir	0.70	4080

a. Gross beta is used to express total nontritium activity, since the environmental progress calls for gross beta measurements and the nuclides that contribute more than 90% of the activity are 100% beta emitters

Thus liquid releases may result in detectable radioactivity levels in the lake water, which in turn could result in detectable radioactivity levels in fish living in the lake and in the sediments of the lake bed.

Samples of the above three media are taken from the Waste Heat Treatment Facility and the North Anna Reservoir. River water and silt are also sampled downstream from the dam site. Groundwater movement is described in Section 2.4.13.

From the above, the fraction of each radionuclide (f_i in Equation 11.2-14) in a mixture of known concentration at the point of discharge from the station can be determined. Assuming that these fractions remain constant, and assuming that the discharge rate of tritium remains constant, the maximum permissible release rate based on MPC values from the waste disposal system of each radionuclide in the mixture was calculated using Equation 11.2-14. These values are listed in Table 11.2-12 for the design case along with the allowable release rate for a single radionuclide based on Equation 11.2-9.

In this analysis, volumes and flow conditions for the average North Anna Reservoir and the Waste Heat Treatment Facility were used. These values are listed in Table 11.2-20. The total amount of water in the North Anna Reservoir and the Waste Heat Treatment Facility and the amount of overflow at the dam vary between the dry and wet seasons; hence, the concentrations also vary. However, because the average residence time of the body of water comprising both the North Anna Reservoir and the Waste Heat Treatment Facility is nearly 2 years, it takes about 7 years for a long-lived radionuclide to reach equilibrium in either the North Anna Reservoir or the Waste Heat Treatment Facility. Since projected minimum North Anna Reservoir overflow rates cannot be sustained for this length of time, there is justification for using average flows and volumes rather than minimum values. The most limiting circulating water flowrate possible (i.e. operation of one unit with two circulating water pumps) is used for the station as the basis for liquid pathway dose commitment calculations. It should be noted that credit was not taken for radioactive decontamination inherent in the reservoir or treatment facilities for various radionuclides, since there is no accurate means of estimating or calculating it.

11.2.6 Release Points

The only release point from the liquid waste disposal system to the environment is to the circulating-water discharge tunnel as shown on Reference Drawing 3. The circulating-water discharge tunnel flows into the discharge canal (Canal A) via the seal pit as shown on the site plan, Reference Drawing 6.

11.2.7 Dilution Factors

Tables 11.2-12 and 11.2-14 through 11.2-16 for the design case and Tables 11.2-13 and 11.2-17 through 11.2-19 for the expected case list the concentrations of radionuclides, including tritium, in the liquid waste disposal system, the discharge canal, the Waste Heat

Treatment Facility, and the North Anna Reservoir. It can be seen from these tables that, even with recirculation, the equilibrium concentration for any single radionuclide decreases in passing from the discharge canal to the Waste Heat Treatment Facility and then to the North Anna Reservoir, the highest concentration being in the liquid waste disposal system, as expected.

For the design case, the total nontritium activity per unit volume from a mixture of radionuclides in the liquid waste disposal system with an 90.8 gpm flow rate is reduced by a factor of 2.1×10^{-4} owing to volume dilution in the discharge canal at a flow rate of 962 cfs. Because of recirculation effects, the actual dilution factor is 3.1×10^{-4}.

Furthermore, the effective dilution factor is 0.49 for the Waste Heat Treatment Facility and 0.67 for the North Anna Reservoir; hence, there is an overall dilution factor of 1.0×10^{-4} from the liquid waste disposal system to the North Anna Reservoir.

For the expected case, the total nontritium activity per unit volume from a mixture of radionuclides in the liquid waste disposal system with a 78.7 gpm flow rate is reduced by a factor of 1.8×10^{-4} owing to volume dilution in the discharge canal at a flow rate of 962 cfs. Because of recirculation effects, the actual dilution factor is 2.2×10^{-4}.

For this case, the effective dilution factor is 0.29 for the Waste Heat Treatment Facility and 0.51 for the North Anna Reservoir; the result is an overall dilution factor of 3.2×10^{-5} from the liquid waste disposal system to the North Anna Reservoir.

The model and method used to calculate the estimated concentrations due to releases from the liquid waste disposal system are presented in Section 11.2.5.

11.2.8 Estimated Doses from Liquid Effluents

The potential radiological impact of the anticipated releases of small amounts of liquid radioactivity from the station has been evaluated in detail. A full and complete description of the analysis is contained in Appendix 11B. A summary of the doses resulting from expected liquid radwaste releases for a core utilizing a 15 x 15 fuel assembly array is presented here.

Potential radiation dosage from liquid releases calculated for the expected case was estimated both for the population as a whole and for a hypothetical maximally exposed individual. All dosage levels are based on the estimated equilibrium radioactivity concentrations for the station Waste Heat Treatment Facility and for the North Anna Reservoir. These concentrations are presented in Tables 11.2-18 and 11.2-19. The potential maximum individual exposure was evaluated for the following exposure pathways.

1. Daily ingestion of 1.2 liters of water taken from the reservoir or the Waste Heat Treatment Facility.
2. Daily ingestion of 50g of fish taken from the reservoir or the Waste Heat Treatment Facility.
3. Swimming 200 hr/yr in the reservoir or Waste Heat Treatment Facility.

4. Boating 500 hr/yr in the reservoir or Waste Heat Treatment Facility.
5. Sunbathing 300 hr/yr along the reservoir or Waste Heat Treatment Facility.

The resulting whole-body and body-organ exposure rates as calculated by SWEC computer codes IND1109E and DUCKMANE are presented in Table 11.2-21 for exposure from use of the North Anna Reservoir, and in Table 11.2-22 for exposure from the use of the Waste Heat Treatment Facility.

The maximum total annual whole-body dose has been calculated as 3.878 mrem for both units. This figure includes 1.646 mrem from exposure via various pathways from radwaste in the North Anna Reservoir and 2.232 mrem from exposure via various pathways from radwaste in the Waste Heat Treatment Facility. Although the two doses have been added here, a single individual could experience only exposure to one or the other, or a mixture of the two, which would not exceed the 2.232 mrem from the Waste Heat Treatment Facility. The maximum annual organ dose is 5.088 mrem for both units. The dose shown is a liver dose; all other organs receive a smaller dose. It includes 2.156 mrem from the reservoir and 2.932 mrem from the Waste Heat Treatment Facility. As stated above, the dose to the liver of a single individual would not exceed the 2.932 mrem from the Waste Heat Treatment Facility. As a comparison, the maximum doses permitted by 10 CFR 50, Appendix I as the total annual body dose and the annual organ dose are 3 mrem per reactor and 10 mrem per reactor, respectively, for each reactor at a site. Therefore, all exposure rates, even though calculated very conservatively, fall within the limits set by Federal regulations.

The potential population exposure due to the expected releases of liquid radwaste has been conservatively evaluated. The Environmental Report prepared to support the licensing of North Anna concluded that there are no known potable water withdrawals and only very limited recreational potential along the entire course of the North Anna River downstream from the site to West Point, about 65 miles southeast. The Environmental Report also concluded that there were no withdrawals of North Anna River waters for public or private use within Spotsylvania or Louisa counties. Hence, all significant sources of population exposure due to liquid radwaste release stem from public use of the cooling water storage system. Potential sources of exposure considered significant are the use of the system as a source of water and fish, and its use for recreational activities such as swimming, boating, and sunbathing.

For each pathway considered to be of potential importance, the total population exposures that could be expected to occur in the year 2000 were evaluated. Conservative projections of community development and recreational use of the reservoir were used in each case.

Also, since there are no physical impediments to the use of the reservoir as a community water supply source, it was assumed that this was already the case. The resulting population exposure rates are presented and totaled in Table 11.2-23. Appendix 11B contains a full explanation of their derivation.

11.2 REFERENCE DRAWINGS

The list of Station Drawings below is provided for information only. The referenced drawings are not part of the UFSAR. This is not intended to be a complete listing of all Station Drawings referenced from this section of the UFSAR. The contents of Station Drawings are controlled by station procedure.

	Drawing Number	Description
1.	11715-FM-087A	Flow/Valve Operating Numbers Diagram: Waste Disposal System, Unit 1
2.	11715-FM-087B	Flow/Valve Operating Numbers Diagram: Waste Disposal System, Unit 1
3.	11715-FM-087C	Flow/Valve Operating Numbers Diagram: Waste Disposal System, Unit 1
4.	11715-FM-087D	Flow/Valve Operating Numbers Diagram: Waste Disposal System, Unit 1
5.	11715-FM-087E	Flow/Valve Operating Numbers Diagram: Waste Disposal System, Unit 1
6.	11715-FY-1B	Site Plan, Units 1 & 2

Table 11.2-1
LIQUID WASTE DISPOSAL EQUIPMENT DESIGN DATA

High-Level Waste Drain Tank	
Number	2
Capacity per tank	5000 gal
Design pressure	25 psig
Design temperature	200°F
Operating pressure	Atmospheric
Operating temperature	120°F
Material	SS 316
Design Code	ASME VIII, Division 1, 1968
Low-Level Waste Drain Tank	
Number	2
Capacity per tank	5000 gal
Design pressure	25 psig
Design temperature	200°F
Operating pressure	Atmospheric
Operating temperature	120°F
Material	SS 316
Design Code	ASME VIII, Division 1, 1968
Waste Disposal Evaporator Test Tanks	
Number	2
Capacity per tank	1500 gal
Design pressure	25 psig
Design temperature	250°F
Operating pressure	Atmospheric
Operating temperature	140°F
Material	SS 304
Design Code	ASME VIII, Division 1, 1968
Contaminated Drain Collection Tanks	
Number	2
Capacity per tank	1050 gal
Design pressure	15 psig
Design temperature	200°F
Operating pressure	Atmospheric
Operating temperature	120°F
Material	SS 304
Design Code	ASME VIII, Division 1, 1968

Table 11.2-1 (continued)
LIQUID WASTE DISPOSAL EQUIPMENT DESIGN DATA

Low-Level Waste Drain Tank Pumps

Number	2
Type	Horizontal centrifugal
Motor horsepower	7.5
Seal type	Mechanical
Capacity per pump	50 gpm
Head at rated capacity	150 ft
Design pressure	220 psig
Materials	
Casing	SS 316
Shaft	SS 316
Impeller	SS 316

High-Level Waste Drain Tank Pumps

Number	2
Type	Horizontal centrifugal
Motor horsepower	3
Seal type	Double mechanical
Capacity per pump	12 gpm
Head at rated capacity	97 ft
Design pressure	220 psig
Materials	
Pump casing	SS 316
Shaft	SS 316
Impeller	SS 316

Waste Disposal Evaporator Test Tank Pumps

Number	2
Type	Horizontal centrifugal
Motor horsepower	10
Seal type	Mechanical
Capacity per pump	50 gpm
Head at rated capacity	195 ft
Design pressure	220 psig
Materials	
Pump casing	SS 316
Shaft	SS 316
Impeller	SS 316

Table 11.2-1 (continued)
LIQUID WASTE DISPOSAL EQUIPMENT DESIGN DATA

Contaminated Drain Transfer Pumps	
Number	2
Type	Horizontal centrifugal
Motor horsepower	7.5
Seal type	Mechanical
Capacity per pump	50 gpm
Head at rated capacity	126 ft
Design pressure	220 psig
Materials	
Pump casing	SS 316
Shaft	SS 316
Impeller	SS 316
Steam Generator Blowdown Tank Pumps	
Number	2
Type	Horizontal centrifugal
Motor horsepower	7.5
Seal type	Mechanical
Capacity per pump	110 gpm
Head at rated capacity	101 ft
Design pressure	220 psig
Materials	
Pump casing	SS 316
Shaft	SS 316
Impeller	SS 316
Clarifier Discharge Pumps	
Number	2
Type	Horizontal centrifugal
Motor horsepower	25
Seal type	Mechanical
Capacity per pump	300 gpm
Head at rated capacity	145 ft
Design pressure	220 psig
Materials	
Pump casing	SS 316
Shaft	SS 316
Impeller	SS 316

Table 11.2-1 (continued)
LIQUID WASTE DISPOSAL EQUIPMENT DESIGN DATA

Steam Generator Blowdown Heat Exchanger

Number	2	
Total duty	5.1×10^6 Btu/hr	
	Shell	Tube
Design pressure	150 psig	150 psig
Design temperature	150°F	250°F
Operating pressure	70 psig	20 psig
Operating temperature, in/out	105°F/125.5°F	212°F/120°F
Material	Carbon Steel	SS 304
Fluid	Water	Water
Design Code	ASME VIII, Division I, 1968	ASME VIII, Division 1, 1968

Waste Disposal Evaporator Distillate Demineralizer

Number	1
Design flow	100 gpm
Demineralizer, resin	organic anion resin
Active volume	17 ft^3
Design pressure	200 psig
Design temperature	250°F
Operating temperature	130°F
Material	SS 316L
Design Code	ASME VIII, Division 1, 1968

Clarifier Demineralizer

Number	2
Design flow	200 gpm
Demineralizer, resin	H-OH mixed bed or organic anion resin with inorganic oxide for cation exchange
Active volume	45 ft^3
Design pressure	200 psig
Design temperature	250°F
Operating temperature	125°F
Material	SS 316L
Design Code	ASME VIII, Division 1, 1968

Liquid Waste Effluent Filters

Number	2
Retention size	5 µm
Filter element material	Cotton

Table 11.2-1 (continued)
LIQUID WASTE DISPOSAL EQUIPMENT DESIGN DATA

Normal capacity	50 gpm
Maximum capacity	75 gpm
Material	SS 304
Design pressure	150 psig
Design temperature	250°F
Design Code	ASME VIII, Division 1, 1968
Waste Disposal Distillate Filter	
Number	1
Retention size	3 µm
Filter element material	Synthetic fiber
Normal capacity	40 gpm
Maximum capacity	75 gpm
Material	SS 304
Design pressure	150 psig
Design temperature	250°F
Design Code	ASME VIII, Division 1, 1968
Spent Resin Dewatering Filter	
Number	1
Retention size	5 µm
Filter element material	Cotton
Normal capacity	100 gpm
Maximum capacity	150 gpm
Material	SS 304
Design pressure	150 psig
Design temperature	250°F
Design Code	ASME VIII, Division 1, 1968
Clarifier Filters	
Number	6
Filter element material	Sand
Normal capacity	65 gpm
Maximum capacity	100 gpm
Material	Carbon steel
Design pressure	150 psig
Design temperature	120°F
Design Code	ASME VIII, Division 1, 1968

Table 11.2-1 (continued)
LIQUID WASTE DISPOSAL EQUIPMENT DESIGN DATA

Clarifier Demineralizer Filters	
Number	2
Retention size	3 µm
Filter element material	Synthetic fiber
Normal capacity	200 gpm
Maximum capacity	300 gpm
Material	SS 304
Design pressure	150 psig
Design temperature	250°F
Design Code	ASME VIII, Division 1, 1968
Clarifiers	
Number	2
Maximum capacity	300 gpm
Hold-up time	2 hr at 200 gpm
Rise rate	0.75 gpm/ft^2 at 200 gpm
Diameter	19 ft
Height	14 ft
Material	Steel
Design Code	AWWA-D-100-65
DF (including clarifier demineralizer)	100 for all radionuclides except Mo, I, and Te, for which DF equals 10
Resin Transfer Pump	
Number	2
Type	Positive displacement, progressing cavity
Seal Type	Mechanical
Motor horsepower	10
Capacity	30 gpm
Head at rated capacity	87 ft
Material	
Pump casing	SS 316
Stator	Natural rubber
Rotor	SS 316
Vendor-Supplied Filter/Demineralizer	
Data are not listed here because Virginia Power may utilize various suppliers for this system. Specific design data is contained in Company records.	

Table 11.2-2
ACTIVITY FROM STEAM GENERATOR BLOWDOWN - DESIGN CASE

DF Waste Disposal System for this Source = 1.00E+01
Decay Time in Waste Disp Sys (hours) = 0.0
Flow Rate (gal/yr) = 1.97E+07

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
CR51	2.2E-06	2.2E-07	1.6E-02
MN54	1.9E-06	1.9E-07	1.4E-02
CO58	6.0E-05	5.9E-06	4.4E-01
FE59	2.5E-06	2.5E-07	1.8E-02
CO60	1.8E-06	1.8E-07	1.3E-02
RB88	2.3E-04	2.3E-05	1.7E+00
SR89	9.4E-06	9.3E-07	6.9E-02
SR90	3.5E-07	3.5E-08	2.6E-03
SR91	2.2E-06	2.2E-07	1.6E-02
Y90	4.1E-07	4.1E-08	3.0E-03
Y91	1.2E-05	1.1E-06	8.5E-02
ZR95	1.7E-06	1.7E-07	1.3E-02
NB95	1.7E-06	1.7E-07	1.3E-02
TC99M	9.9E-03	9.9E-04	7.3E+01
MO99	1.1E-02	1.1E-03	8.4E+01
I131	5.8E-03	5.8E-04	4.3E+01
I132	8.5E-04	8.5E-05	6.3E+00
I133	6.4E-03	6.4E-04	4.7E+01
I134	1.0E-04	1.0E-05	7.5E-01
I135	1.5E-05	1.5E-06	1.1E-01
TE132	5.7E-04	5.7E-05	4.2E+00
CS134	6.6E-04	6.6E-05	4.9E+00
CS136	2.7E-04	2.7E-05	2.0E+00
CS137	3.3E-03	3.3E-04	2.4E+01
BA137M	3.0E-03	3.0E-04	2.2E+01
BA140	1.0E-05	1.0E-06	7.5E-02
LA140	5.1E-06	5.1E-07	3.8E-02
CE144	8.0E-07	8.0E-08	5.9E-03
TOTAL	4.3E-02	4.3E-03	3.2E+02

Table 11.2-3
ACTIVITY FROM LAUNDRY DRAINS - DESIGN CASE

DF Waste Disposal System for this Source = 1.00E+01
Decay Time in Waste Disp Sys (hours) = 0.0
Flow Rate (gal/yr) = 2.63E+06

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
MN54	1.0E-07	1.0E-08	9.9E-05
CO58	4.1E-07	4.0E-08	4.0E-04
CO60	9.1E-07	9.1E-08	8.9E-04
ZR95	1.4E-07	1.4E-08	1.4E-04
NB95	2.0E-07	2.0E-08	2.0E-04
RU103	1.4E-08	1.4E-09	1.4E-05
RU106	9.3E-07	9.3E-08	9.2E-06
RH103M	9.2E-07	2.4E-08	9.2E-06
RH106	2.4E-07	2.4E-08	2.3E-04
I131	6.0E-08	6.0E-09	5.9E-05
CS134	1.3E-06	1.3E-07	1.3E-03
CS137	2.4E-06	2.4E-07	2.3E-03
BA137M	2.1E-06	2.1E-07	2.1E-03
CE144	5.1E-07	5.1E-08	4.9E-04
PR-144	4.5E-07	4.5E-08	4.5E-04
TOTAL	9.1E-06	9.1E-07	8.9E-03

Table 11.2-4
ACTIVITY FROM BORON RECOVERY - DESIGN CASE

DF Waste Disposal System for this Source = 1.00E+06[a]
Decay Time in Waste Disp Sys (hours) = 8.00E+01
Flow Rate (gal/yr) = 4.38E+06

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
CR51	9.4E-04	8.2E-10	1.3E-05
MN54	7.8E-04	7.7E-10	1.3E-05
FE59	2.5E-02	2.4E-08	3.9E-04
CO58	1.0E-03	9.2E-10	1.5E-05
CO60	7.5E-04	7.5E-10	1.2E-05
RB88	3.8E+00	2.2E-10	1.0E-05
SR89	3.4E-03	3.1E-09	5.0E-05
SR90	1.8E-04	1.8E-10	3.0E-06
SR91	2.0E-03	2.4E-11	4.0E-07
Y90	2.1E-04	1.9E-10	3.1E-06
Y91	6.2E-03	5.8E-09	9.6E-05
NB95	7.1E-04	6.4E-10	1.0E-05
TC99M	0.0	1.5E-06	2.5E-02
MO99	5.4E+00	1.6E-06	2.6E-02
I131	2.5E+00	1.6E-05	2.5E-02
I132	9.2E-01	1.5E-07	2.4E-01
I133	4.1E+00	2.2E-06	2.5E-03
I134	5.7E-01	5.9E-10	3.6E-02
I135	2.2E+00	1.3E-07	9.6E-06
TE132	2.7E-01	9.3E-08	2.1E-03
CS134	3.0E-01	1.5E-06	1.5E-03
CS136	1.5E-01	5.6E-07	2.6E-02

a. Includes DF from Boron Recovery System

Notes:

1. Mixed Bed Demineralizer with DF = 100 for all Radionuclides except Cs and Rb for which the DF = 20
2. Cation Removal Bed with a BF in the Chemical and Volume Control System = 10 for Cs and Rb and = 1 for all other isotopes.
3. Boron Evaporator with a DF = 1000 for all Radionuclides except I for initial H. DF = 100.

Table 11.2-4 (continued)
ACTIVITY FROM BORON RECOVERY - DESIGN CASE

DF Waste Disposal System for this Source = 1.00E+06[a]
Decay Time in Waste Disp Sys (hours) = 8.00E+01
Flow Rate (gal/yr) = 4.38E+06

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
CS137	1.5E-01	7.5E-07	9.1E-03
BA137M	0.0	7.1E-07	1.2E-02
BA140	4.4E-03	3.3E-09	1.1E-02
LA140	1.5E-03	3.2E-09	5.5E-06
CE144	4.5E-04	4.4E-10	7.3E-06
TOTAL	2.0E+01	2.5E-05	4.1E-01

a. Includes DF from Boron Recovery System

Notes:

1. Mixed Bed Demineralizer with DF = 100 for all Radionuclides except Cs and Rb for which the DF = 20
2. Cation Removal Bed with a BF in the Chemical and Volume Control System = 10 for Cs and Rb and = 1 for all other isotopes.
3. Boron Evaporator with a DF = 1000 for all Radionuclides except I for initial H. DF = 100.

Table 11.2-5
ACTIVITY FROM PRIMARY COOLANT SYSTEM LEAKAGE (HLWDT) - DESIGN CASE[a]

DF Waste Disposal System for this Source = 1.00E+06
Decay Time in Waste Disp Sys (hours) = 1.67E+00
Flow Rate (gal/yr) = 2.10E+07

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
CR51	1.9E-04	1.9E-10	1.5E-05
MN54	1.6E-04	1.6E-10	1.3E-05
FE59	5.3E-03	5.1E-09	4.0E-04
CO58	2.0E-04	2.0E-10	1.6E-05
CO60	7.8E-01	1.5E-10	1.2E-05
RB88	1.6E-04	2.4E-06	1.9E-01
SR89	7.0E-04	7.0E-10	5.5E-05
SR90	3.7E-05	3.7E-11	2.9E-06
SR91	4.1E-04	3.6E-10	2.8E-05
Y90	4.0E-05	4.1E-11	3.2E-06
Y91	1.3E-03	1.3E-09	1.0E-04
ZR95	0.0	0.0	0.0
NB95	1.5E-04	1.5E-10	1.2E-05
MO99	1.1E+00	1.1E-06	8.7E-02
TC99M	0.0	1.7E-07	1.3E-02
I131	5.3E-01	5.1E-05	4.0E+00
I132	1.9E-01	1.3E-05	1.0E+00
I133	8.6E-01	8.0E-05	6.3E+00
I134	1.2E-01	3.6E-06	2.8E-01
I135	4.5E-01	3.8E-05	3.0E+00
TE132	5.7E-02	5.5E-08	4.3E-03
CS134	6.1E-02	3.1E-06	2.4E-01
CS136	3.1E-02	1.5E-06	1.2E-01
CS137	3.1E-02	1.5E-06	1.2E-01
BA137M	0.0	1.2E-06	9.5E-02
BA140	9.0E-04	9.0E-10	7.1E-05
LA140	3.1E-04	3.2E-10	2.5E-06
CE144	9.4E-05	9.2E-11	7.2E-06

a. Includes Containment Building Sumps, Safeguards Sumps, Auxiliary Building Sumps, Fuel Building Sumps, and Laboratory Drains.

Table 11.2-5 (continued)
ACTIVITY FROM PRIMARY COOLANT SYSTEM LEAKAGE (HLWDT) - DESIGN CASE[a]

DF Waste Disposal System for this Source = 1.00E+06
Decay Time in Waste Disp Sys (hours) = 1.67E+00
Flow Rate (gal/yr) = 2.10E+07

Nuclide	Initial Activity (µC/GM)	Activity After Treatment (µC/GM)	Discharge Rate from W.D. System (Ci/yr)
TOTAL	4.2E+00	2.0E-04	1.6E+01

a. Includes Containment Building Sumps, Safeguards Sumps, Auxiliary Building Sumps, Fuel Building Sumps, and Laboratory Drains.

Table 11.2-6
ACTIVITY FROM DECONTAMINATION BUILDING SUMPS - DESIGN CASE

DF Waste Disposal System For This Source = 1.00E+06
Decay Time in Waste Disp Sys (hours) = 4.59
Flow Rate (gal/yr) = 5.03E+05

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
CR51	9.4E-06	9.2E-12	1.7E-08
MN54	7.8E-06	7.8E-12	1.5E-08
FE59	2.5E-04	2.5E-10	4.7E-07
CO58	1.0E-05	9.9E-12	1.9E-08
CO60	7.5E-06	7.5E-12	1.4E-08
RB88	3.8E-02	2.8E-09	5.3E-06
SR89	3.4E-05	3.4E-11	6.4E-08
SR90	1.8E-06	1.8E-12	3.4E-09
SR91	2.0E-05	5.6E-12	1.1E-08
Y90	2.1E-06	1.9E-12	3.6E-09
Y91	6.2E-05	6.1E-11	1.2E-07
ZR95	0.0	0.0	0.0
NB95	7.1E-06	7.0E-12	1.3E-08
MO99	5.4E-02	4.3E-08	8.1E-05
TC99M	0.0	3.3E-08	6.2E-05
I131	2.5E-02	2.3E-06	4.3E-03
I132	9.1E-03	1.9E-07	3.6E-04
I133	4.1E-02	2.1E-06	4.0E-03
I134	5.7E-03	6.7E-09	1.2E-05
I135	2.2E-02	4.3E-07	8.1E-04
TE132	2.7E-03	2.2E-09	4.1E-06
CS134	3.0E-03	1.5E-07	2.8E-04
CS136	1.5E-03	7.1E-08	1.3E-04
CS137	1.5E-03	7.5E-08	1.4E-04
BA137M	0.0	6.4E-08	1.2E-04
BA140	4.4E-05	4.2E-11	7.9E-08
LA140	1.5E-05	2.3E-11	4.3E-08
CE144	4.5E-06	4.5E-12	8.5E-09
TOTAL	2.0E-01	5.5E-06	1.0E-02

Table 11.2-7

ACTIVITY FROM STEAM GENERATOR BLOWDOWN - EXPECTED CASE

DF WAste Disposal System for this Source = 1.00E+01
Decay Time in Waste Disp Sys (hours) = 0.0
Flow Rate (gal/yr) = 4.80E+07

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
CR51	2.4E-07	2.4E-08	4.3E-03
MN54	5.3E-08	5.3E-09	9.5E-04
FE55	2.1E-07	2.1E-08	3.8E-03
FE59	1.6E-07	1.6E-08	2.9E-03
CO58	2.1E-06	2.1E-07	3.8E-02
CO60	2.4E-07	2.4E-08	4.3E-03
SR89	5.3E-08	5.3E-09	2.6E-04
SR90	1.1E-09	1.1E-10	2.0E-05
SR91	3.5E-08	3.5E-09	6.3E-04
Y90	1.9E-10	1.9E-11	3.4E-06
Y91M	1.1E-08	1.1E-09	2.0E-04
Y91	7.9E-09	7.9E-10	1.4E-04
Y93	1.8E-09	1.8E-10	3.2E-05
ZR95	1.1E-08	1.1E-09	2.0E-04
NB95	1.1E-08	1.1E-09	2.0E-04
MO99	9.6E-06	9.6E-07	1.7E-01
TC99M	4.8E-06	4.8E-07	8.6E-02
RU103	5.3E-09	5.3E-10	9.5E-05
RU106	1.1E-09	1.1E-10	2.0E-05
RH103M	2.3E-09	2.3E-10	4.1E-05
RH106	4.0E-10	3.8E-11	6.8E-06
TE125M	2.6E-09	2.6E-10	4.7E-05
TE127M	2.6E-08	2.6E-09	4.8E-04
TE127	5.3E-08	5.3E-09	9.5E-04
TE129M	1.6E-07	1.6E-08	2.9E-03
TE129	6.9E-08	6.9E-09	1.2E-03
TE131M	2.2E-07	2.2E-08	4.0E-03
TE131	2.1E-08	2.1E-09	3.8E-04
TE132	2.4E-06	2.4E-07	4.3E-02
BA-37M	9.0E-07	8.9E-08	1.6E-02
BA140	2.6E-08	2.6E-09	4.7E-04

Table 11.2-7 (continued)
ACTIVITY FROM STEAM GENERATOR BLOWDOWN - EXPECTED CASE

DF WAste Disposal System for this Source = 1.00E+01
Decay Time in Waste Disp Sys (hours) = 0.0
Flow Rate (gal/yr) = 4.80E+07

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
LA140	1.6E-08	1.6E-09	2.9E-04
CE141	1.1E-08	1.1E-09	2.0E-04
CE143	2.2E-09	2.2E-10	4.0E-05
CE144	5.3E-09	5.3E-10	9.5E-05
PR143	5.2E-09	5.2E-10	9.4E-05
PR144	2.1E-09	2.1E-10	3.8E-05
NP239	1.4E-07	1.4E-08	2.5E-03
BR83	1.2E-07	1.2E-08	2.2E-03
BR84	1.8E-08	1.8E-09	3.2E-04
BR85	2.0E-10	2.0E-11	3.6E-06
I130	1.5E-07	1.5E-08	2.7E-03
I131	3.3E-05	3.3E-06	5.9E-01
I132	3.3E-06	3.3E-07	5.9E-02
I133	3.3E-05	3.3E-06	5.9E-01
I134	5.0E-07	5.0E-08	9.0E-03
I135	9.7E-06	9.7E-07	1.7E-01
RB86	1.0E-08	1.0E-09	1.8E-04
RB88	7.6E-07	7.6E-08	1.4E-02
CS134	3.0E-06	3.0E-07	5.4E-02
CS136	1.5E-06	1.5E-07	2.7E-02
CS137	2.2E-06	2.2E-07	4.0E-02
TOTAL	1.6E+00	1.1E-05	2.0E+00

Table 11.2-8

ACTIVITY FROM LAUNDRY DRAINS - EXPECTED CASE

DF Waste Disposal System for this Source = 1.00E+01
Decay Time in Waste Disp Sys (hours) = 0.0
Flow Rate (gal/yr) = 2.10E+06

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
MN54	1.3E-07	1.3E-08	1.0E-04
CO58	5.1E-07	5.1E-08	4.0E-04
CO60	1.1E-06	1.1E-07	8.7E-04
ZR95	1.8E-07	1.8E-08	1.4E-04
NB95	2.5E-07	2.5E-08	2.0E-04
RU103	1.8E-08	1.8E-09	1.4E-05
RU106	3.0E-07	3.0E-08	2.4E-04
RH103M	1.3E-08	1.3E-09	1.0E-05
RH106	3.0E-07	3.0E-08	2.4E-04
I131	7.5E-08	7.5E-09	5.9E-05
CS134	1.6E-06	1.6E-07	1.3E-03
CS137	3.0E-06	3.0E-07	2.4E-03
BA137M	2.7E-06	2.7E-07	2.1E-03
CE144	6.3E-07	6.3E-08	5.0E-04
PR144	5.7E-07	5.7E-08	4.5E-04
TOTAL	1.2E-05	1.2E-06	9.5E-03

Table 11.2-9
ACTIVITY FROM BORON RECOVERY - EXPECTED CASE

DF Waste Disposal System for this Source = 1.00E+06[a]
Decay Time in Waste Disp Sys (hours) = 8.0E+01
Flow Rate (gal/yr) = 4.38E+06

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
CR51	2.6E-03	2.3E-09	3.8E-05
MN54	4.3E-04	4.2E-10	6.9E-06
FE55	2.2E-03	2.2E-09	2.6E-05
FE59	1.4E-03	1.3E-09	2.1E-05
CO58	2.2E-02	2.1E-08	3.4E-04
CO60	2.8E-03	2.8E-09	4.6E-05
SR89	4.9E-04	4.5E-10	7.4E-06
SR90	1.4E-05	1.4E-11	2.6E-07
SR91	7.9E-04	9.6E-12	1.6E-07
Y90	1.6E-06	1.0E-11	1.6E-07
Y91M	4.0E-04	6.5E-12	1.1E-07
Y91	8.9E-04	8.4E-10	1.4E-05
Y93	4.2E-05	5.9E-13	7.7E-09
ZR95	8.4E-05	7.9E-11	1.3E-06
NB95	7.0E-05	7.1E-11	1.2E-06
MO99	1.1E-01	3.2E-08	5.3E-04
TC99M	5.7E-02	3.1E-08	5.1E-04
RU103	6.3E-05	5.7E-11	9.4E-07
RU106	1.4E-05	1.4E-11	2.3E-07
RH103M	5.0E-05	5.7E-11	2.4E-07
RH106	1.1E-05	1.4E-11	2.3E-07
TE125M	4.0E-05	3.7E-11	6.1E-07
TE127M	3.9E-04	3.8E-10	6.2E-06
TE127	1.0E-03	3.8E-10	6.2E-06

a. Includes DF from Boron Recovery System.

Notes:

1. Mixed Bed Demineralizer with DF = 10 for all Radionuclides except Cs and Rb for which the DF = 20
2. Cation Removal Bed with a DF in the Chemical and Volume control system = 10 for Cs and Rb and = 1 for all other isotopes.
3. Boron Evaporator with a DF = 1000 for all radionuclides except I, for which the DF = 100.

Table 11.2-9 (continued)
ACTIVITY FROM BORON RECOVERY - EXPECTED CASE

DF Waste Disposal System for this Source = 1.00E+06[a]
Decay Time in Waste Disp Sys (hours) = 8.0E+01
Flow Rate (gal/yr) = 4.38E+06

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
TE129M	1.9E-03	1.7E-09	2.0E-05
TE129	1.8E-03	1.1E-09	1.0E-05
TE131M	3.2E-03	3.2E-10	5.3E-06
TE131	1.2E-03	5.9E-11	9.7E-07
TE132	3.6E-02	1.2E-08	2.0E-04
BA137M	1.8E-02	1.1E-07	1.0E-03
BA140	3.0E-04	2.2E-10	3.6E-06
LA140	2.0E-04	2.3E-10	3.0E-06
CE141	9.7E-05	8.6E-11	1.4E-06
CE143	5.2E-05	6.1E-12	1.0E-07
CE144	4.6E-05	4.5E-11	2.4E-07
PR143	6.9E-05	5.6E-11	2.2E-07
PR144	3.7E-05	4.5E-11	7.4E-07
NP239	1.6E-03	3.9E-10	6.4E-06
BR83	5.5E-03	4.3E-12	7.1E-08
BR84	2.9E-03	1.1E-13	1.8E-07
BR85	3.3E-04	1.0E-16	1.6E-12
I130	2.6E-03	5.4E-10	8.9E-06
I131	3.7E-01	2.3E-06	3.8E-02
I132	1.1E-01	2.0E-08	3.3E-04
I133	4.9E-01	2.7E-07	4.4E-03
I134	5.3E-02	5.5E-11	2.0E-07
I135	2.3E-01	1.4E-08	2.3E-04
RB86	1.1E-04	4.5E-10	2.4E-06

a. Includes DF from Boron Recovery System.

Notes:

1. Mixed Bed Demineralizer with DF = 10 for all Radionuclides except Cs and Rb for which the DF = 20
2. Cation Removal Bed with a DF in the Chemical and Volume control system = 10 for Cs and Rb and = 1 for all other isotopes.
3. Boron Evaporator with a DF = 1000 for all radionuclides except I, for which the DF = 100.

Table 11.2-9 (continued)
ACTIVITY FROM BORON RECOVERY - EXPECTED CASE

DF Waste Disposal System for this Source = 1.00E+06[a]
Decay Time in Waste Disp Sys (hours) = 8.0E+01
Flow Rate (gal/yr) = 4.38E+06

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
RB88	2.2E-01	1.3E-11	2.1E-07
CS134	3.2E-02	1.6E-07	2.6E-03
CS136	1.6E-02	6.0E-08	9.9E-04
CS137	2.3E-02	1.1E-07	1.8E-03
TOTAL	1.8E+00	3.2E-06	5.2E-02

a. Includes DF from Boron Recovery System.

Notes:

1. Mixed Bed Demineralizer with DF = 10 for all Radionuclides except Cs and Rb for which the DF = 20
2. Cation Removal Bed with a DF in the Chemical and Volume control system = 10 for Cs and Rb and = 1 for all other isotopes.
3. Boron Evaporator with a DF = 1000 for all radionuclides except I, for which the DF = 100.

Table 11.2-10
ACTIVITY FROM PRIMARY COOLANT SYSTEM
LEAKAGE (HLWDT) - EXPECTED CASE

DF Waste Disposal System for this Source = 1.00E+06[a]
Decay Time in Waste Disp Sys (hours) = 1.67E+00
Flow Rate (gal/yr) = 1.48E+07

Nuclide	Initial Activity (μC/GM)	Activity After Treatment (μC/GM)	Discharge Rate from W.D. System (Ci/yr)
CR51	5.3E-04	5.3E-10	2.9E-05
MN54	8.8E-05	8.8E-11	4.9E-06
FE55	4.5E-04	4.5E-10	2.5E-05
FE59	2.9E-04	2.9E-10	1.6E-05
CO58	4.5E-03	4.5E-09	2.5E-04
CO60	5.7E-04	5.7E-10	3.2E-05
SR89	1.0E-04	1.0E-10	5.6E-06
SR90	2.9E-06	2.9E-12	1.6E-07
SR91	1.6E-04	1.4E-10	7.8E-06
Y90	3.3E-07	3.1E-13	1.7E-08
Y91M	8.2E-05	8.9E-11	4.9E-06
Y91	1.8E-04	1.8E-10	1.0E-05
Y93	8.6E-06	7.5E-12	4.2E-07
ZR95	1.7E-05	1.7E-11	7.4E-07
NB95	1.4E-05	1.4E-11	7.8E-07
MO99	2.2E-02	2.2E-08	1.2E-03
TC99M	1.1E-02	1.3E-08	7.2E-04
RU103	1.3E-05	1.3E-11	7.2E-07
RU106	2.9E-06	2.9E-12	1.6E-07
RH103M	1.0E-05	1.2E-11	6.9E-07
RH106	2.3E-06	2.9E-12	1.6E-07
TE125M	8.2E-06	8.2E-12	4.6E-07
TE127M	8.0E-05	8.0E-11	4.4E-06
TE127	2.1E-04	1.9E-10	1.1E-05
TE129M	3.9E-04	3.9E-10	2.2E-05
TE129	3.7E-04	2.9E-10	1.6E-05
TE131M	6.6E-04	6.3E-10	3.5E-05

a. Includes Containment Building Sumps, Safeguards Sumps, Auxiliary Building Sumps, Fuel Building Sumps and Laboratory Drains.

Table 11.2-10 (continued)
ACTIVITY FROM PRIMARY COOLANT SYSTEM
LEAKAGE (HLWDT) - EXPECTED CASE

DF Waste Disposal System for this Source = 1.00E+06[a]
Decay Time in Waste Disp Sys (hours) = 1.67E+00
Flow Rate (gal/yr) = 1.48E+07

Nuclide	Initial Activity (µC/GM)	Activity After Treatment (µC/GM)	Discharge Rate from W.D. System (Ci/yr)
TE131	2.5E-04	1.3E-10	7.2E-06
TE132	7.4E-03	7.3E-09	4.1E-04
BA137M	3.7E-03	1.9E-07	1.1E-02
BA140	6.2E-05	6.1E-11	3.4E-06
LA140	4.1E-05	4.2E-11	2.3E-06
CE141	2.0E-05	2.0E-11	1.1E-06
CE143	1.1E-05	1.0E-11	5.6E-07
CE144	9.4E-06	9.4E-12	5.2E-07
PR143	1.4E-05	1.4E-11	7.8E-07
PR144	7.6E-06	9.3E-12	5.2E-07
NP239	3.3E-04	3.2E-10	1.8E-05
BR83	1.1E-03	6.5E-10	3.6E-05
BR84	5.9E-04	7.5E-11	4.2E-06
BR85	6.8E-05	8.3E-14	4.6E-09
I130	5.3E-04	4.8E-08	2.7E-03
I131	7.6E-02	7.5E-06	4.2E-01
I132	2.3E-02	1.4E-06	7.8E-02
I133	1.0E-01	9.4E-06	5.2E-01
I134	1.1E-02	2.8E-07	1.6E-02
I135	4.7E-02	3.8E-06	2.1E-01
RB86	2.3E-05	1.1E-09	6.1E-05
RB88	4.5E-02	1.1E-07	5.6E-03
CS134	6.6E-03	3.3E-07	1.8E-02
CS136	3.3E-03	1.6E-07	8.9E-03
CS137	4.7E-03	2.4E-07	1.3E-02
TOTAL	3.7E-01	2.4E-05	1.3E+00

a. Includes Containment Building Sumps, Safeguards Sumps, Auxiliary Building Sumps, Fuel Building Sumps and Laboratory Drains.

Table 11.2-11
ACTIVITY FROM DECONTAMINATION BUILDING SUMPS - EXPECTED CASE

DF Waste Disposal System for this Source = 1.00E+06
Decay Time in Waste Disp Sys (hours) = 2.92
Flow Rate (gal/yr) = 3.62E+05

Nuclide	Initial Activity (µC/GM)	Activity After Treatment (µC/GM)	Discharge Rate from W.D. System (Ci/yr)
CR51	2.6E-05	2.5E-11	3.4E-08
MN54	4.3E-06	4.3E-12	5.8E-09
FE55	2.2E-05	2.2E-11	3.0E-08
FE59	1.4E-05	1.4E-11	1.9E-08
CO58	2.2E-04	2.2E-10	3.0E-07
CO60	2.8E-05	2.8E-11	3.8E-08
SR89	4.9E-06	4.8E-12	6.6E-09
SR90	1.4E-07	1.4E-13	1.9E-10
SR91	7.7E-06	1.7E-12	2.3E-09
Y90	1.6E-08	4.1E-14	5.6E-11
Y91M	4.0E-06	1.1E-12	1.5E-09
Y91	8.9E-06	8.8E-12	1.2E-08
Y93	4.2E-07	9.5E-14	1.3E-10
ZR95	8.4E-07	8.3E-13	1.1E-09
NB95	7.0E-07	7.0E-13	9.5E-10
MO99	1.1E-03	8.1E-10	1.1E-06
TC99M	5.7E-04	7.2E-10	9.8E-07
RU103	6.3E-07	6.2E-13	8.4E-10
RU106	1.4E-07	1.4E-13	1.9E-10
RH103M	5.0E-07	6.1E-13	8.3E-10
RH106	1.1E-07	1.4E-13	1.9E-10
TE125M	4.0E-07	3.9E-13	5.3E-10
TE127M	3.9E-06	3.9E-12	5.3E-09
TE127	1.0E-05	5.1E-12	6.9E-09
TE129M	1.9E-05	1.9E-11	2.6E-08
TE129	1.8E-05	1.2E-11	1.6E-08
TE131M	3.2E-05	1.7E-11	2.3E-08
TE131	1.2E-05	3.1E-12	4.2E-09
TE132	3.6E-04	2.8E-10	3.8E-07
BA137M	1.8E-04	9.8E-09	1.3E-05
BA140	3.0E-06	2.8E-12	3.8E-07

Table 11.2-11 (continued)

ACTIVITY FROM DECONTAMINATION BUILDING SUMPS - EXPECTED CASE

DF Waste Disposal System for this Source = 1.00E+06
Decay Time in Waste Disp Sys (hours) = 2.92
Flow Rate (gal/yr) = 3.62E+05

Nuclide	Initial Activity (µC/GM)	Activity After Treatment (µC/GM)	Discharge Rate from W.D. System (Ci/yr)
LA140	2.0E-06	2.3E-12	3.1E-07
CE141	9.7E-07	9.4E-13	1.3E-07
CE143	5.2E-07	2.9E-13	3.9E-10
CE144	4.6E-07	4.6E-13	6.2E-10
PR143	6.9E-07	6.7E-13	9.1E-10
PR144	3.9E-07	4.6E-13	6.2E-10
NP239	1.6E-05	1.1E-11	1.5E-08
BR83	5.5E-05	2.2E-12	3.0E-09
BR84	2.9E-05	9.6E-14	1.2E-10
BR85	3.3E-06	9.2E-17	1.2E-13
I130	2.6E-05	7.1E-10	9.6E-07
I131	3.7E-03	3.3E-07	4.6E-04
I132	1.1E-03	2.2E-08	3.0E-05
I133	4.9E-03	2.1E-07	2.9E-04
I134	5.3E-04	4.5E-10	6.1E-07
I135	2.3E-03	3.2E-08	4.3E-05
RB86	1.1E-06	5.2E-11	7.1E-08
RB88	2.2E-03	1.2E-10	1.6E-07
CS134	3.2E-04	1.6E-08	2.2E-05
CS136	1.6E-04	7.5E-09	1.0E-05
CS137	2.3E-04	1.1E-08	1.5E-05
TOTAL	1.8E-02	6.4E-07	8.7E-04

Table 11.2-12
ACTIVITY IN WASTE DISPOSAL SYSTEM
WITH STEAM GENERATOR LEAKAGE - DESIGN CASE

Calculated Maximum Allowable Discharge Rate (Ci/yr) = 2.5E+03
Calculated Total Discharge Flow Rate (gpm) = 90.8

Nuclide	Initial Activity (μC/gm)	Actual Disch. Rate (Ci/yr)	Allowable Discharge Rate	
			Mixture (Ci/yr)	Single (Ci/yr)
H3	6.6E-03	1.2E+03	1.2E+03	6.6E+05
CR51	9.5E-08	1.7E-02	6.8E-02	6.8E+06
MN54	7.8E-08	1.4E-02	5.6E-02	1.4E+05
CO58	2.5E-06	4.4E-01	1.8E+00	2.2E+05
FE59	1.0E-07	1.8E-02	7.2E-02	1.4E+05
CO60	7.8E-08	1.4E-02	5.6E-02	2.8E+04
SR89	3.9E-07	6.9E-02	2.8E-01	8.0E+03
SR90	1.5E-08	2.6E-03	1.0E-02	2.4E+02
SR91	8.9E-08	1.6E-02	6.4E-02	1.9E+05
Y90	1.7E-08	3.0E-03	1.2E-02	1.9E+04
Y91	4.7E-07	8.5E-02	3.4E-01	7.6E+04
ZR95	7.3E-08	1.3E-02	5.2E-02	1.5E+04
NB95	7.3E-08	1.3E-02	5.2E-02	2.4E+05
TC99M	4.1E-04	7.4E+01	3.0E+02	1.1E+07
MO99	4.7E-04	8.4E+01	3.4E+02	1.4E+05
RU103	7.8E-11	1.4E-05	5.6E-05	
RU106	1.3E-09	2.4E-04	9.6E-04	
RH103M	5.1E-11	9.2E-06	3.7E-05	
RH106	1.3E-09	2.4E-04	9.6E-04	
I131	2.6E-04	4.7E+01	1.9E+02	1.1E+03
I132	4.1E-05	7.3E+00	2.9E+01	2.6E+04
I133	3.0E-04	5.4E+01	2.2E+02	3.5E+05
I134	5.6E-06	1.0E+00	4.0E+00	6.0E+04
I135	1.7E-05	3.1E+00	1.2E+01	1.3E+04
TE122	2.3E-05	4.2E+00	1.7E+01	7.1E+04
CS134	2.8E-05	5.1E+00	2.0E+01	1.0E+04
CS136	1.2E-05	2.1E+00	8.4E+00	2.0E+05
CS137	1.4E-04	2.5E+01	1.0E+02	1.7E+04
BA140	4.2E-07	7.6E-02	3.0E-01	6.5E+04
LA140	2.1E-07	3.8E-02	1.5E-01	6.3E+04

Table 11.2-12 (continued)
ACTIVITY IN WASTE DISPOSAL SYSTEM
WITH STEAM GENERATOR LEAKAGE - DESIGN CASE

Calculated Maximum Allowable Discharge Rate (Ci/yr) = 2.5E+03
Calculated Total Discharge Flow Rate (gpm) = 90.8

Nuclide	Initial Activity (μC/gm)	Actual Disch. Rate (Ci/yr)	Allowable Discharge Rate	
			Mixture (Ci/yr)	Single (Ci/yr)
CE144	3.6E-08	6.5E-03	2.6E-02	1.4E+04
Total	8.4E-03	1.5E+03	2.5E+03	
Total (Non-Tritium)	1.9E-03	3.3E+02	1.3E+03	

Ratio of Allowable To Actual Discharge Rate Of Mixture, Excluding H3 = 3.99E+00

Table 11.2-13
ACTIVITY IN WASTE DISPOSAL SYSTEM
WITH STEAM GENERATOR LEAKAGE - EXPECTED CASE

Calculated Total Discharge Flow Rate (gpm) = 78.7

Nuclide	Initial Activity (μC/gm)	Actual Disch. Rate (Ci/yr)
CR51	5.3E-12	4.5E-03
MN54	1.3E-12	1.1E-03
FE55	4.6E-12	4.0E-03
FE59	3.5E-12	3.0E-03
CO58	4.7E-11	4.0E-02
CO60	6.4E-12	5.5E-03
SR89	1.2E-12	1.0E-03
SR90	2.4E-14	2.1E-05
SR91	7.6E-13	6.6E-04
Y90	4.3E-15	3.7E-06
Y91M	2.4E-13	2.1E-04
Y91	2.0E-13	1.7E-04
Y93	3.9E-14	3.4E-05
ZR95	4.1E-13	3.5E-04
NB95	4.8E-13	4.2E-04
MO99	2.1E-10	1.8E-01
TC99M	1.1E-10	9.0E-02
RU103	1.3E-13	1.1E-04
RU106	3.2E-13	2.7E-04
RH103M	6.4E-14	5.5E-05
RH106	3.0E-13	2.6E-04
TE125M	5.7E-14	4.9E-05
TE127M	5.7E-13	4.9E-04
TE127	1.2E-12	1.0E-03
TE129M	3.5E-12	3.0E-03
TE129	1.5E-12	1.3E-03
TE131M	4.8E-12	4.1E-03
TE131	4.6E-13	4.0E-04
TE132	5.3E-11	4.5E-02
BA137M	3.7E-11	3.2E-02
BA140	5.7E-13	4.9E-04

Table 11.2-13 (continued)
ACTIVITY IN WASTE DISPOSAL SYSTEM
WITH STEAM GENERATOR LEAKAGE - EXPECTED CASE

Calculated Total Discharge Flow Rate (gpm) = 78.7

Nuclide	Initial Activity (μC/gm)	Actual Disch. Rate (Ci/yr)
LA140	3.5E-13	3.0E-04
CE141	2.4E-13	2.1E-04
CE143	4.8E-14	4.1E-05
CE144	7.2E-13	6.2E-04
PR143	1.1E-13	9.8E-05
PR144	6.0E-13	5.1E-04
NP239	3.1E-12	2.6E-03
BR83	2.6E-12	2.3E-03
BR84	3.9E-13	3.4E-04
BR85	4.3E-15	3.7E-06
I130	6.5E-12	5.6E-03
I131	1.3E-09	1.1E+00
I132	1.7E-10	1.4E-01
I133	1.4E-09	1.2E+00
I134	2.9E-11	2.5E-02
I135	4.7E-10	4.0E-01
RB86	3.0E-13	2.6E-04
RB88	2.3E-11	2.0E-02
CS134	9.2E-11	7.9E-02
CS136	4.5E-11	3.8E-02
CS137	6.9E-11	5.9E-02
H3	2.8E-06	2.4E+03
Total	2.8E-06	2.4E+03
Total (Non-Tritium)	4.0E-09	3.5E+00

Table 11.2-14
ACTIVITY IN DISCHARGE CANAL - DESIGN CASE

Nuclide	MPC (µC/cc)	Actual Activity (µC/cc)	Ratio (µC/cc)/ MPC	Allowable Activity (µC/cc)	Ratio (µC/cc)/ MPC
H3	3.0E-03	5.5E-06	1.8E-03	5.5E-06	1.8E-03
CR51	2.0E-03	2.3E-11	1.1E-08	9.1E-11	4.4E-08
MN54	1.0E-04	3.9E-11	3.9E-07	1.6E-10	1.6E-06
CO58	9.0E-05	7.4E-10	8.2E-06	2.9E-07	3.3E-05
FE59	5.0E-05	2.6E-11	5.3E-07	1.1E-10	2.1E-06
CO60	3.0E-05	6.0E-11	2.0E-06	2.4E-10	8.0E-06
SR89	3.0E-06	1.1E-10	3.5E-05	4.2E-10	1.4E-04
SR90	3.0E-07	1.2E-11	4.1E-05	4.7E-11	1.6E-04
SR91	5.0E-05	1.9E-11	3.7E-07	7.5E-11	1.5E-06
Y90	2.0E-05	1.3E-11	6.3E-07	5.0E-11	2.5E-06
Y91	3.0E-05	1.3E-10	4.5E-06	5.4E-10	1.8E-05
ZR95	6.0E-05	2.1E-11	3.5E-07	8.4E-11	1.4E-06
NB95	1.0E-04	2.2E-11	2.2E-07	8.8E-11	8.8E-07
TC99M	3.0E-03	8.5E-08	2.8E-05	3.4E-07	1.1E-04
MO99	4.0E-05	9.9E-08	2.5E-03	4.0E-07	1.0E-02
I131	3.0E-07	5.6E-08	1.8E-01	2.2E-07	7.2E-01
I132	3.0E-06	8.5E-09	1.1E-03	3.4E-08	4.4E-03
I133	1.0E-06	6.2E-08	6.2E-06	2.5E-07	2.4E-01
I134	2.0E-05	1.2E-09	5.9E-05	4.7E-09	2.4E-04
I135	4.0E-06	3.6E-09	9.0E-04	1.4E-08	3.6E-03
TE132	2.0E-05	4.8E-09	2.4E-04	1.9E-08	9.6E-04
CS134	9.0E-06	1.8E-08	2.0E-03	7.3E-08	8.0E-03
CS136	6.0E-05	2.6E-09	4.3E-05	1.0E-08	1.7E-04
CS137	2.0E-05	1.2E-07	5.9E-03	4.7E-07	2.4E-02
BA140	2.0E-05	9.2E-11	4.6E-06	3.7E-10	1.8E-05
LA140	2.0E-05	4.8E-11	2.4E-06	1.9E-10	9.6E-06
CE144	1.0E-05	1.8E-11	1.8E-06	7.2E-11	7.2E-06
Total		6.4E-06	2.6E-01	7.3E-06	1.0E-00
Total (Non-Tritium)		5.7E-07	2.5E-01	1.8E-06	9.9E-01

Table 11.2-15
ACTIVITY IN WASTE HEAT TREATMENT FACILITIES - DESIGN CASE

Nuclide	MPC (μC/cc)	Actual Activity (μC/cc)	Ratio (μC/cc)/ MPC	Allowable Activity (μC/cc)	Ratio (μC/cc)/ MPC
H3	3.0E-03	5.7E-06	1.8E-03	5.3E-06	1.8E-03
CR51	2.0E-03	1.2E-11	6.2E-09	4.8E-11	2.5E-08
MN54	1.0E-04	3.5E-11	3.5E-07	1.4E-10	1.4E-06
CO58	9.0E-05	5.5E-10	6.1E-06	2.2E-09	2.4E-05
FE59	5.0E-05	1.7E-11	3.5E-07	6.8E-11	1.4E-06
CO60	3.0E-05	5.7E-11	1.9E-06	2.3E-10	7.6E-06
SR89	3.0E-06	7.1E-11	2.4E-05	2.8E-10	9.6E-05
SR90	3.0E-07	1.2E-11	3.9E-05	4.8E-11	1.6E-04
SR91	5.0E-05	3.3E-13	6.5E-09	1.3E-12	2.6E-08
Y90	2.0E-05	1.1E-11	5.5E-07	4.4E-11	2.2E-06
Y91	3.0E-05	9.5E-11	3.2E-06	3.8E-10	1.8E-05
ZR95	6.0E-05	1.5E-11	2.5E-07	6.0E-11	1.0E-06
NB95	1.0E-04	1.7E-11	1.7E-07	6.0E-11	6.8E-07
TC99M	3.0E-03	1.0E-08	3.5E-06	4.0E-08	1.4E-05
MO99	4.0E-05	1.1E-08	2.9E-04	4.4E-08	1.1E-03
I131	3.0E-07	1.5E-08	5.0E-02	6.0E-08	2.0E-01
I132	3.0E-06	6.4E-10	8.0E-05	2.6E-09	3.2E-04
I133	1.0E-06	2.3E-09	2.3E-03	9.2E-09	9.2E-03
I134	2.0E-05	1.9E-12	9.9E-08	7.6E-12	3.9E-07
I135	4.0E-06	4.4E-11	1.1E-05	1.8E-10	4.4E-05
TE132	2.0E-05	6.1E-10	3.0E-05	2.4E-09	1.2E-04
CS134	9.0E-06	1.7E-08	1.9E-03	6.8E-08	7.6E-03
CS136	6.0E-05	9.4E-10	1.6E-05	3.8E-09	6.4E-05
CS137	2.0E-05	1.1E-07	5.7E-03	4.4E-07	2.3E-02
BA140	2.0E-05	3.3E-11	1.7E-06	1.3E-10	6.8E-06
LA140	2.0E-05	3.4E-11	1.7E-06	1.4E-10	6.8E-06
CE144	1.0E-05	1.6E-11	1.2E-06	6.4E-11	6.4E-06
Total		5.9E-06	6.2E-02	6.4E-06	2.4E-01
Total (Non-Tritium)		2.8E-07	6.0E-02	1.1E-06	2.4E-01

Table 11.2-16
ACTIVITY IN NORTH ANNA RESERVOIR - DESIGN CASE

Nuclide	MPC (µC/cc)	Actual Activity (µC/cc)	Ratio (µC/cc)/ MPC	Allowable Activity (µC/cc)	Ratio (µC/cc)/ MPC
H3	3.0E-03	4.1E-06	1.4E-03	4.1E-06	1.4E-03
CR51	2.0E-03	2.9E-12	1.4E-09	1.2E-11	5.6E-09
MN54	1.0E-04	2.3E-11	2.3E-07	9.2E-11	9.2E-07
CO58	9.0E-05	2.2E-10	2.5E-06	8.8E-10	1.0E-05
FE59	5.0E-05	5.5E-12	1.1E-07	2.2E-11	4.4E-07
CO60	3.0E-05	4.4E-11	1.5E-06	1.8E-10	6.0E-06
SR89	3.0E-06	2.4E-11	8.0E-06	9.6E-11	3.2E-05
SR90	3.0E-07	9.3E-12	3.1E-05	3.7E-11	1.2E-04
SR91	5.0E-05	1.5E-15	3.0E-11	6.0E-15	1.2E-10
Y90	2.0E-05	9.0E-12	4.5E-07	3.6E-11	1.8E-06
Y91	3.0E-05	3.5E-11	1.2E-06	1.4E-10	4.8E-06
ZR95	6.0E-05	5.9E-12	9.9E-08	2.4E-11	4.0E-07
NB95	1.0E-04	7.1E-12	7.1E-08	2.0E-11	2.8E-07
TC99M	3.0E-03	3.0E-10	9.9E-08	1.2E-09	4.0E-07
MO99	4.0E-05	3.4E-10	8.4E-06	1.4E-09	3.4E-05
I131	3.0E-07	1.3E-09	4.2E-03	5.2E-09	1.7E-02
I132	8.0E-06	2.2E-11	2.8E-06	8.8E-11	1.1E-05
I133	1.0E-06	2.4E-11	2.4E-05	9.6E-11	9.6E-05
I134	2.0E-05	8.3E-16	4.1E-11	3.3E-15	1.6E-10
I135	4.0E-05	1.4E-13	3.5E-08	5.6E-13	1.4E-07
TE132	2.0E-05	2.2E-11	1.1E-06	8.8E-11	4.4E-06
CS134	9.0E-06	1.2E-08	1.4E-03	4.8E-08	5.6E-03
CS136	6.0E-05	1.2E-10	2.0E-06	4.8E-10	8.0E-06
CS137	2.0E-05	8.9E-08	4.5E-03	3.6E-07	1.8E-02
BA140	2.0E-05	4.2E-12	2.1E-07	1.7E-11	8.4E-07
LA140	2.0E-05	4.2E-12	2.1E-07	1.7E-11	8.4E-07
CE144	1.0E-05	1.0E-11	1.0E-06	4.0E-11	4.0E-06
Total		4.2E-06	1.1E-02	4.9E-06	4.1E-02
Total (Non-Tritium)		1.0E-07	1.0E-02	7.6E-07	4.0E-02

Table 11.2-17
ACTIVITY IN DISCHARGE CANAL - EXPECTED CASE

Nuclide	Activity (µC/gm)
CR51	5.9E-12
MN54	3.1E-12
FE55	1.6E-11
FE59	4.4E-12
CO58	6.8E-11
CO60	2.3E-11
SR89	1.5E-12
SR90	1.0E-13
SR91	7.7E-13
Y90	7.9E-14
Y91M	2.5E-13
Y91	2.9E-13
Y93	4.0E-14
ZR95	5.7E-13
NB95	6.8E-13
MO99	2.1E-10
TC99M	1.1E-10
RU103	1.6E-13
RU106	8.1E-13
RH103M	8.8E-14
RH106	7.9E-13
TE125M	7.9E-14
TE127M	9.7E-13
TE127	1.6E-12
TE129M	4.1E-12
TE129	1.9E-12
TE-131M	4.8E-12
TE-131	4.8E-13
TE-132	5.2E-11
BA137M	2.4E-10
BA140	6.1E-13
LA140	3.8E-13
CE141	2.9E-13
CE143	4.8E-14

Table 11.2-17 (continued)
ACTIVITY IN DISCHARGE CANAL - EXPECTED CASE

Nuclide	Activity (µC/gm)
CE144	1.7E-12
PR143	1.2E-13
PR144	1.6E-12
NP239	3.0E-12
BR83	2.7E-12
BR84	4.0E-13
BR85	4.4E-15
I130	6.6E-12
I131	1.3E-09
I132	1.6E-10
I133	1.4E-09
I134	2.9E-11
I135	4.8E-10
RB86	3.3E-13
RB88	2.3E-11
CS134	2.9E-10
CS136	4.6E-11
CS137	2.8E-10
H3	5.5E-06
Total	5.5E-06
Total (Non-Tritium)	4.8E-09

Table 11.2-18
ACTIVITY IN WASTE HEAT TREATMENT FACILITY - EXPECTED CASE

Nuclide	Activity (μC/gm)
CR51	3.2E-12
MN54	2.8E-12
FE55	1.5E-11
FE59	2.9E-12
CO58	5.1E-11
CO60	2.2E-11
SR89	1.0E-12
SR90	9.7E-14
SR91	1.4E-14
Y90	8.7E-14
Y91M	8.2E-15
Y91	1.9E-13
Y93	7.6E-16
ZR95	4.2E-13
NB95	5.0E-13
MO99	2.3E-11
TC99M	2.1E-11
RU103	9.8E-14
RU106	7.4E-13
RH103M	8.9E-14
RH106	7.4E-13
TE125M	5.6E-14
TE127M	7.8E-13
TE127	7.9E-13
TE129M	2.4E-12
TE129	1.6E-12
TE131M	2.5E-13
TE131	5.6E-14
TE132	6.6E-12
BA137M	2.6E-10
BA140	2.2E-13
LA140	2.3E-13
CE141	1.7E-13
CE143	2.8E-15

Table 11.2-18 (continued)
ACTIVITY IN WASTE HEAT TREATMENT FACILITY - EXPECTED CASE

Nuclide	Activity (µC/gm)
CE144	1.6E-12
PR143	4.7E-14
PR144	1.6E-12
NP239	2.9E-13
BR83	1.2E-14
BR84	4.0E-16
BR85	4.0E-19
I130	1.5E-13
I131	3.4E-10
I132	7.2E-12
I133	5.2E-11
I134	4.8E-14
I135	5.8E-12
RB86	1.5E-13
RB88	1.3E-14
CS134	2.7E-10
CS136	1.7E-11
CS137	2.7E-10
H3	5.3E-06
Total	5.3E-06
Total (Non-Tritium)	1.4E-09

Table 11.2-19
ACTIVITY IN NORTH ANNA RESERVOIR - EXPECTED CASE

Nuclide	Activity (μC/gm)
CR51	7.4E-13
MN54	1.8E-12
FE55	1.1E-11
FE59	9.1E-13
CO58	2.1E-11
CO60	1.7E-11
SR89	3.5E-13
SR90	7.6E-14
SR91	6.3E-17
Y90	7.4E-14
Y91M	3.6E-17
Y91	7.0E-14
Y93	3.7E-18
ZR95	1.6E-13
NB95	2.1E-13
MO99	7.1E-13
TC99M	6.3E-13
RU103	2.9E-14
RU106	4.9E-13
RH103M	2.6E-14
RH106	4.9E-13
TE125M	2.0E-14
TE127M	3.8E-13
TE127	3.8E-13
TE129M	6.4E-13
TE129	4.1E-13
TE131M	3.7E-15
TE131	8.0E-16
TE132	2.4E-13
BA137M	2.0E-10
BA140	2.8E-14
LA140	2.8E-14
CE141	4.3E-14
CE143	4.4E-17

Table 11.2-19 (continued)
ACTIVITY IN NORTH ANNA RESERVOIR - EXPECTED CASE

Nuclide	Activity (μC/gm)
CE144	9.9E-13
PR143	6.0E-15
NP239	7.7E-15
BR83	1.4E-17
BR84	1.0E-19
BR85	9.2E-24
I130	9.1E-16
I131	2.9E-11
I132	2.4E-13
I133	5.3E-13
I134	2.0E-17
I135	1.9E-14
RB86	2.5E-14
RB88	1.8E-18
CS134	1.9E-10
CS136	2.2E-12
CS137	2.2E-10
H3	4.1E-06
Total	4.1E-06
Total (Non-Tritium)	7.0E-10

Table 11.2-20
FLOW CONDITIONS IN NORTH ANNA RESERVOIR
AND WASTE HEAT TREATMENT FACILITIES

Parameter	Value
Volume of reservoir	1.06E+10 ft^3
Environmental flow rate into reservoir	270.00 cfs
Evaporation rate from reservoir	59.00 cfs
Overflow rate from reservoir	220.00 cfs
Recirculation flow, reservoir to Waste Heat Treatment Facility	962 cfs
Volume of Waste Heat Treatment Facility	2.66E+09 ft^3
Environmental flow rate into Waste Heat Treatment Facility	30.00
Evaporation rate from Waste Heat Treatment Facility	21.00 cfs
Recirculation flow, Waste Heat Treatment Facility to reservoir	971 cfs

Table 11.2-21
MAXIMUM INDIVIDUAL WHOLE-BODY AND BODY-ORGAN EXPOSURE
DUE TO LIQUID RADWASTE IN THE NORTH ANNA RESERVOIR
Annual Radiation Exposure (mrem/yr)

Exposure Source	Whole Body	Lungs	Liver	Kidney	Bone	Thyroid	Lower Large Intestine
Water ingestion, 1.2 liters/day	0.20	0.19	0.21	0.20	0.013	0.21	0.19
Fish ingestion, 50 g/day	1.4	0.22	1.9	0.64	1.1	0.022	0.046
Swimming, 200 hr/yr	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Boating, 500 hr/yr	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Sunbathing, 300 hr/yr	0.046	0.046	0.046	0.046	0.046	0.046	0.046
Totals	1.646	0.456	2.156	0.886	1.159	0.278	0.282

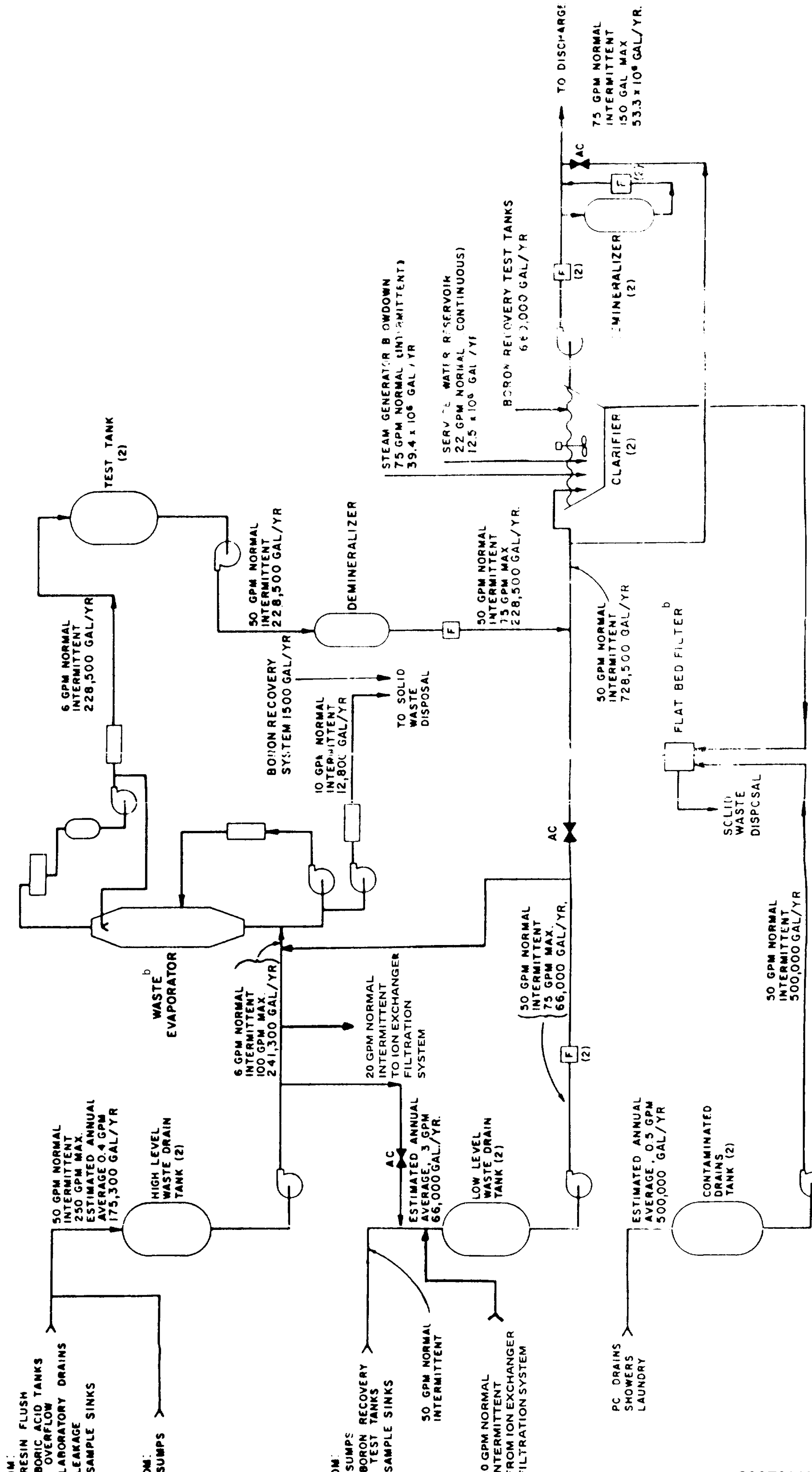
Table 11.2-22
MAXIMUM INDIVIDUAL WHOLE-BODY AND BODY-ORGAN EXPOSURE
DUE TO LIQUID RADWASTE IN THE WASTE HEAT FACILITY
Annual Radiation Exposure (mrem/yr)

Exposure Source	Whole Body	Lungs	Liver	Kidney	Bone	Thyroid	Lower Large Intestine
Water ingestion, 1.2 liters/day	0.27	0.25	0.27	0.25	0.018	0.54	0.24
Fish ingestion, 50 g/day	1.9	0.29	2.6	0.86	1.4	0.20	0.070
Swimming, 200 hr/yr	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Boating, 500 hr/yr	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
Sunbathing, 300 hr/yr	0.061	0.061	0.061	0.061	0.061	0.061	0.061
Totals	2.232	0.601	2.932	1.172	1.480	0.802	0.372

Table 11.2-23
WHOLE-BODY POPULATION EXPOSURE DUE TO LIQUID
RADWASTE IN THE NORTH ANNA COOLING WATER STORAGE SYSTEM

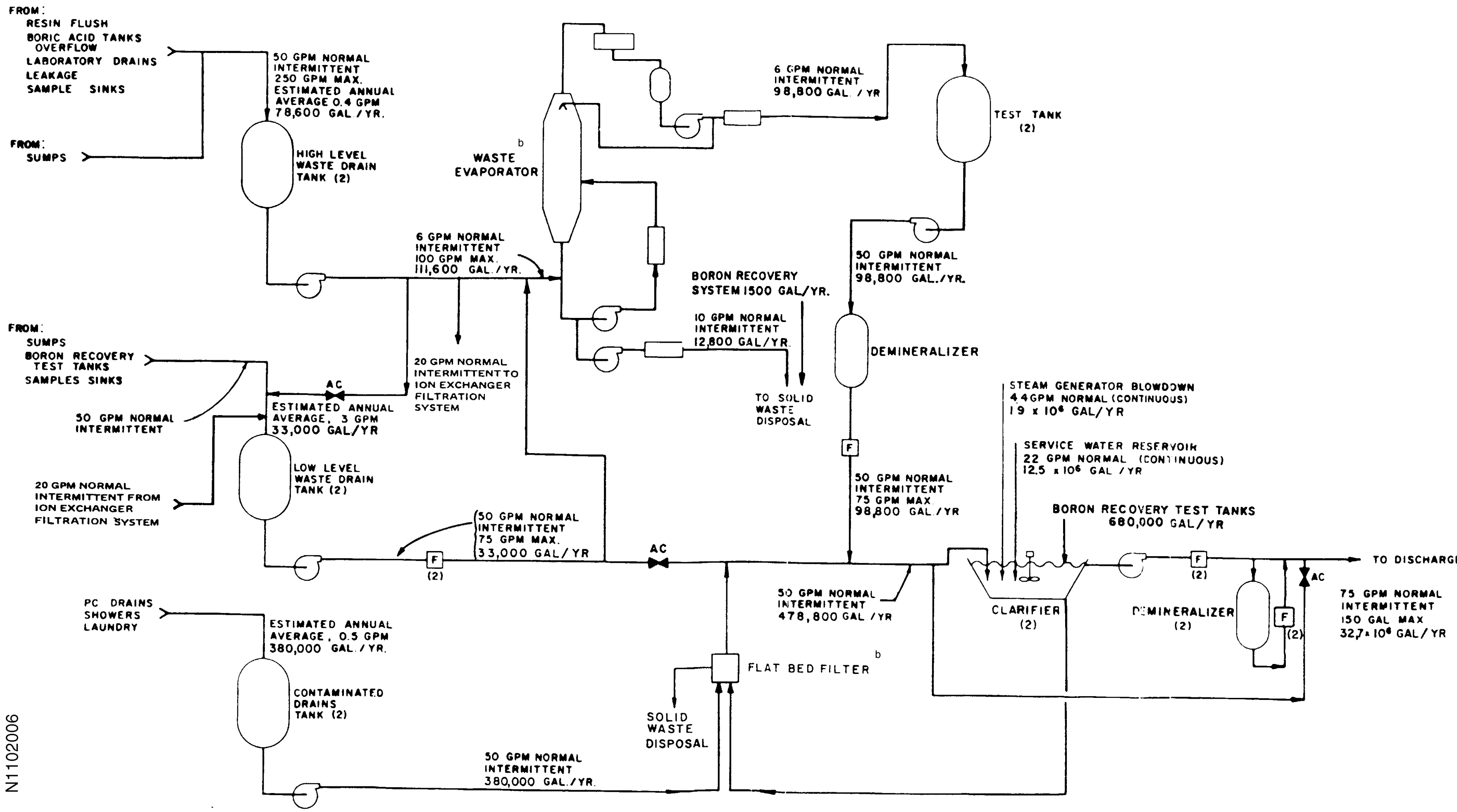
Exposure Source	Estimated Exposure Rate (mrem/yr) in the Year 2000
Ingestion of water taken from the reservoir	3.0
Ingestion of fish taken from the cooling-water storage system	4.15
Swimming in the reservoir	0.002
Boating on the reservoir	0.002
Sunbathing along the reservoir	0.483
Totals	7.637

Figure 11.2-1
LIQUID WASTE DISPOSAL SYSTEM—DESIGN CONDITIONS[a]



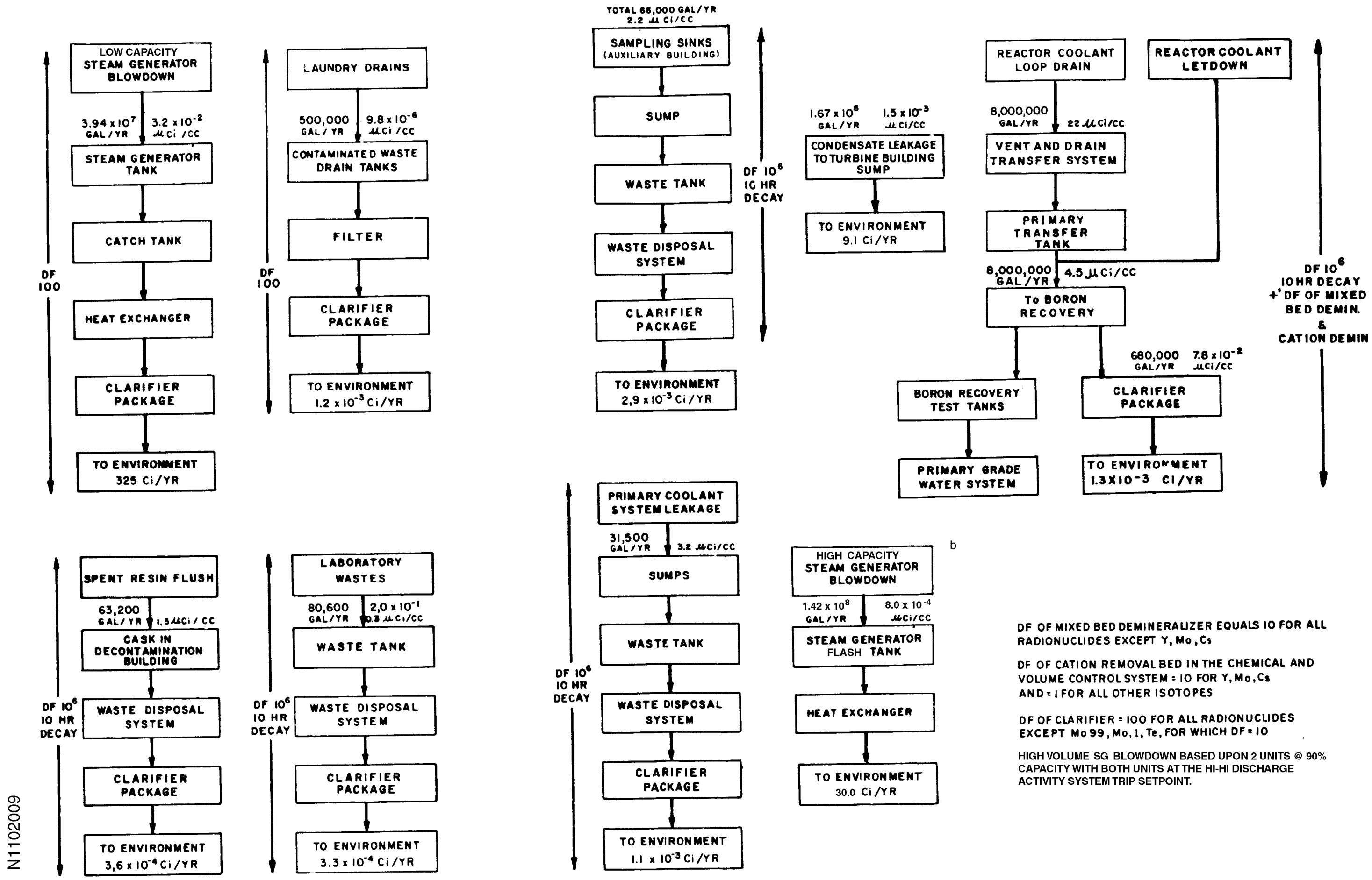
a. Based on original plant configuration and liquid waste processing assumptions.
b. Abandoned in place.

Figure 11.2-2
LIQUID WASTE DISPOSAL SYSTEM—EXPECTED CONDITIONS[a]



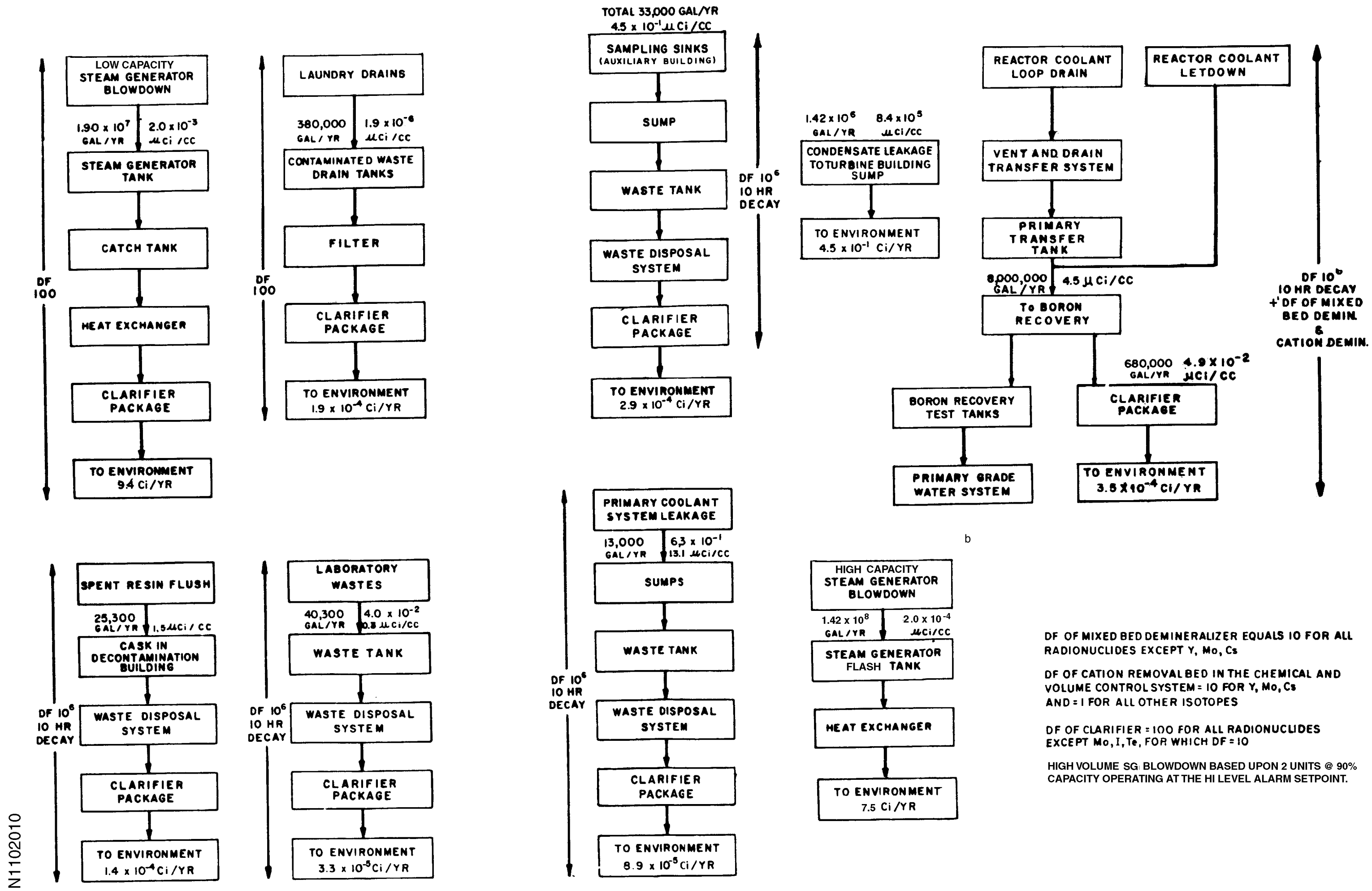
a. Based on original plant configuration and liquid waste processing assumptions.
b. Abandoned in place

Figure 11.2-3
FLOW CHART—ESTIMATED QUANTITIES LIQUID WASTE DISPOSAL—DESIGN CASE[a]



a. Based on original plant configuration and liquid waste processing assumptions, except where noted.
b. Systems added to upgrade blowdown capacity.

Figure 11.2-4
FLOW CHART—ESTIMATED QUANTITIES LIQUID
WASTE DISPOSAL—EXPECTED CASE[a]



a. Based on original plant configuration and liquid waste processing assumptions, except where noted.
b. Systems added to upgrade blowdown capacity.

11.3 GASEOUS WASTE DISPOSAL SYSTEM

11.3.1 Design Objectives

The gaseous waste disposal system is designed to maintain effluent radioactivity levels as low as practicable and below the limits of applicable regulations. The system is designed to satisfy the applicable sections of the general criteria of Section 3.1, to conform with original Atomic Energy Commission (AEC) and present NRC general design criteria, and to meet the intent of 10 CFR 20, 10 CFR 50, and 10 CFR 100, so as not to endanger the health of station operating personnel or the general public.

The gaseous waste disposal system is common to both units and is sized to treat the radioactive gases released during simultaneous operation of both units. Fission product gases and uncondensed radioactive vapors are held for decay, filtered, and diluted with ventilation air until they may be safely released through one of the two vent stacks on top of the Unit 1 containment.

The gaseous waste disposal system is designed to provide adequate storage for radioactive decay time of the waste gases and, in addition, provide for holdup of these gases when adverse meteorological conditions make it desirable to discontinue release of waste gas to the environment.

Section 11.3.5 presents the expected gaseous activity release, by nuclide, from North Anna Units 1 and 2 for a core utilizing a 15 x 15 fuel assembly array. (This is greater than a 17 x 17 as discussed in Section 11.1.1.2.) Virginia Power implemented the revised 10 CFR 20 rule on January 1, 1994. The calculational methodology for the design and expected gaseous activity releases, which are based on the criteria of the old 10 CFR 20, are valid design analyses and does not need to be redone according to the criteria of the revised 10 CFR 20. (Reference: Seventh Set of NRC Q/A #456.) The exposures received by the general public as a result of these releases are presented in Section 11.3.8.

11.3.2 System Description

Figure 11.3-1 and Reference Drawings 1 and 2 depict the gaseous waste disposal system. The system is designed to receive, decay, process, dilute, and discharge potentially radioactive gases, fission product gases, and uncondensed vapors from the vent and drain system, boron recovery system, primary coolant leakages, and the reactor plant. The design minimizes possible personnel exposure and ensures that radioactive releases to the environment are ALARA.

Area and effluent monitoring ensures that any accidental radioactivity release would be detected within a reasonable period of time. The largest accidental radioactivity release from the gaseous waste disposal system would be caused by the rupturing of the waste gas decay tanks. An analysis of this accident is reported in Section 15.3.5. Periodic samples of the gas in the waste decay tanks are analyzed by health physics personnel to determine nuclide composition and ensure that the activity inventory in these tanks does not exceed prescribed levels. Releases from the relief valves will be detected by instrumentation in Vent Stack B.

The system is a closed loop consisting of two waste gas compressors, two waste gas decay tanks, and connecting piping to collect and filter vapors from tanks containing radioactive liquids as shown in Figure 11.3-1.

Table 11.3-1 gives a summary of design parameters for gaseous waste disposal system equipment. The gaseous waste inputs to the gaseous waste system are identified by source in Section 11.1. The activity data for all gaseous waste discharged to the atmosphere are presented in Section 11.3.5.

The process vent subsystem dilutes and discharges the effluents of the gaseous waste disposal system to the atmosphere. The ventilation vent subsystem, described in Section 9.4, regulates the discharge of air from potentially contaminated areas, and from the steam reliefs of the boron evaporators, waste disposal evaporator (the waste disposal evaporator is not used: the ion exchange filtration system (DURATEK) is used instead), gas strippers and waste gas decay tanks to the atmosphere. Discharges from both subsystems are monitored by particulate and gas monitors described in the process radiation monitoring system, Section 11.4.

Gaseous waste enters the process vent subsystem of the gaseous waste disposal system from the waste gas decay tanks, the vent and drain system, the containment purge system and the containment vacuum system, as shown on Figure 11.3-1 and Reference Drawings 1 and 2.

Two double-walled waste gas decay tanks are located in underground concrete vaults for missile protection. The inner tank is fabricated of stainless steel in accordance with Section III C, and the outer tank of carbon steel in accordance with Section VIII, Division I, of the ASME Boiler and Pressure Vessel Code. Connections are provided for sampling the tank contents and the annular space between tanks.

Overpressure relief protection is provided at the waste gas decay tanks in accordance with Section III C of the ASME Code. The protective devices consist of rupture disc assemblies followed by bellows-sealed pressure relief valves. The use of bellows seals and rupture discs precludes leakage of the waste gas to the environment during normal operation of the gaseous waste disposal system. The piping downstream of the protective devices relieves to vent stack B upstream of all radiation monitoring equipment.

After sufficient decay time and sampling, the gas is released into the process vent system at the suction of the process vent blowers. These blowers also take suction on the containment vacuum compressor discharge and on the vents of liquid waste tanks, as well as the bleed of the nitrogen supply line. These gases are mixed with filtered air from the auxiliary building and are drawn through charcoal and high-efficiency particulate air (HEPA) filters to remove iodine. The gases then pass through a regenerative heat exchanger and are discharged to the atmosphere.

The heat exchanger raises the temperature of the inlet gas to the charcoal filters sufficiently to prevent water adsorption.

The process vent blowers maintain a slight vacuum in the charcoal filters to prevent leakage from the filter assembly. The decay tank pressure relief valves discharge to vent stack B.

The process vent discharge nozzle and the process vent blowers are sized such that the minimum exit velocity is approximately 100 fps. This exit velocity prevents any significant downdrafting of the effluent with atmospheric winds as high as 35 mph. The process vent terminates at an elevation approximately 21 feet above the top of the Unit 1 containment structure.

11.3.3 Operating Procedures

In the event that the activity of the process vent stream exceeds the setting of the process vent radiation monitors, the release from the waste gas decay tanks and the containment vacuum pumps to the process vent are terminated automatically; releases from tank vents to the process vent are terminated manually. The monitor also alarms in the main control room prior to valve closure if the activity approaches a preset value. Subsequent restart of the gaseous release to the process vent is accomplished manually in accordance with administrative procedures.

The gaseous waste disposal system provides adequate radioactive decay storage time for the waste gases and long-term holdup of these gases when either high-flow letdown is required or adverse meteorological conditions make it desirable to discontinue release of waste gas to environment. Gases in these tanks should be allowed to decay for 60 days before release, unless additional gas storage capacity is required by reactor shutdown or start-up activities. It is assumed that essentially all of the gases and that a very small percentage (0.1%) of the iodines are removed from the letdown stream at the gas stripper and sent to the waste gas decay tanks. Utilization of steam heating at the gas stripper will vary with the level of coolant activity due to fuel defects.

The estimated curies of each radionuclide that will be released from the station via the gaseous waste disposal system are listed in Table 11.3-3. The estimated gaseous releases are based on a set of assumptions, discussed in Section 11.3.5, regarding the operation of the gaseous waste disposal system and various process system radioactive liquid flowrates. These assumptions were developed during the plant design to demonstrate compliance with NRC effluent release regulations. These assumptions were intended to be representative of the plant operation. In some instances, this is not the case since various system process parameters have proven to be different from the initial estimated values. These original estimates represented the basis for compliance to the NRC requirements in the original licensing basis. Adherence to the gaseous waste effluent requirements is monitored by procedures in accordance with the Offsite Dose Calculation Manual (ODCM), as discussed in Section 11.4.4.2.

Monitoring gaseous effluents in accordance with the ODCM ensures that the composite results of the variations in gaseous waste inputs and processing on the actual releases are within the accepted current licensing basis for the gaseous waste disposal system as specified in the acceptance criteria of the ODCM. In addition, this monitoring has demonstrated that the released gaseous waste activities are typically significantly less than the expected case releases from Table 11.3-3.

11.3.3.1 Ventilation Vent Subsystem

The ventilation vent subsystem is considered to be a portion of the gaseous waste disposal system only for purposes of radiological surveillance, and it is designed on this basis. The relief valves that relieve into the ventilation vent stack B contain potentially radioactive gases and hydrogen. However, since the gases to be handled are predominantly of nonradioactive origin, this subsystem has been considered an auxiliary system for the purpose of this report. A full description of this subsystem is included in Section 9.4.

11.3.3.2 Safety Considerations

There are two portions of the gaseous waste disposal system where oxygen and hydrogen are mixed. The decay tanks discharge into a dilution air line prior to release from the process vents. Relief valves discharge into vent stack B.

The waste gas decay tank mixture, after decaying, is discharged into the process vent at a maximum rate of 3.0 scfm and mixed with dilution air. The dilution air is drawn continuously by one of two process vent blowers with a system flow specified in the Technical Requirements Manual. An oxygen sampling system and nitrogen blanket system are provided on the inner tank of the double-walled decay tanks, in addition to manual sample connections. Manual controls are provided to add nitrogen and take samples from outer tanks of the decay tanks. The oxygen concentration within the inner tanks is monitored to verify a concentration of less than or equal to 2% by volume at all times, whenever the hydrogen concentration could exceed 4% by volume.

The relief valves that relieve into vent stack B contain potentially radioactive gases and hydrogen. The relief valve sizing is such that the maximum discharge rate of hydrogen from the gas decay tanks will not produce greater than 4 volume percent hydrogen in the mixed discharge of vent stack B.

11.3.4 Performance Tests

During the preliminary operation period, all equipment in the gaseous waste disposal system was tested to verify conformance with specification performance requirements. All control systems and interlocks were tested and operated to ensure satisfactory performance and reliability.

Continuous monitoring of the effluent from the waste gas decay tanks and the process vent discharge, coupled with periodic sampling and analysis of system influents and effluents, yield information on the performance of the system.

11.3.5 Estimated Releases

The gaseous releases presented in Tables 11.3-2 and 11.3-3 are based on the assumptions given in Section 11.1 and the following assumptions for each specific source.

11.3.5.1 **Waste Gas Decay Tanks**

The gaseous waste disposal system is designed to provide adequate radioactive decay storage time for the waste gases and, in addition, to provide long-term holdup of these gases when either high-flow letdown is required or adverse meteorological conditions make it desirable to discontinue release of waste gas to the environment. The tanks are located within vaults south of the fuel building, as shown on Reference Drawing 4. These tanks are provided with high-pressure alarms. In addition, tank pressure can be monitored in the control room. The air space of the waste gas decay tank vaults can be sampled by the radiation monitoring system for gaseous and particulate activity.

For the design release case, the waste gas release estimates are calculated for two units in the base load cycle assuming (1) 1.0% failed fuel; (2) one unit 4 weeks behind the other; (3) a 365-day feed (including the stripping of all noble gas from one unit at the end of the feed cycle), a 60-day nominal decay after the feed cycle is complete, and a 10-day bleed cycle for the waste gas decay tank; and (4) the stripping of all noble gas from the other unit and the feeding of this gas to the tank at the beginning of the feed cycle.

Coolant gaseous activity at the start of the feed cycle equals zero.

Fuel activity at the start of the feed cycle is equal to one-third of a two-year-old core, one third of a one-year-old core, and one-third of a new core.

The annual average letdown for two units in the base load cycle is 0.94 gpm. It is assumed that all of the gases and 0.1% of the iodines in the letdown will be removed at the gas stripper and sent to the waste gas decay tank.

The iodine activity released from the waste gas decay tank passes through charcoal filters (90% efficiency for iodine collection) in the process vent subsystem.

For the expected case, all assumptions are the same except that feed time to the waste gas decay tanks is 300 days and the iodine activity released from the waste gas decay tank passes through charcoal filters with 99% efficiency for iodine collection.

Based on the above factors, the dose rate at the ground surface above the vaults is less than 0.75 mrem/hour.

The design values of the radioisotope inventory in the waste gas decay tank are listed in Table 11.3-4.

11.3.5.2 Boron Recovery Tanks

The three boron recovery tanks are 120,000-gallon non-seismic tanks inside a protective enclosure which is located south of the Unit 1 containment as shown on Reference Drawing 4. Inside the enclosure, each tank is located within a Seismic Class 1 dike which is capable of retaining the entire contents of the tank, as described in Section 3.8.1.1.8.

This analysis assumes that all of the noble gases are stripped from the boron recovery letdown in the gas stripper prior to entering the boron recovery tank and are not available for release from the boron recovery tanks. However, some isotopes of xenon are produced in the boron recovery tanks from the decay of iodines and it is assumed that 0.1% of this xenon diffuses from the liquid and is released to the environment. Any amount released to the surface of the boron recovery tanks is passed through the process vent by sweep gas.

Analysis of the expected radiation level from the boron recovery tank is based on a 0.2% failed fuel inventory and on boron recovery tanks with a volume of 120,000 gallons. One boron recovery tank is assumed to be filled with demineralized and degassed primary coolant that has passed through the mixed bed demineralizer with a decontamination factor (DF) of 10 for all isotopes except Cs, Mo, and Y, and through a cation demineralizer with a DF of 10 for iodines. Operation is for 365 days in the design case and 300 days in the expected case. The rate of xenon production at this maximum inventory is assumed to occur for the entire year. Even with these conservative assumptions, the gaseous activity released from the boron recovery tanks is insignificant compared to other sources. The expected radiation level is less than 0.75 mrem/hour in all accessible areas external to the dike.

The tanks are provided with level indication, high-level alarms, and overflows to each other as safeguards against overfilling.

11.3.5.3 Boron Recovery Test Tanks

These tanks are located external to and above the underground portion of the Auxiliary Building north of the Unit 1 containment, as shown on Reference Drawing 4. These tanks are non-seismic and act only as a temporary storage location for distillate formed from the boron recovery evaporator. These tanks have level indication in the control room. The tanks are designed with an overflow system that is connected between each tank and that will overflow to the low level liquid waste tanks. The dose rate at the surface of these tanks will be less than 0.75 mrem/hour. This calculation is based on the following:

1. Failed fuel at 0.2%
2. Maximum boron recovery tank inventory pumped to the boron evaporators.

3. Boron recovery evaporator with a DF of 10^4.
4. Boron recovery test tank volume of 20,000 gallons.

11.3.5.4 **Refueling Water Storage Tanks**

These tanks are located south of the service building and adjacent to the respective unit containments, as shown on Reference Drawing 4. The tanks, described in Section 6.2.2.2, are Seismic Class I structures. They are provided with level indication and low and high alarms to detect leakage, as discussed in Chapter 9. Radiation levels at the surface of the tanks are to be maintained ALARA.

11.3.5.5 **Primary-Grade Water Tanks**

The tanks are located south of the fuel building between the containments for Units 1 and 2, as shown on Reference Drawing 4. These tanks are non-seismic. These tanks can receive liquid from the water treatment system, the condensate tanks, or from the boron recovery test tank. These tanks provide a holdup volume for water that meets primary coolant chemistry specifications. The radiation level at the surface of these tanks is less than 0.75 mrem/hour. This calculation is based on the following:

1. 0.2% failed fuel.
2. Maximum boron recovery test tank inventory pumped to the primary grade water tanks.
3. No credit taken for decay during transfer to the primary-grade water tanks.
4. No credit taken for dilution in the primary-grade water tanks.

11.3.5.6 **High-Level Liquid Waste System**

As in the boron recovery tanks, iodine decay is the source of the noble gas released from this system.

For this analysis it is assumed that all of the flow from the sampling sinks, laboratory wastes, boron recovery system, sumps, and spent resin flush passes through the high-level waste system.

Total flow assumed for this system is 240,000 gallons per year for the design case and 110,000 gallons per year for the expected case. With a high-level liquid waste tank volume of 5000 gallons, this results in approximately 48 tankfuls per year in the design case and 22 tankfuls per year in the expected case.

The rate of xenon production at the maximum inventory of one tank is assumed to occur for the entire operating year. Of the xenon produced, 0.1% is assumed to diffuse out of the liquid and is vented to the environment.

In this analysis, maximum production rates for xenon are assumed for the entire operating year, with no decay of the xenon. Even with these conservative assumptions, the total amount of xenon from the high-level waste system is insignificant compared to other sources listed in Table 11.3-2.

11.3.5.7 Containment Purge

The activity released from purging the containment after shutdown is based on the failed fuel percentage and the primary coolant leakage to the containment given in Section 11.1.

For this analysis, two purges per year per unit are assumed. In the design case, the buildup of activity is assumed to occur for 180 days before purging. In the expected case, the buildup of activity in the containment at the end of the buildup period is assumed to be available for release. Equilibrium primary coolant activities are conservatively assumed to be in the primary coolant for the entire buildup period. During purge operations, iodine is passed through HEPA/charcoal filters with an assumed iodine collection efficiency of 90% for the design case and 99% for the expected case.

A discussion of the containment ventilation purge system appears in Section 9.4.9. The installed HEPA and charcoal filters used to limit releases are discussed in Section 9.4.8.

11.3.5.8 Auxiliary Building Vent

The activity released to the environment from the auxiliary building ventilation has as its source the equilibrium airborne activity in the auxiliary building from miscellaneous primary coolant leakages described in Section 12.2.3 from the sample sink hood ventilation and from various radioactive relief valves. For the design case, activity is assumed to be released for 365 days, and for the expected case for 300 days. Auxiliary building ventilation flow is passed through HEPA/charcoal filters with an assumed iodine collection efficiency of 90% for the design case and 99% for the expected case. Assuming that only one assembly is operational, either the auxiliary building general area exhaust or the auxiliary building central area exhaust may be passed through the filter assembly.

Each exhaust is monitored periodically on a fixed-time cycle from the main control room and, if a high radiation signal is received, the control room operator will manually divert the contaminated flow to the filter bank. Radioactive relief valves will be checked to determine if any have lifted. In order not to exceed the capacity of the filter bank, the operator will manually shut off the two auxiliary building supply fans and one exhaust fan in the contaminated system.

Section 9.4.8.1 describes the efficiency of the HEPA filters and charcoal adsorbers, which will limit atmospheric releases of airborne radioactivity to the as-low-as-practicable guideline.

11.3.5.9 **Steam Generator Blowdown Tank Vent**

When the low-capacity steam generator blowdown system is in operation, steam generator blowdown liquid flashes in the steam generator blowdown tank, resulting in the release of a fraction of the iodines contained in the steam generator blowdown liquid. It is assumed that 1 μCi of iodine is released from the liquid for every 50 μCi of iodine that enter the blowdown tank. It is further assumed that the steam flashed from the blowdown tank is condensed by the steam generator blowdown tank vent condenser. Under normal conditions, the vent condenser would provide a DF of infinity for the iodines, since they would all be returned with the condensed steam to the steam generator blowdown stream for discharge through the clarifiers. However, in this analysis, a DF of 100 has been conservatively assumed for the condenser.

11.3.5.10 **Secondary Steam Releases**

With primary to secondary leakage in the steam generator, the potential for the release of radioactivity exists in the main and auxiliary steam systems and through condenser air ejectors. Main steam activities are listed in Tables 11.1-8 and 11.1-9.

For this analysis all of the noble gases in the main steam are assumed to be discharged to the environment via the main condenser air ejector.

Iodine in the main steam may be released to the environment from:

1. Main steam leakage to the turbine building. The steam has the iodine concentration listed in Tables 11.1-8 and 11.1-9.
2. The heating system drain receiver vent and auxiliary steam drain receiver vent. The main steam activity is assumed to have a plateout factor of 2 in the condenser and the reflashed steam has a partition factor of 10; thus, there is an overall reduction factor of 0.05 for the main steam activity.
3. The main condenser air ejector, gland seal ejector, and chilled water unit air ejector condenser. The main steam activity has a plateout factor of 2 in the condenser and a partition factor of 10 ($\mu Ci/cm^3$ liquid/$\mu Ci/cm^3$ gas) from the condensed liquid to the water vapor. With a density of 0.068 lb/ft^3 of air vapor, the discharge per pound has an activity equivalent up to 0.045 times the main steam activity per pound.

11.3.6 Release Points

Release points from the gaseous waste systems to the environment are shown on the system diagrams, Reference Drawing 1 through 3.

11.3.7 Dilution Factors

In evaluating the estimated annual radiation doses resulting from the expected releases presented in Table 11.3-3, annual average χ/Q values were obtained from meteorological data collected onsite. These data are presented in Section 2.3. The χ/Q values were generated from these data assuming a continuous source and a ground-level release model. Dispersion attributable to release height, exit velocity, and plume buoyancy was not included in the model. In calculating offsite radionuclide concentrations, plume depletion, which would occur from deposition and radioactive decay, was not assumed.

11.3.8 Estimated Doses from Gaseous Effluents

A full and complete evaluation of the radiological impact to be incurred by the expected gaseous radioactive releases from the station is contained in Appendix 11B. Only a summary of the more important features of that appendix and the doses obtained are presented here.

Maximum individual external exposure rates due to the gaseous releases calculated for the expected case have been evaluated at the position of maximum dose rate for locations on land outside the 1-mile exclusion radius. The applicable annual average χ/Q at the position of interest, 1 mile SSE of the reactors, has been obtained from onsite meteorological data collected during the period September 6, 1971, through September 15, 1972, and is equal to 1.83×10^{-6} sec/m^3. Using the semi-infinite sphere model, the annual whole-body exposure of a person at the given location is calculated to be 0.616 mrem/yr. The annual thyroid dose at the same location from inhalation of released radioiodines is calculated to be 0.070 mrem/yr. The release rates upon which these doses are based are presented in Table 11.3-3. Appendix 11B contains the mathematical formulae and dose parameters used in the evaluation.

The potential radiation exposure of a child's thyroid from ingestion of milk containing radioactive iodine has been estimated.

Gaseous radioiodine may be deposited on nearby grazing lands following release from the station, and it may be ingested by lactating cows. Some of the iodine will then be transferred to the milk produced by the animals. Because of the small size of the thyroid gland, the critical receptor for this exposure pathway is a young child 6 months to 1 year in age. Conservatively assuming that the cows graze on grass for the full year and that no dilution with other milk supplies occurs, the potential exposure from ingestion from this source at the nearest Grade A dairy farm (about 3.6 miles SSE of the reactors) is estimated at 1.21 mrem/yr. The annual average χ/Q at this location is 1.20×10^{-7} sec/m^3.

The combined maximum annual dose from radioiodine due to inhalation of released radioiodines (0.070 mrem) and milk ingestion (1.21 mrem) is 1.28 mrem, well below the maximum dose permitted by Appendix I of 10 CFR 50 (15 mrem). No other exposure pathways have been found to be of any significance. Only external exposure from the released radiogases is of significance regarding population exposure.

Population exposure from expected gaseous releases has been estimated on the basis of the projected population distributions within 50 miles of the station. The projections, presented in Chapter 2, are available for the years 1970, 1980, 1990, 2000, 2010, and 2020. Using the semi-infinite sphere model, the total population exposure within 50 miles at the station has been evaluated and is as follows:

Year	Persons Within 50 Miles	Total Man-Rem Within 50 Miles of the Site	Millirem Per Capita
1970	836,250	3.115	0.00373
1980	998,408	3.709	0.00371
1990	1,176,590	4.373	0.00372
2000	1,363,945	5.066	0.00371
2010	1,566,731	5.820	0.00371
2020	1,795,944	6.655	0.00370

The above population exposure due to station operation may be placed in perspective by a comparison with the exposure occurring within 50 miles due to natural background radiation, which ranges from 104,531 man-rem/yr in 1970 to 224,493 man-rem/yr in the year 2020.

Any projected increase in environmental radioactivity or radiation levels due to gaseous waste releases is therefore expected to be insignificant, undetectable in most cases, and the use of source term calculations would be the only practical way to quantify such increases.

11.3 REFERENCE DRAWINGS

The list of Station Drawings below is provided for information only. The referenced drawings are not part of the UFSAR. This is not intended to be a complete listing of all Station Drawings referenced from this section of the UFSAR. The contents of Station Drawings are controlled by station procedure.

	Drawing Number	Description
1.	11715-FM-097A	Flow/Valve Operating Numbers Diagram: Gaseous Waste Disposal System, Unit 1
2.	11715-FM-097B	Flow/Valve Operating Numbers Diagram: Gaseous Waste Disposal System, Unit 1
3.	11715-FY-1B	Site Plan, Units 1 & 2
4.	11715-FY-1A	Plot Plan, Units 1 & 2

Table 11.3-1
GASEOUS WASTE DISPOSAL EQUIPMENT DESIGN DATA

Waste Gas Decay Tanks		
Number	2	
Capacity per tank	462 scf	
Design pressure	Outer Tank	Inner Tank
	Full vacuum to 137 psig	Full vacuum[a] to 175 psig
Design temperature	200°F	200°F
Operating pressure, max.	5 psig	125 psig
Operating temperature	120°F	140°F
Material	Carbon steel	SS 304L
Design Code	ASME VIII, 1968	ASME III C, 1968
Waste Gas Surge Tank		
Number	1	
Capacity	14.7 scf	
Design pressure	Full vacuum to 175 psig	
Design temperature	300°F	
Operating pressure	Atmospheric	
Operating temperature	200°F	
Material	SS 304	
Design Code	ASME III C, 1968	
Process Vent Regenerative Heat Exchanger		
Number	1	
Total duty	3.5×10^3 Btu/hr	
	Shell	Tube
Design pressure	15 psig	15 psig
Design temperature	180°F	180°F
Operating pressure	Atmospheric	2 psig
Operating temperature, in/out, max.	105°F/115°F	145°F/135°F
Material	Carbon steel	SS 304
Fluid	Air	Air
Design Code	ASME VIII, Division I, 1968	ASME VIII, Division I, 1968
Process Vent Blower		
Number	2	
Type	Multistage centrifugal	
Motor horsepower	7.5	
Capacity per blower	307 scfm	

a. The inner tank low pressure design is related to the outer tank pressure. If the inner tank pressure is less than the outer tank pressure, the differential pressure must be less than 18.2 psid. There is no design limitation if the inner tank is at a higher pressure than the outer tank.

Table 11.3-1 (continued)
GASEOUS WASTE DISPOSAL EQUIPMENT DESIGN DATA

Differential pressure (at rated flow)	1.65 psi
Suction pressure	14.2 psia
Discharge pressure	15.9 psia
Waste Gas Compressor	
Number	2
Type	Diaphragm
Motor horsepower	3
Capacity per compressor	1.5 scfm
Discharge pressure at rated capacity	150 psig
Design pressure	220 psig
Materials	
Cylinder	Carbon steel
Piston rod	Forged steel
Piston	Nodular iron
Diaphragms and parts contacting waste gas	SS 304/316
Waste Gas Filter Assemblies	
Number	2
Filter element type	HEPA and activated charcoal
HEPA Filters	
Number per assembly	1
Normal capacity	1000 cfm
Maximum capacity	1200 cfm
Frame material	Cadmium plated steel
Design pressure	15 psig
Design temperature	250°F
Design Code	USAEC Health and Safety Bulletin 306, Type II B
Filter efficiency	99.97
Charcoal Filters	
Number per assembly	3
Normal capacity	300 cfm
Maximum capacity	1000 cfm
Frame material	304 stainless steel
Design pressure	15 psig

a. The inner tank low pressure design is related to the outer tank pressure. If the inner tank pressure is less than the outer tank pressure, the differential pressure must be less than 18.2 psid. There is no design limitation if the inner tank is at a higher pressure than the outer tank.

Table 11.3-1 (continued)
GASEOUS WASTE DISPOSAL EQUIPMENT DESIGN DATA

Design temperature	250°F
Design Code	Specification NAS-262
Elemental iodine adsorption efficiency	
Expected	99%
For calculation of design releases	90%

a. The inner tank low pressure design is related to the outer tank pressure. If the inner tank pressure is less than the outer tank pressure, the differential pressure must be less than 18.2 psid. There is no design limitation if the inner tank is at a higher pressure than the outer tank.

Table 11.3-2
ESTIMATED GASEOUS EFFLUENTS CI/YR FOR TWO UNITS DESIGN CASE

Isotope	Waste Gas Decay Tanks	Boron Recovery and High-Level Waste Tanks	Containment Purge	Auxiliary Building Vent	Steam Generator Blowdown Tank Vents	Main Condenser Air Ejector Vents	Auxiliary Steam Drain Receiver	Turbine Bldg. Ventilation Exhaust	Gland Seal Ejector Vent	Heating System Drain Receiver Vents	Chilled Water Air Ejector Vents	Total
I-131	2.0×10^{-5}	—	4.6×10^{-2}	6.0×10^{-1}	1.3×10^{-1}	1.8×10^{-2}	4.4×10^{-1}	4.4×10^{-1}	4.8×10^{-1}	1.6×10^{-2}	3.7×10^{-3}	2.2×10^{0}
I-132	—	—	8.1×10^{-3}	2.1×10^{-1}	1.9×10^{-2}	2.7×10^{-3}	6.4×10^{-2}	6.4×10^{-2}	7.0×10^{-2}	2.4×10^{-3}	5.3×10^{-4}	4.4×10^{-1}
I-133	—	—	6.0×10^{-2}	9.7×10^{-1}	1.5×10^{-1}	2.0×10^{-2}	4.9×10^{-1}	4.9×10^{-1}	5.3×10^{-1}	1.8×10^{-2}	4.0×10^{-3}	2.7×10^{0}
I-134	—	—	1.4×10^{-3}	1.3×10^{-1}	2.3×10^{-3}	3.2×10^{-4}	7.7×10^{-3}	7.7×10^{-3}	8.4×10^{-3}	2.8×10^{-4}	6.4×10^{-5}	1.6×10^{-1}
I-135	—	—	2.3×10^{-2}	5.2×10^{-1}	4.5×10^{-2}	6.2×10^{-3}	1.5×10^{-1}	1.5×10^{-1}	1.6×10^{-1}	5.5×10^{-3}	1.2×10^{-3}	1.1×10^{0}
Kr-85m	—	—	3.0×10^{-1}	5.1×10^{1}	—	6.2×10^{2}	—	—	—	—	—	6.7×10^{2}
Kr-85	1.0×10^{4}	—	4.9×10^{2}	1.3×10^{2}	—	1.5×10^{3}	—	—	—	—	—	1.2×10^{4}
Kr-87	—	—	5.2×10^{-2}	2.9×10^{1}	—	3.5×10^{2}	—	—	—	—	—	3.8×10^{2}
Kr-88	—	—	3.4×10^{-1}	9.0×10^{1}	—	1.1×10^{3}	—	—	—	—	—	1.2×10^{3}
Xe-131m	1.5×10^{0}	5.6×10^{-1}	1.5×10^{1}	2.9×10^{-3}	—	—	—	—	—	—	—	1.7×10^{1}
Xe-133m	1.3×10^{-6}	1.8×10^{-2}	5.7×10^{0}	7.7×10^{1}	—	8.9×10^{2}	—	—	—	—	—	9.7×10^{2}
Xe-133	9.0×10^{0}	3.2×10^{-1}	1.2×10^{3}	6.9×10^{3}	—	8.0×10^{4}	—	—	—	—	—	8.8×10^{4}
Xe-135m	—	7.5×10^{0}	1.4×10^{-1}	4.2×10^{0}	—	5.4×10^{1}	—	—	—	—	—	6.6×10^{1}
Xe-135	—	5.8×10^{-1}	2.3×10^{0}	1.5×10^{2}	—	1.8×10^{3}	—	—	—	—	—	2.0×10^{3}
Xe-138	—	—	6.2×10^{-3}	1.5×10^{1}	—	1.9×10^{2}	—	—	—	—	—	2.1×10^{2}

Table 11.3-3

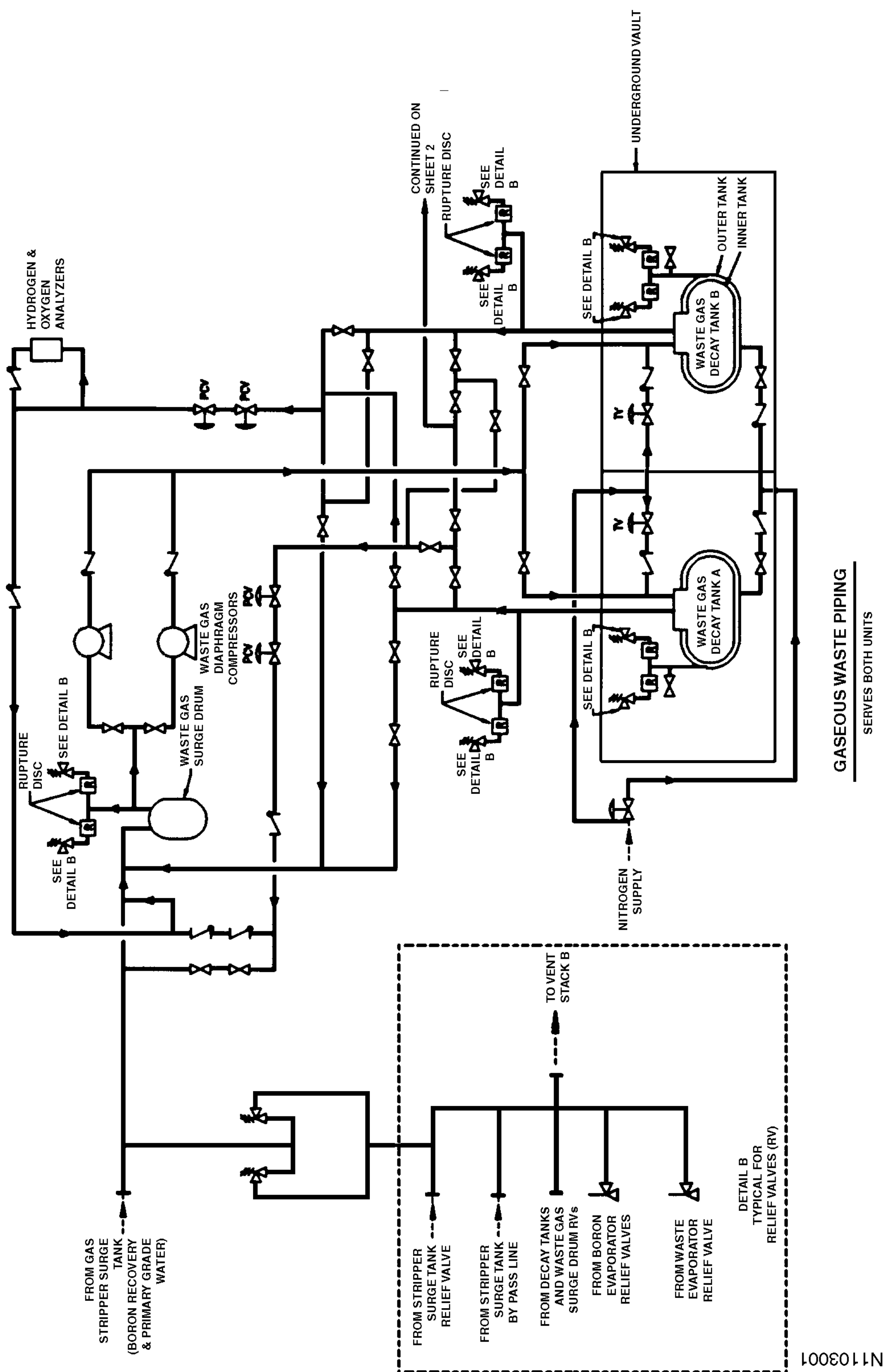
ESTIMATED GASEOUS EFFLUENTS CI/YR FOR TWO UNITS EXPECTED CASE

Isotope	Waste Gas Decay Tanks	Boron Recovery and High-Level Waste Tanks	Containment Purge	Auxiliary Building Vent	Steam Generator Blowdown Tank Vents	Main Condenser Air Ejector Vents	Auxiliary Steam Drain Receiver	Turbine Bldg. Ventilation Exhaust	Gland Seal Ejector Vent	Heating System Drain Receiver Vents	Chilled Water Air Ejector Vents	Total
I-131	4.0×10^{-7}	—	4.2×10^{-4}	4.8×10^{-3}	4.2×10^{-3}	9.9×10^{-4}	2.4×10^{-2}	2.4×10^{-2}	2.6×10^{-2}	1.1×10^{-3}	2.4×10^{-4}	8.6×10^{-2}
I-132	—	—	7.7×10^{-5}	1.7×10^{-3}	5.3×10^{-4}	1.2×10^{-4}	3.0×10^{-3}	3.0×10^{-3}	3.3×10^{-3}	1.3×10^{-4}	3.0×10^{-5}	1.2×10^{-2}
I-133	—	—	5.6×10^{-4}	7.8×10^{-3}	3.8×10^{-3}	9.1×10^{-4}	2.2×10^{-2}	2.2×10^{-2}	2.4×10^{-2}	9.8×10^{-4}	2.2×10^{-4}	8.2×10^{-2}
I-134	—	—	1.4×10^{-5}	1.0×10^{-3}	4.6×10^{-5}	1.1×10^{-5}	2.6×10^{-4}	2.6×10^{-4}	2.8×10^{-4}	1.2×10^{-5}	2.6×10^{-6}	1.9×10^{-3}
I-135	—	—	2.1×10^{-4}	4.2×10^{-3}	1.0×10^{-3}	2.4×10^{-4}	5.8×10^{-3}	5.8×10^{-3}	6.3×10^{-3}	2.6×10^{-4}	5.8×10^{-5}	2.4×10^{-2}
Kr-85m	—	—	3.0×10^{-2}	4.2×10^{0}	—	2.0×10^{1}	—	—	—	—	—	2.4×10^{1}
Kr-85	1.8×10^{3}	—	4.1×10^{1}	1.0×10^{1}	—	4.8×10^{1}	—	—	—	—	—	1.9×10^{3}
Kr-87	—	—	5.2×10^{-3}	2.4×10^{0}	—	1.1×10^{1}	—	—	—	—	—	1.3×10^{1}
Kr-88	—	—	3.4×10^{-2}	7.3×10^{0}	—	3.5×10^{1}	—	—	—	—	—	4.2×10^{1}
Xe-131m	3.0×10^{-1}	9.5×10^{-2}	1.5×10^{0}	2.3×10^{-4}	—	—	—	—	—	—	—	1.9×10^{0}
Xe-133m	2.1×10^{-7}	2.5×10^{-3}	5.7×10^{-1}	6.2×10^{0}	—	2.9×10^{1}	—	—	—	—	—	3.5×10^{1}
Xe-133	1.5×10^{0}	4.4×10^{-2}	1.2×10^{2}	5.6×10^{2}	—	2.7×10^{3}	—	—	—	—	—	3.4×10^{3}
Xe-135m	—	1.0×10^{0}	1.4×10^{-2}	3.4×10^{-1}	—	1.8×10^{0}	—	—	—	—	—	2.8×10^{0}
Xe-135	—	7.9×10^{-2}	2.3×10^{-1}	1.2×10^{1}	—	5.8×10^{1}	—	—	—	—	—	7.0×10^{1}
Xe-138	—	—	6.2×10^{-4}	1.2×10^{0}	—	6.3×10^{0}	—	—	—	—	—	7.5×10^{0}

Table 11.3-4
WASTE GAS DECAY TANK MAXIMUM RADIOACTIVE GASEOUS ACTIVITY DESIGN CASE

Isotope	Concentration ($\mu Ci/cm^3$)
Kr-85m	6.6
Kr-85	8.0×10^{2}
Kr-87	9.2×10^{-2}
Kr-88	4.7
Xe-131m	5.8
Xe-133m	4.4×10^{1}
Xe-133	4.6×10^{3}
Xe-135m	1.7×10^{-1}
Xe-135	3.5×10^{1}
Xe-138	2.4×10^{-10}
I-131	5.0×10^{-3}
I-132	1.6×10^{-4}
I-133	4.7×10^{-3}
I-134	3.5×10^{-7}
I-135	1.2×10^{-3}

Figure 11.3-1 (SHEET 1 OF 2)
GASEOUS WASTE SYSTEM



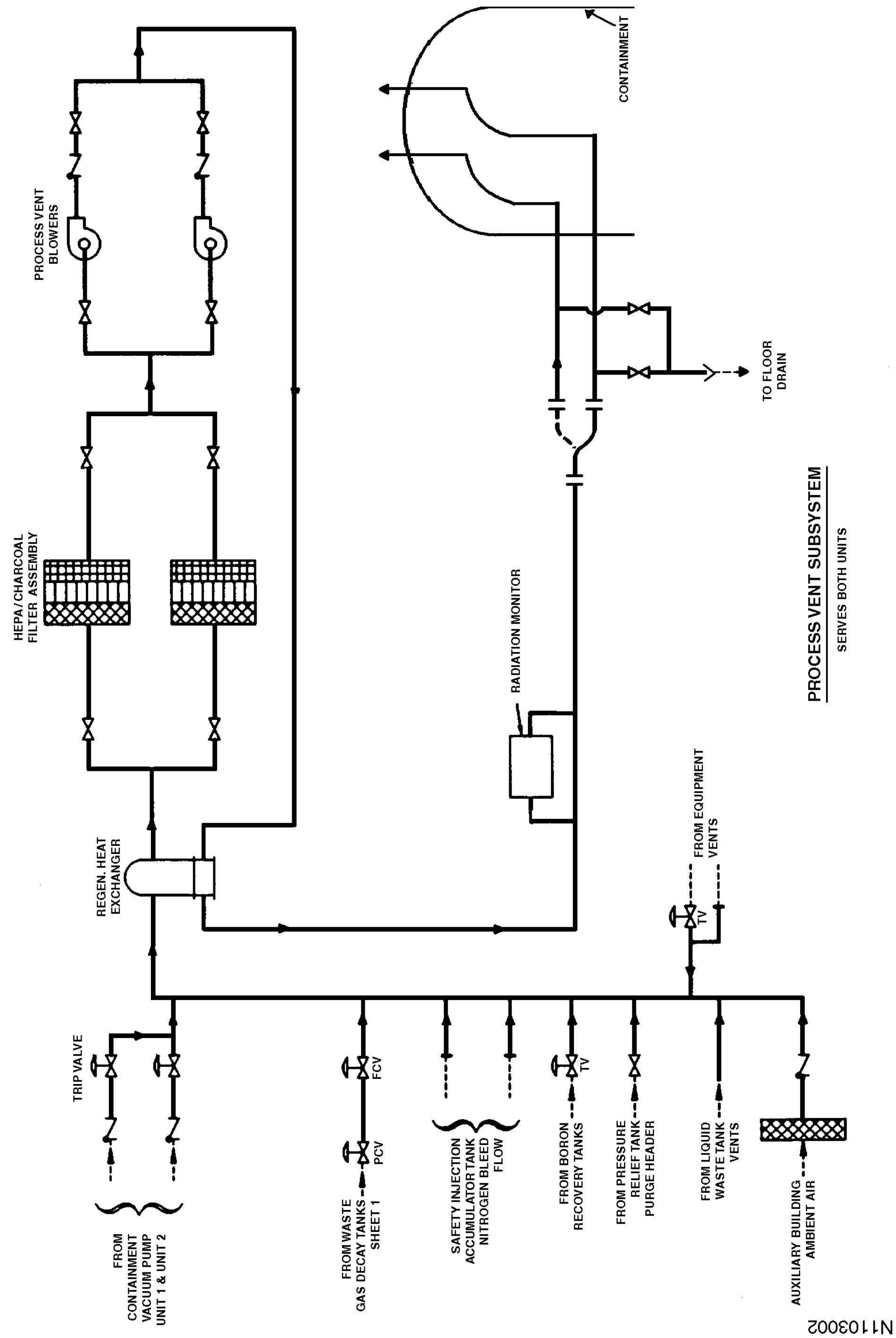


Figure 11.3-1 (SHEET 2 OF 2)
GASEOUS WASTE SYSTEM

Intentionally Blank

11.4 PROCESS AND EFFLUENT RADIATION MONITORING SYSTEM

11.4.1 Design Objectives

The process and effluent radiation monitoring system (RMS) continuously monitors selected lines containing, or possibly containing, radioactive effluent. The system's function is to warn personnel of increasing radiation levels, to give early warning of a system malfunction, and to record and control discharges of radioactive fluids and gases to the environment at permissible emission rates to meet the requirements of 10 CFR 20, 10 CFR 50, and 10 CFR 50 Appendix A General Design Criterion 64.

Design objectives are to provide early warning of system malfunctions and to initiate action to mitigate the consequences of a malfunction.

The post-accident monitoring portion of this system is designed to satisfy the requirements of NUREG-0578, *TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations* and NUREG-0737, *Clarification of TMI Action Plan Requirements*, as described in Section 11.4.3.

The recirculation spray cooler service water outlet monitors and the RMS control room cabinets are designed to Seismic Class I requirements to ensure their availability under accident conditions.

11.4.2 Continuous Monitoring

The process and effluent radiation monitoring system serving both units during normal operation consists of the channels listed in Table 11.4-1. Each channel that monitors a discharge path to the environment is located downstream from the last point of possible fluid addition to the effluent path being monitored.

Each radiation monitoring channel is designed to provide continuous information about the process or effluent stream being monitored. Continuous, as used to describe the operation of the process and effluent radiation monitoring systems, means that a monitor provides the required information at all times with the following exceptions: (1) the system is not required to be in operation because of specified plant conditions given in the Technical Requirements Manual, or (2) the system is out of service for testing or maintenance and approved alternate monitoring, sampling, or recording methods are in place.

The containment gas and particulate monitor sample point is located as close as possible to the intake of the ventilation duct to minimize losses in the duct. Samples for the component cooling-water monitor and the liquid waste evaporator monitor are located so as to obtain a representative sample of the radioactive fluids being monitored.

Each detector is located in an easily accessible area and is provided with sufficient shielding to ensure that the required sensitivity is achieved when the background radiation level is at the design maximum for the area, as shown in Table 11.4-1.

11.4.2.1 **Anticipated Concentrations, Sensitivities, and Ranges**

A channel is deemed to have the required sensitivity when the count rate indicated in the main control room with the detector exposed to the nuclide concentration in the effluent being monitored equals or exceeds twice the count rate due to area background.

Each channel listed in Table 11.4-1 monitors gross concentrations, and detector output is measured in counts per minute (cpm), except the letdown monitors, which indicate mrem/hr, the process vent monitors, the ventilation vent monitors, and the high capacity SG blowdown discharge monitors, which indicate in μCi/cc. Each channel has a minimum range of three decades, except for the recirculation spray cooler service water outlet monitors, which have a minimum range of two decades to increase sensitivity.

The expected concentrations of nuclides in the effluent streams monitored by the liquid waste monitors, the steam generator blowdown monitors, and the circulating-water discharge tunnel monitors are presented in Section 11.2.5.

The expected release rates of nuclides in the effluent streams monitored by the process vent monitors, the containment gas and particulate monitors, and the condenser air ejector monitors are presented in Section 11.3.5.

The purpose of the following monitors is to detect leaks or spills into normally nonradioactive systems or areas. The expected concentrations of nuclides in the streams they monitor is that due to normal background.

- Ventilation vent gas and particulate monitors.
- Ventilation vent sample gas and particulate monitors.
- Component cooling-water monitor.
- Component-cooling heat exchanger service-water monitor.
- Service-water discharge to canal monitor.
- Service-water discharge to Service Water Reservoir monitor.

The containment recirculation spray cooler service water outlet monitors are only used in the event of a loss-of-coolant accident (LOCA). They ensure that any leaks in the containment recirculation coolers leading to contamination of the service water are detected at levels well below those representing a hazard to the public.

The reactor coolant letdown activity may range from negligible when the unit is at the beginning of the fuel cycle to about 215 μCi/cc if there is 1% failed fuel. The reactor coolant letdown monitor has a minimum sensitivity capable of detecting 0.1% fuel failures.

Each channel, except the high capacity SG blowdown discharge monitors, has a readout at the main control room and selected ones, as indicated in Table 11.4-1, have a readout at the detector location. Each channel has two visual alarms for radiation levels in excess of preset values. Each channel provides a signal to the main control room causing an audible alarm to sound if either of the two preset radiation levels are reached. The output from all channels is documented on recorders that produce a continuous record of radiation levels and radioactive discharges from the station except the high capacity SG blowdown discharge monitors which utilize computer data storage. Each channel has its own power supply and check source (except the letdown monitors, the high capacity SG blowdown discharge monitors, the normal/high range process vent and vent-vent (MGPI) effluent monitors, which do not have a check source), remotely operated from the main control room, thus making it completely independent of any other channel. The MGPI equipment is continually self-checking in that, should the detector output signal drop below some prescribed value, effectively indicating that there is no background signal, the detector will be considered faulty. This monitoring, in conjunction with the continual testing of the electronic signal processing circuits by generation and confirmed receipt of test signals, provides assurance that the circuits remain in good health.

Adjustment of alarm setpoints, voltage, power, and other variables is made from the main control room, except for the following: (1) the high capacity SG blowdown discharge monitors are adjusted at their local controller workstation, (2) the service water discharge to the reservoir monitor is adjusted at the local instrument chassis, (3) the normal/high range process vent (MGPI) and vent-vent (MGPI) effluent monitors which can be adjusted either at the local display unit (LDU) or remote display unit (RDU) and (4) the reactor coolant letdown gross activity monitors which can be adjusted either at their LDU or RDU. The entire system is designed with emphasis on system reliability and availability. Certain channels, as indicated in the following text, actuate control valves on an alarm signal.

Channels monitoring Unit 1 are powered from the 480V emergency bus 1H; channels monitoring Unit 2 are powered from the 480V emergency bus 2H; channels monitoring systems or areas common to both units are powered from the emergency bus for either Unit 1 or Unit 2. (Letdown monitors are not powered from emergency buses.)

To ensure the availability of at least two of the recirculation spray cooler service water outlet monitors per unit under accident conditions, one pair of the recirculation spray cooler service-water outlet monitors for Unit 1 is powered from the vital bus panel 1, channel I, and the second pair is supplied from the vital bus panel 1, channel III; one pair for Unit 2 is supplied from the vital bus panel 2, channel I, and the second pair for Unit 2 is supplied from the vital bus panel 2, channel III.

The types of detectors, sensitivity, range, background radiation, and other information for each channel are listed in Table 11.4-1. The counting rates of limiting isotopes for each channel, except the letdown monitors, are shown in Table 11.4-2. A description of each channel is included in the following text.

11.4.2.2 **Process Vent Particulate Monitor**

This channel continuously withdraws a sample from the process vent and passes the sample through a moving filter paper having a collection efficiency of 99% for particle sizes greater than 0.3 μm. The amount of deposited activity is continuously scanned by a silicon diode type detector. A high-activity alarm automatically stops the discharge of gases from the gaseous waste disposal systems. The sample pumping system, which serves both the particulate and gaseous process vent monitors, includes a pump, a mass flowmeter, and isolation valves.

11.4.2.3 **Process Vent Gas Monitor**

This channel takes the continuous process vent sample, after it has passed through the particulate filter paper, and draws them through a sealed system to the process vent gas monitor assembly. This assembly is a fixed, lead-shielded sampler containing a silicon diode type detector. The sample activity is measured, and then the sample is returned to the process vent. A high-activity alarm automatically stops the discharge of gases from the gaseous waste disposal systems. A purge system is integral with the gas-monitoring system for flushing the sampler with clean air for purposes of calibration.

11.4.2.4 **Ventilation Vent A Particulate Monitor and Ventilation Vent A Gas Monitor**

These two channels in ventilation vent A continuously sample for particulates and gas in the same way that the two channels monitor the process vent sample. All equipment is similar to that of the two process vent channels, except that multiprobe samplers are provided to obtain a representative sample in the 90-inch-diameter ventilation vent A ducts.

11.4.2.5 **Ventilation Vent B Particulate Monitor and Ventilation Vent B Gas Monitor**

These two channels in ventilation vent B continuously sample for particulates and gas in the same way that the two process vent channels monitor the process vent sample, except that multiprobe samplers are provided to obtain a representative sample in the 90-inch-diameter ventilation vent B duct, and that both channels are equipped with silicon diode type detectors. An advantage that the gas detector has is a sensitivity to Kr-85, the radiologically dominant nuclide for the ventilation vent B effluent pathway, which includes exhaust air from the Spent Fuel Pool area.

11.4.2.6 **Ventilation Vent Multiport Sampler Particulate and Ventilation Vent Multiport Sampler Gas Monitor**

These two channels take a sample from any one of seven ducts and monitor particulates and gases in the same way as the two channels monitoring the process vent. All equipment is identical to that of the process vent's two channels except that:

1. This system includes seven isokinetic nozzles, a manifold, and a control valve system. A control panel automatically switches the valves on a periodic basis to permit sampling from the seven different areas. A manual positioner is provided to permit locking in on any chosen area.
2. The equipment has the capability to program the filter to remain in a fixed position for a specified length of time. The filter remains in a stationary position for a programmed length of time before advancing.
3. The sequencing of the valves is synchronized to the step advance programmer and the operator is able to select a sampling time at each of the seven areas between 30 minutes and 24 hours.

11.4.2.7 **Component Cooling-Water Monitor**

This channel continuously monitors the component cooling-water system. Samples from each component cooling-water heat exchanger vent are continuously monitored by a common detector mounted in an in-line liquid sampler. Activity is indicative of a leak into the component cooling-water system from the reactor coolant system or one of the other radioactive systems that is served by the component cooling-water system. A valving arrangement allows the heat exchangers to be individually sampled to identify the source of activity.

11.4.2.8 **Component Cooling Heat Exchanger Service-Water Monitor**

This channel continuously monitors the service-water effluent from the four component cooling-water heat exchangers. Samples from each main discharge are individually pumped to and continuously monitored by a detector mounted in an off-line liquid sampler. A valving arrangement allows the heat exchangers to be individually sampled to determine the source of any high activity.

11.4.2.9 **Service-Water Discharge to Canal Monitor**

This channel continuously monitors the service-water discharge to the discharge canal. Samples from the two 24-inch discharge lines are mixed in a common header and the common sample is continuously monitored by a detector mounted in an off-line liquid sampler. A valving arrangement allows the two discharge lines to be individually sampled to determine the source of any high activity.

11.4.2.10 Service Water Discharge to Service Water Reservoir Monitor

This channel continuously monitors the service-water discharge to the Service Water Reservoir. Samples from the two 36-inch discharge lines are mixed in a common header and the common sample continuously monitored by a detector mounted in an off-line liquid sampler. A valving arrangement allows the two discharge lines to be individually sampled to determine the source of any high activity.

11.4.2.11 Recirculation Spray Cooler—Service Water Outlet Monitors

The recirculation spray coolers, as part of the recirculation spray subsystem, operate only after the occurrence of a LOCA.

There are four recirculation spray coolers per unit, and each service-water outlet line is monitored, thus giving a total of eight channels. All of these channels are identical. In the event that the containment spray system is placed in service, a continuous sample is drawn out of the service-water outlet line and passed through an off-line liquid sampler, where it is monitored for activity indicative of a leak in the respective recirculation spray cooler. After passing through the liquid sampler, located outside the containment in an enclosed, heavily lead-shielded structure, the sample is returned to the service-water line.

11.4.2.12 Liquid Waste Disposal System Monitors

The liquid waste disposal system is monitored by two detectors, each of which is located in an in-line liquid sampler. One detector is located downstream from the clarifier unit, which is the last possible point where radioactive materials can be added. It monitors the liquid being discharged from this system to the circulating water system and then to the environment. A high-activity alarm automatically stops the discharge of liquid waste effluent. The other detector, which is located between the waste disposal evaporator and the clarifier unit, is used for process evaluation.

11.4.2.13 Condenser Air Ejector Monitors

Each of these identical channels (one channel per unit) continuously monitors the gaseous effluent from the condenser air ejectors by means of a G-M tube detector mounted in an in-line sampler. Activity is indicative of a primary to secondary system leak. On a high-activity alarm, the flow is automatically diverted to the containment unless the containment has been isolated by a Phase A containment isolation signal.

These monitors, or the steam generator blowdown monitors described below, will detect radioactive contamination in the steam supply used for building heating. These monitors will warn personnel of increasing radioactivity levels and therefore provide early indication of system malfunctions.

11.4.2.14 **Steam Generator Blowdown Monitors**

11.4.2.14.1 Steam Generator Blowdown Sample Monitors

Each of these channels (three per unit) monitors the liquid phase of the steam generators for radioactivity indicative of a primary to secondary system leak. The use of three channels per unit will allow continuous monitoring of the blowdown from each of the three generators. Valving exists to allow combinations of generator blowdown flow to be used to compensate for maintenance of channels, or should special situations exist.

After being monitored, samples pass into the steam generator blowdown tank.

11.4.2.14.2 High-Capacity Steam Generator Blowdown Discharge Monitors

The high-capacity steam generator blowdown system flash tank drains are continuously monitored by a radiation monitor in the effluent line. This monitor does not perform a safety function, but is included as added protection against radiation release to the environment. The high-capacity system will be isolated automatically if the effluent radiation monitor setpoint is exceeded.

The proportional sampling system provides the required cooled blowdown effluent monitoring capability to allow the high-capacity blowdown system to be operated when low levels of primary to secondary leakage is within Technical Specification limits. The required minimum sample flow rate for the proportional sample is 0.5 ml/gal of effluent. When the sample from the tank shows no radioactivity, drains from the sample collection tank are batch discharged to the turbine building floor drains.

11.4.2.15 **Reactor Coolant Letdown Gross Activity Monitors**

Each unit has its reactor coolant continuously monitored by means of a detector mounted adjacent to the letdown line in the Chemical and Volume Control System. In this system, large variations in activity level are possible in the event of fuel element failure. There is one such system for each unit. In the event of a fuel element failure, the activity released will be sufficient to raise the coolant activity level above 1.0 µCi/cc of gross fission products. This will cause the letdown monitor to begin to indicate activity data corresponding to the presence of fuel failures.

11.4.2.16 **Circulating-Water Discharge Tunnel Monitors**

Each of these identical channels (one per unit) monitors the effluent (service water, condenser circulating water, and liquid waste) in the circulating-water discharge tunnel beyond the last point of possible radioactive material addition. A gamma scintillation detector slides into a pipe that is inserted directly into the discharge tunnel. At the top of the pipe is a waterproof support assembly that encloses a check source. The entire device is waterproof.

11.4.2.17 **Containment Particulate Monitors**

Each channel, one per containment, continuously withdraws a sample from the containment atmosphere into a closed, shielded system exterior to the containment. The sample is passed through a moving filter paper with a collection efficiency of 99% of particles greater than 0.3 μm. The amount of deposited activity is continuously scanned by a lead shielded gamma scintillation detector with a sensitivity as shown in Table 11.4-1. This sample system, which is common to both the particulate and gas monitors, includes a pump, a flowmeter, a flow-regulating valve, and isolation valves. A sample point is available for taking a sample of the containment atmosphere after an accident for spectrum analysis in the laboratory. During refueling, if the particulate nuclide concentration exceeds a predetermined setpoint, a high-activity alarm automatically trips the containment purge air supply and exhaust fans and closes the purge system butterfly valves, thus isolating the purge system.

11.4.2.18 **Containment Gas Monitors**

Each channel, one per containment, takes the continuous containment atmosphere sample, after it has passed through the particulate filter paper, and draws it through an in-line, easily removable, charcoal cartridge arrangement to the containment gas monitor assembly, which is a fixed-volume, lead- shielded sample chamber enclosing a G-M tube detector. The sensitivity of this detector is 5×10^{-6} μCi/cc for Kr-85 in a background of 0.75 mrem/hr. The sample activity is measured, and then the sample is returned to the containment.

During refueling, if the airborne gaseous activity concentration exceeds a predetermined setpoint, a high-activity alarm automatically trips the containment purge air supply and exhaust fans and closes the purge system butterfly valves, thus isolating the purge system.

A purge valve arrangement blocks the normal sample flow to permit purging the detector with a “clean” sample for calibration. Purged gases are discharged to the ventilation vent.

11.4.2.19 **Spare Channels**

Two spare channels consist of a complete instrument chassis, one identical to that of the process vent particulate monitor and one identical to the process vent gas monitor.

11.4.3 Post-Accident Monitoring

The purpose of the following radiation monitors is to provide additional instrumentation which during normal operations supplements the process and effluent radiation monitoring equipment discussed in Section 11.4.2, and provide accurate indication of plant releases of noble gases and particulates during and following an accident according to the requirements of NUREG-0578 (Section 2.1.8.b) as clarified by NUREG-0737 (Section II.F.1).

Following the accident at TMI-2 and in response to NUREG-0578, high range effluent monitors were installed in potential post-accident release pathways. These include the main steam lines and the auxiliary feedwater turbine-driven pump exhaust lines. These monitors are discussed in Section 11.4.3.2.

NUREG-0737 clarified the post-accident radiation monitoring requirements of NUREG-0578. In response to NUREG-0737, a dual range (normal and high range) effluent gas monitor system manufactured by MGP Instruments has been installed. The MGP Instruments monitoring systems are installed in the process vent and in ventilation vents A & B. These monitors are discussed in Section 11.4.3.1.

11.4.3.1 **Normal and High-Range Effluent Gas Monitors**

11.4.3.1.1 Design Basis

The post-accident normal and high-range noble gas effluent monitors located at the process vent and ventilation vents are manufactured by MGP Instruments. They are designed to meet the requirements of NUREG-0737, Section II.F.1, Attachments 1, *Noble Gas Effluent Monitor.* Also, NUREG-0737, Section II.F.1, Attachment 2, *Sampling and Analysis of Plant Effluents,* requires the capability to collect and analyze or measure representative samples of radioactive iodines and particulates in plant gaseous effluents during and following an accident. This capability is integrated into the MGP Instruments monitoring system. The MGP Instruments post-accident monitors are listed in Table 11.4-3.

The monitors have a total range extending from normal condition concentrations to a maximum of 1.0×10^5 μCi/cc (Xe-133). This exceeds the design basis maximum range of 1.0×10^3 μCi/cc specified in NUREG-0737, Table II.F.1-1.

The process vent and ventilation vent effluents are monitored by the MGP Instruments systems downstream of all input streams. Redundancy is not required.

The MGP Instruments process and ventilation vent equipment and monitors are powered from emergency (diesel-backed) buses. The 480V ac power is supplied by either MCC-1H1-4 (normal) or MCC-1J1-1 (alternate) via a manual transfer switch. The 120V ac power is supplied by 1-EP-CB-16C (semi-vital bus) and 1-EP-CB-16D distribution panels.

Procedures are in place to routinely calibrate the detectors by using an acceptable source.

Continuous display of equivalent Xe-133 concentrations (μCi/cc) is provided in the control room. Radiation concentrations and release rates will be recorded by recorders.

The MGP Instruments monitors and instruments are designed for the accident environment.

Seismic qualification of the system is not required. However, sampling nozzles installed in seismic pipe are seismically qualified and supported.

Particulate and iodine collectors are mounted in 6-inch 4π lead shields. A similar portable shielded transfer housing is provided to protect personnel during transfer. The dose rate 1 foot from the filter assembly will be 0.1 mrem/hr assuming the design-basis sample (100 μCi/cc

[0.5 Mev gamma] 30-minute sampling time) and flow rate of 1000 cc/min. This meets the shielding design basis specified in NUREG-0737, Table II.F.1-2.

The iodine collector has a cartridge with an effective adsorption of not less than 95%. The particulate collector is a paper filter disk with a collection efficiency of 99% for 0.3 micron particles.

The post-accident monitor sampling systems are designed to ensure representative sampling. Sampling nozzles are installed in the effluent streams. The MGP Instruments monitors, with the exception of the process vent monitor, which has fixed sample flow, will adjust sample flow automatically in proportion with the effluent stream. Flow signals from the ventilation vent A & B stack flow transmitters will be input to the flow controllers for this function.

Heat tracing is required on the post-accident ventilation vent and process vent sample piping to prevent condensation.

The post-accident monitors must operate continuously in accordance with the Technical Requirements Manual when the ventilation stacks or the process vent system is discharging.

The post-accident particulate and iodine collectors are sufficiently shielded to minimize personnel exposure during retrieval and transport.

Three-foot tongs will be used to transfer the unshielded filter to the movable shielded cart.

Control room instrumentation to meet the requirements of NUREG-0737 Section II.F.1 is installed in a common high-range effluent radiation monitoring panel. This includes displays for the process vent, ventilation vent, and steam release monitors. Common annunciators (main steam Unit 1, main steam Unit 2, process vent, ventilation vents) are used to reduce the number of additions to the main control panel. These annunciators direct the operator to the high-range effluent radiation monitoring panel. Minimizing the number of annunciators, and grouping of related displays into a common panel is consistent with current human factors analysis standards and will serve to reduce the amount of confusion to the operator.

11.4.3.1.2 Description

Each MGP Instruments post-accident monitoring system is mounted on a skid and consists of a noble gas monitor, particulate and iodine collectors, sample extractor, control room displays, local displays, electronics, piping, valves, pumps, and a microcomputer controller. Flow elements and transmitters for ventilation stacks A and B, and the process vent flow transmitter supply linear signals to the normal- and high-range microcomputer controller. The process vent normal-range monitor serves a control function when alarm setpoints are reached. A high activity alarm on the particulate or normal range gaseous channel automatically stops the discharge of gases from the gaseous waste disposal systems. The MGP Instruments process vent monitors are located in the normal switchgear room of the service building to minimize post-accident background radiation and allow for personnel access to retrieve iodine and particulate filters for laboratory analysis.

The process vent system is part of the gaseous waste disposal system as shown in Reference Drawing 1. The MGP Instruments monitor sampling lines run from a sample nozzle installed in the discharge line of the process vent system (6-inch-GW-18-154) on the 291-ft. 10-in. elevation of the auxiliary building, through the auxiliary building to the normal switchgear room of the service building. An effluent sample return line runs a similar path back to the process vent discharge pipe.

The MGP Instruments ventilation vent monitors are mounted on the operating floor of the turbine building near the condensate polishing system control panel. The effluent sample lines run from a sample nozzle installed in the vertical section of vent stack A and B in the turbine building and the respective monitors.

The normal operation process vent and ventilation vent effluent radiation monitoring systems described in Section 11.4.2 are installed and operational to satisfy the Technical Specification requirement for continuous monitoring and recording of gaseous and particulate releases. The particulate monitors contain a moving filter paper with monitor to provide “real time” indication of particulate releases during normal operation. The post-accident high-range MGP Instruments monitors contain shielded particulate filters designed to minimize personnel exposure during retrieval and laboratory analysis. This meets the requirements of NUREG-0737 Section II.F.1 since continuous monitoring of accident level particulate releases is not considered practical at this time.

The MGP Instruments post-accident process vent and ventilation vent monitors are common to Units 1 and 2. The monitors are supplied with 480V ac power from the 1H1-4 or 1J1-1, emergency, motor control center via a transfer switch.

Local and remote display units are supplied with 120V ac power from 1-EP-CB-16C, semi-vital bus distribution panel.

Instrument cables are routed from each monitor skid to its corresponding local display unit and to a corresponding remote display unit located in the control room.

Instrument cables are routed from the existing process vent flow transmitter and the flow transmitters are mounted in ventilation vent stacks A and B, near the sample nozzles to the respective remote display unit for computing effluent release concentrations μCi/cc (Xe-133) and release rates Ci/sec (Xe-133).

Ambient air is supplied to the monitors for purging the monitors and sample piping.

Sample piping is 1-inch Class ICN8, welded stainless steel. Connections to the MGP Instruments monitor skids are compression fittings. Sample tubing for the ventilation vent monitors that runs outside of the turbine building is heat traced to prevent condensation.

Each microcomputer provides for complete control of the associated monitor. It can be controlled locally or remotely through the remote display unit in the control room. Alarms are provided at the microcomputer and remote display unit. In addition, a common annunciator and alarm is provided on the control board for the MGP Instruments process vent and ventilation vent high-range monitors. Continuous display of radiation readings and recording of concentrations (μCi/cc) and release rates (Ci/sec) by recorders is provided.

11.4.3.1.3 Operation

The normal operation process vent and ventilation vent systems must be operational during any mode (modes 1 through 6) of station operation. Gaseous and particulate monitoring and recording is required by Technical Specification whenever an effluent release occurs.

The MGP Instruments post-accident high-range noble gas effluent monitors will operate to provide continuous monitoring and recording of noble gas and particulate releases. The MGP Instruments monitors are also used during normal operation to monitor effluent releases.

The MGP Instruments post-accident high-range monitors are required to operate during and after an accident to provide continuous monitoring of high-level releases of noble gases, and continuous sampling of iodine and particulate releases.

The MGP Instruments post-accident and normal operation process vent and ventilation stack A and B monitoring systems may be operated independently of each other.

11.4.3.2 **High-Range Effluent Monitors**

Prior to the addition of the MGP Instruments system described above, several post-accident high-range effluent radiation monitors were installed in response to NUREG-0578. These monitors are listed in Table 11.4-4.

The high-range effluent monitors consist of the detector and the control unit. The detector has a 9-decade range of 10^{-2} to 10^{7} mR/hr and is comprised of an ion chamber and a built-in radioactive source that provides a reference signal for testing purposes. The components are enclosed in a box that protects them from expected operating environments. The detector is enclosed in a lead shield to reduce background radiation, except in the main steam valve house detectors where the shield is used to reduce background radiation and permit collimation of the release path radiation field. The detectors are intended to monitor release paths. Eight paths of two types are monitored. The detectors are located at the following effluent points.

Main Steam Lines.

These detectors are intended to measure activity that might be released via main steam safety valves or atmospheric dump and decay heat release valves. The detectors and their associated shields are mounted on the Unit 1 and 2 main steam valve house south interior walls facing the 32-inch safety valve riser, SHP-22, 23, or 24 for Unit 1 and SHP-422, 423, or 424 for Unit 2. These shields collimate the radiation field from the centerline of the pipe. As each main steam header is a possible independent release path, each safety valve riser is monitored.

Turbine-Driven Auxiliary Feedwater Pump Exhaust Lines.

These detectors are intended to monitor the steam exhaust from the turbine-driven auxiliary feedwater pump. The detector for Unit 1 is located in the auxiliary feedwater pumphouse on a platform which permits access to the detectors for maintenance. The Unit 2 detectors are located on the auxiliary feedwater pumphouse roof facing one of the two discharge lines. The discharge lines were rerouted to allow for adequate shielding of the detector from background radiation.

The control unit for each detector contains the electronics necessary to interpret and display detector readings. These units are housed in boxes and have connections for the detector, remote readout, and power. Visual alarms for failure alert, and high radiation are included. One control unit is required for each detector. Three of the four control units are located in the Quench Spray Pump House of each respective Unit and one control unit is located in the Auxiliary Feedwater Pump House of its respective Unit.

The monitors are powered from a reliable, diesel backed source (Semi-Vital bus of the respective Unit).

Although not required to function after a seismic event, each detector and its associated shield is seismically constrained.

11.4.4 Sampling

11.4.4.1 **Liquid Systems**

Liquid samples for determination of levels of radioactivity are periodically taken.

Normally, high-level waste drain tanks are processed via the IEFS system. The influents and effluents of these filters and demineralizers are sampled periodically, generally daily. The low-level waste drain tanks are normally sampled weekly. If high concentration liquids are being processed, or are anticipated, the sampling frequency of the low-level waste drain tanks is evaluated and adjusted accordingly.

Concentrations may approach 0.15 μCi/ml of mixed fission and activation products in the high-level waste drain tanks. Low-level waste drain tank samples determine if the tank contents may be discharged or require further treatment. Concentrations generally will be between 10^{-4} and 10^{-8} μCi/ml.

Contaminated waste drain tanks are normally sampled weekly. The boron recovery test tanks and the boron recovery tanks are normally sampled prior to release. If the clarifier demin is bypassed, the boron recovery test tank and the boron recovery tank will be sampled prior to release. The contents of the tank are discharged to the environment through the clarifier package. Concentrations of mixed fission and activation products (excluding Noble Gases) in these tanks will generally be between 10^{-3} μCi/ml and 10-6 μCi/ml. Sampling determines if the tanks may be discharged or require further processing.

Treated effluent is monitored by a radiation monitor before its release to the discharge canal. In addition, treated clarifier effluent is continuously sampled in proportion to the rate of flow of the effluent stream.

The clarifier effluent line contains a manual regulating valve which continuously samples effluent discharge that is collected in the clarifier effluent proportional tank, thus fulfilling the sampling requirements of NRC Regulatory Guide 1.21. A sample is drawn from the clarifier effluent proportional tank for analysis as required. A commercially available, motor-driven mixer is installed in the tank, and before samples are taken, the contents will be mixed for at least 10 minutes. The minimum ratio of the sample rate to the effluent rate for the 125 gpm to 300 gpm range is 1:7826. The minimum and maximum flow limitations established is between 125 gpm and 300 gpm respectively.

The control system for the clarifier effluent line sampling system is as follows:

1. 1-LW-SOV-121 is controlled from a locally mounted control switch. In the “Auto” mode the SOV is open whenever 1-LW-PCV-115 is not fully closed thus allowing discharge effluent to the manual regulating valve 1-LW-1130.
2. The control system is fed from the process control cabinet, which is fed from the nonvital bus. The SOV is fed from 120V ac Waste Disposal Building distribution panel, which in turn is fed from Motor Control Center (MCC) 1B1-1A.

Operating Procedures require system flow to be maintained between the specified range, so that a proportional sample is provided. If reduced flow is required, hold-up capacity is provided, such that sufficient volume to provide the required flow, can be obtained by stopping flow for a period of time.

The instrumentation of the continuous sampling system is calibrated and checked every 18 months. Periodic clarifier samples that are taken act as a check on this monitor and are also used to determine demineralization requirements. Radioactive concentrations in the clarifier samples normally will be lower than 10^{-6} μCi/ml.

The sampling program is based on gamma counting, using a multi-channel spectral analyzer.

A sample is taken from the tank to be potentially discharged. The tank is recirculated before sampling to ensure a representative sample. Part of the sample is then analyzed. If measured activity permits, the tank is then discharged, and an amount of the sample proportional to the volume discharged is transferred to a weekly and/or monthly composite for future isotopic analyses for effluent release reporting.

If a multi-channel spectral analyzer is not available, a gross gamma counter can be used to assess the beta-gamma activity of the waste stream being discharged. The gross gamma counter is periodically calibrated. The minimum sensitivity of the gamma counter is approximately

10^{-6} μCi/ml. Isotopic analysis employs a high-resolution gamma spectrometer, supplemented with radiochemical separation and analysis if required. Analytical sensitivities are approximately 50 pCi per nuclide per sample. Gross beta-gamma counting of waste samples typically has a sensitivity of approximately 10 pCi per sample.

Calculated levels of activity in the liquid waste disposal system, assuming the conditions presented in Section 11.1, are presented in Section 11.2.5. Surveillance requirements for the liquid waste sampling and monitoring system are contained in the Offsite Dose Calculation Manual (ODCM).

11.4.4.2 **Gaseous Systems**

Waste gas decay tanks and the containments are sampled before discharge or purging, and an isotopic analysis is made using a high-resolution gamma detector such as germanium. All significant peaks are identified and quantified. A tritium determination is made for all containment purges and waste gas decay tank releases.

Sampling of the containment atmosphere for purging data is performed inside the containment vessel using particulate and charcoal filters with known flow rates. Tritium vapors are collected and analyzed using liquid scintillation. Known volumes of gases are collected in thin-walled containers and gamma-counted directly.

Local sample points are available on waste gas decay tanks, which allows the passing of known volumes through filters for laboratory analysis. Gas samples are collected in small sampling vessels so that appropriate volumes can be tested for the noble gases.

Ventilation exhausts are monitored by gas and particulate monitors as described in Sections 11.4.2, and 11.4.3. In addition, area monitors are used, as described in Section 12.1.4, to monitor radiation levels in selected portions of the station. In addition, health physics personnel routinely take air samples in ventilated areas of the station where airborne activity could exist and be discharged to the environment through the ventilation systems. Isotopic analyses of these air samples are performed.

Measured concentrations of gaseous activity, especially in the reactor containments and waste gas decay tanks, are expected to fluctuate over a wide range.

Maximum expected levels of airborne activity in the station are presented in Section 12.2.3; the original estimates of the maximum expected levels of radioactivity in the waste gas decay tanks are presented in Section 11.3.5. Should measured values of airborne activity show an unexpected increase to or above levels that could potentially cause a violation of the Offsite Dose Calculation Manual (ODCM) limits, measures will be taken, as required, to identify the cause of the increase and to reduce the amount of radioactivity released. Should airborne activity exceed limiting values in areas of the station not being ventilated, radiation control procedures will be implemented as required by the ODCM.

Surveillance requirements for gaseous waste sampling and monitoring are contained in the ODCM.

11.4.5 Calibration and Maintenance

Channel checks, channel operational tests, and channel calibrations are specified in the ODCM.

The channel check uses an installed check source that can be remotely positioned from the control room. For the MGP Instruments monitors on the effluent gas channels, their local processing units (LPUs) perform various self-checks automatically. Their electrical self-check introduces a known and fixed level of pulses into the electronics excluding the detector and verifies that the response is correct or a fault is generated. Additionally, the electronics continuously monitor the detector for a minimum count rate otherwise a fault alarm is generated. The channel operational test is used to verify the functionality of alarms and, when applicable, the functionality of automatic functions. The channel calibration uses a test source to observe the response of the detector and related components.

11.4 REFERENCE DRAWINGS

The list of Station Drawings below is provided for information only. The referenced drawings are not part of the UFSAR. This is not intended to be a complete listing of all Station Drawings referenced from this section of the UFSAR. The contents of Station Drawings are controlled by station procedure.

	Drawing Number	Description
1.	11715-FM-097B	Flow/Valve Operating Numbers Diagram: Gaseous Waste Disposal System, Unit 1

Table 11.4-1
PROCESS AND EFFLUENT RADIATION MONITORING
SYSTEM[a] NORMAL OPERATION

Monitor	No.	Type of Detector	Medium	Relevant Isotopes	Sensitivity (μCi/cc)	Minimum Range (decades)	Maximum Area Background (mrem/hr)
Process vent particulate (1-GW-RM-178-1)	1	Silicon diode	Gas, air	I-131	5×10^{-10} (I-131)	3	0.75
Process vent gas (1-GW-RM-178-1)	1	Silicon diode	Gas, air	Xe-133, Kr-85	5×10^{-5} (Kr-85)	4	0.75
Ventilation vent A particulate (1-VG-RM-179-1)	1	Silicon diode	Air	I-131	5×10^{-10} (I-131)	3	0.75
Ventilation vent A gas (1-VG-RM-179-1)	1	Silicon diode	Air	Xe-133, Kr-85	5×10^{-6} (Kr-85)	3	0.75
Ventilation vent B particulate (1-VG-RM-180-1)	1	Silicon diode	Air	Co-60, Cs-137	5×10^{-10} (I-131)	3	0.75
Ventilation vent B gas (1-VG-RM-180-1)	1	Silicon diode	Air	Xe-133, Kr-85	5×10^{-6} (Kr-85)	3	0.75
Ventilation vent multiport sampler particulate (1-VG-RM-105)	1	Gamma scintillator	Air	I-131	5×10^{-10} (I-131)	3	0.75
Ventilation vent multiport sampler gas (1-VG-RM-106)	1	Geiger-Mueller	Air	Xe-133, Kr-85	5×10^{-6} (Kr-85)	3	0.75
Containment particulate [b] (1/2-RM-RMS-159/259)	2	Gamma scintillator	Air	I-131	5×10^{-10} (I-131)	3	0.75

a. This table contains information based on the requirements for the various specifications for the listed monitors. The actual monitors meet or exceed these requirements.
b. Also have local readout and alarm.

Table 11.4-1 (continued)
PROCESS AND EFFLUENT RADIATION MONITORING SYSTEM[a] NORMAL OPERATION

Monitor	No.	Type of Detector	Medium	Relevant Isotopes	Sensitivity (μCi/cc)	Minimum Range (decades)	Maximum Area Background (mrem/hr)
Containment gas[b] (1/2-RM-RMS-160/260)	2	Geiger-Mueller tube	Air	Xe-133, Kr-85	5×10^{-6} (Kr-85)	3	0.75
Component cooling water (1-CC-RM-120)	1	Gamma scintillator	Water	Co-60, Cs-137	1×10^{-5} (Cs-137)	3	0.75
Component cooling heat exchanger service water (1-SW-RM-107)	1	Gamma scintillator	Water	Co-60, Cs-137	1×10^{-5} (Cs-137)	3	0.75
Service-water discharge to tunnel (1-SW-RM-108)	1	Gamma scintillator	Water	Co-60, Cs-137	1×10^{-5} (Cs-137)	3	0.75
Service-water discharge to Service-Water Reservoir[b] (1-SW-RM-109)	1	Gamma scintillator	Water	Co-60, Cs-137, I-131	1×10^{-6} (Cs-137)	5	100.0
Recirculating spray cooler service water (1/2-SW-RM-124/224, 125/225, 126/226, 127/227)	8	Gamma scintillator	Water	Co-60, Cs-137	3×10^{-4} (Cs-137)	2	5.0
Liquid waste disposal[b] (1-LW-RM-110,111)	2	Gamma scintillator	Water	Co-60, Cs-137, I-131	1×10^{-6} (Cs-137)	4	0.75
Condenser air ejector (1/2-SV-RM-121/221)	2	Geiger-Mueller tube	Vapor	Xe-133, Kr-85	3×10^{-3} (Kr-85)	3	0.75

a. This table contains information based on the requirements for the various specifications for the listed monitors. The actual monitors meet or exceed these requirements.
b. Also have local readout and alarm.

Table 11.4-1 (continued)
PROCESS AND EFFLUENT RADIATION MONITORING SYSTEM[a] NORMAL OPERATION

Monitor	No.	Type of Detector	Medium	Relevant Isotopes	Sensitivity (µCi/cc)	Minimum Range (decades)	Maximum Area Background (mrem/hr)
Steam generator blowdown[b] (1/2-SS-RM-122/222, 123/223, 124/224)	6	Gamma scintillator	Water	Co-60, Cs-137	4×10^{-6} (Cs-137)	3	0.75
Reactor coolant letdown[b] (1/2-CH-RM-128/228)	2	Geiger-Mueller tube	Water	mixed fission products	2×10^{1}	4	200
Circulating-water discharge tunnel (1/2-SW-RM-130/230)	2	Gamma scintillator	Water	Co-60, Cs-137	2×10^{-7} (Cs-137)	3	0.05
High capacity SG blowdown discharge monitor (1/2-SS-RM-125/225)	2	Gamma scintillator	Water	Co-60, Cs-137	1×10^{-6} (Cs-137)	4	0.05

a. This table contains information based on the requirements for the various specifications for the listed monitors. The actual monitors meet or exceed these requirements.
b. Also have local readout and alarm.

Table 11.4-2
PROCESS RADIATION MONITORING SYSTEM COUNTING RATES OF RELEVANT ISOTOPES (cpm/MCi/cc)

Monitor	I-131	Xe-133	Kr-85	Cs-137	Co-60
Process vent particulate [a]	1.04E+9	-	-	1.15E+9	-
Process vent gas [b]	-	1.17E-6	2.92E-6	-	-
Ventilation vent A particulate [a]	1.04E+9	-	-	1.15E+9	-
Ventilation vent A gas [b]	-	1.17E-6	2.92E-6	-	-
Ventilation vent B particulate [a]	1.04E+9	-	-	1.15E+9	7.10E+8
Ventilation vent B gas [b]	-	-	2.92E-6	-	-
Ventilation vent multiport sample, particulate	1.7E+12	-	-	1.5E+12	-
Ventilation vent multiport sample, gas	-	1.9E+6	3.5E+7	-	-
Containment particulate	1.7E+12	-	-	1.5E+12	-
Containment gas	-	1.9E+6	3.5E+7	-	-
Component-cooling water	2.5E+6	-	-	2.2E+6	5.2E+6
Component-cooling heat exchanger service water	2.5E+6	-	-	2.2E+6	5.2E+6
Service-water discharge to tunnel	2.5E+6	-	-	2.2E+6	5.2E+6
Service-water discharge to Service Water Reservoir	1.1E+8	-	-	7.7E+7	1.7E+8
Liquid waste disposal	2.5E+6	-	-	2.2E+6	5.2E+6
Condenser air ejector	-	4.00E+2	1.16E+4	-	-
Steam generator blowdown	2.5E+6	-	-	2.2E+6	5.2E+6
Recirculating spray cooler	2.5E+6	-	-	2.2E+6	5.2E+6
Circulating-water discharge tunnel	5.6E+8	-	-	5.0E+8	1.2E+9
High-capacity SG blowdown discharge	-	-	-	6.8E+8	1.8E+9

a. These counting rates are in cps/µCi/cc from the particulate monitor Monte Carlo Analysis Report.

b. These counting rates are in cps/Bq/m^3 from the noble gas monitor Monte Carlo Analysis Report.

Table 11.4-3
POST-ACCIDENT RADIATION MONITORING SYSTEM NORMAL AND HIGH-RANGE NOBLE GAS EFFLUENT MONITORS (PER NUREG-0737, SECTION II.F.1)

Normal-Range Noble Gas Effluent Monitors
- Process Vent (1-GW-RM-178-1)
- Ventilation Vent A (1-VG-RM-179-1)
- Ventilation Vent B (1-VG-RM-180-1)

High Range Noble Gas Effluent Monitors
- Process Vent (1-GW-RM-178-2)
- Ventilation Vent A (1-VG-RM-179-2)
- Ventilation Vent B (1-VG-RM-180-2)

Table 11.4-4
POST-ACCIDENT RADIATION MONITORING SYSTEM HIGH-RANGE EFFLUENT MONITORS (PER NUREG-0578, SECTION 2.1.8.B)

Main Steam Lines (in Main Steam Valve House)
- 1A (1-MS-RM-170)
- 1B (1-MS-RM-171)
- 1C (1-MS-RM-172)
- 2A (2-MS-RM-270)
- 2B (2-MS-RM-271)
- 2C (2-MS-RM-272)

Auxiliary Feedwater Turbine Exhaust (1-MS-RM-176) (2-MS-RM-276)

Intentionally Blank

11.5 SOLID WASTE SYSTEM

The estimated solid waste volumes were based on typical industry assumptions and experience for nuclear power plants available at the time of original plant licensing. These assumptions and estimates were developed to demonstrate the ability of the plant design to accommodate and dispose of solid radioactive waste. These assumptions were intended to be representative of the plant operation. In some instances, this is not the case since various system process parameters have proven to be different from the initial assumptions and estimated values. These original estimates represented the basis for demonstrating the ability to properly dispose of this waste in accordance with the NRC requirements in the original licensing basis. Adherence to the solid waste disposal requirements is monitored by procedures in accordance with the approved Process Control Program (PCP).

As originally designed, the waste solidification system used urea formaldehyde as a solidification agent, as did numerous other nuclear plants such as Trojan and Palisades. However, experience throughout the industry has demonstrated that this system needs further development to assure reliable solidification, elimination of free water, and no unacceptable leaching. Consequently, the system is not used. Waste is now being processed for shipment by dewatering and shipment in high-integrity containers, or steel liners. Final shipment preparations (inspection, health physics approval, etc.) remain the responsibility of VEPCO.

The following discussion describes the basic procedures for disposing of various types of waste, all within regulations of the NRC, the Department of Transportation, and the receiving burial site.

11.5.1 Design Objectives

The solid waste disposal system provides holdup, packaging, and storage facilities for the eventual shipment off the site and the ultimate disposal of radioactive waste. Materials that may be handled as solid waste include spent resin slurries; spent filter cartridges; and other miscellaneous solid radioactive material resulting from station operation and maintenance.

11.5.2 System Inputs

The solid waste handling operations are described in Section 11.5.3. The volume activity level estimated for each of these streams is shown on Figures 11.5-1 and 11.5-2.

11.5.2.1 Spent Resins

The spent resin system is shown on Reference Drawing 3. It was originally estimated that 1500 ft^3/yr/unit of resin would require disposal based on the original plant system design. This material will be transferred as slurry to be dewatered and shipped, in disposal containers, which are placed in shielded shipping casks as required, for offsite shipping and disposal. The shielded shipping casks are generally reused.

11.5.2.2 Evaporator Bottoms

The liquid waste bottom piping is shown on Reference Drawing 2. The waste disposal evaporator is abandoned in place.

The boron recovery bottom piping is shown on Figure 9.3-6 and Reference Drawing 1.

11.5.2.3 Clarifier Sludge

The clarifiers are no longer operated in a manner which generates sludge. They serve only as hold-up tanks to provide additional decay time.

11.5.2.4 Miscellaneous Solid Waste

Rags, gloves, boots, brooms, filter cartridges, and other miscellaneous tools and apparel that become contaminated during normal operation and cleanup will be handled as described in Section 11.5.3; original estimates indicated the amount may be approximately 1500 ft^3/yr/unit. Original estimates also indicated that spent filters may be changed at expected rates of 175 ft^3/yr/unit. Those filters that are highly radioactive will be processed as described in Section 11.5.3.4.

11.5.3 Equipment and Operation

Table 11.5-1 presents a summary of the design parameters for the equipment. When solidification operations are necessary, acceptable vendors supply this service which must adhere to the requirements of the Process Control Program.

11.5.3.1 Solidification Operation

It is not expected that solidification will be used on-site. If solidification operations are necessary, acceptable vendors supply this service as stated in Section 11.5.3.

11.5.3.2 Baling Operation

Compaction/baling of dry active waste (DAW), such as absorbent paper, cloth, rubber, and plastic items, was originally used to volume reduce waste. Baling operations are no longer performed at North Anna. The processing of DAW for volume reduction prior to disposal is performed offsite by approved vendors.

11.5.3.3 Spent Resin Handling Operation

Spent resin facilities are located below grade in the decontamination building. This portion of the decontamination building is designed to Seismic Class I criteria.

A shielded resin holdup tank accumulates spent resin from ion exchangers. A transfer system permits the spent resin to be flushed from the hold tank to be dewatered and shipped.

The resin in an ion exchanger is considered to be spent when the decontamination factor drops below a predetermined value, the dose rate on the outside of the ion exchanger approaches a predetermined value, or the pressure drop across the ion exchanger becomes excessive. The unit is then isolated and primary-grade water or recycled resin flush water is used to flush the spent resin into the spent resin holdup tank. The spent resin remains in the holdup tank and flushed liquid passes through a filter and discharges by way of the spent resin dewatering tank and the vent and drain system to one of the waste drain tanks.

There is no significant temperature increase in the spent resin holdup tank due to decay heat. A conservative analysis shows that the maximum conceivable temperature rise in the resin is 45°F.

11.5.3.4 **Spent Filter Cartridge Handling Operation**

Filters in radioactive liquid service are removed from service when the pressure drop across the filter becomes excessive or the radiation level approaches the transport cask shielding capabilities. To remove the expended cartridges from filters that are located in limited access, shielded cubicles, the filter removal shield is positioned on the shield floor over the filter vessel after removal of the shield plug. The filter cover is opened remotely and the cartridges are drawn up into the shield. The spent filter and shield are transferred to the waste solids area. The spent filter is lowered into a shielded disposable container (High Integrity Container - HIC) in preparation for disposal. Filters located in limited access, shielded cubicles, that present a low radiological risk, may be removed without use of the filter removal shield prior to being lowered into a disposal container in preparation for disposal. Filters that present a low radiological risk are defined based on ALARA considerations and described in the provisions of specific procedures.

Other filters that are not located in limited access, shielded cubicles, are removed without the use of the filter removal shield. These filters are removed and transported to Waste Solids under the provisions of specific procedures and ALARA considerations.

11.5.4 Estimated Volumes

Estimated design volumes of solid waste are given in Section 11.5.2. The total amount of waste (originally estimated at the time of plant licensing) to be processed by the system in one year is shown in Figure 11.5-1. The design quantities of waste and the content of this waste (in microcuries per cubic centimeter) are shown on Figure 11.5-2. The specific isotope breakdown within any one container cannot be ascertained. However, the isotope breakdown over a year’s operation for a given set of conditions can be determined. The curies within any one container will comply with radioactive material transportation regulations. The design total curies per year by isotope to the solid waste system from the station sources is shown in Table 11.5-2.

Design was based on the following assumptions:

1. Failed fuel is at 1%.
2. Source activity is the primary coolant activity per Table 11.1-6. This activity is collected on the mixed-bed demineralizers for 1 year.

3. The flow rate to the mixed-bed demineralizer is 60 gpm.
4. Collection efficiencies for this demineralizer are as follows:
   a. Twenty percent for corrosion products.
   b. Eighty percent for cesium.
   c. Ninety percent for molybdenum and yttrium.
   d. Zero percent for noble gases and tritium.
   e. Ninety-nine percent for all other isotopes.
5. Decay credit is taken for the buildup time on the resin bed.
6. No decay credit is taken for holdup in the resin hold tank, the waste solidification system, or the solid waste storage area.
7. The total activity is based on the assumption that all resins are at the same concentration as those in the mixed-bed demineralizer.

11.5.5 Packaging

Material handled as radioactive solid waste may include spent resin, spent filter cartridges, sludges, and miscellaneous solid materials resulting from station operation and maintenance, such as contaminated rags, paper, and equipment parts.

For ultimate disposal, these wastes are packaged and shipped off the site to approved radwaste processors. These processors minimize the amount of waste prior to shipment to specifically approved burial grounds. The packaging meets all applicable NRC and U.S. Department of Transportation (DOT) regulations (10 CFR 71 and 49 CFR 170 through 179) for transportation of radioactive materials.

Originally, all waste was to be packaged in either 55-gallon drums (7.5 ft^3) or in cylindrical containers of 50-ft^3 capacity. However, various types of strong tight containers of varying shapes and capacities are currently available for use. Containers vary from large seavans to the original 55-gallon drum containers. The choice of container size depends on the type, size and shape, radioactivity, etc., of the waste. The total quantity of waste to be shipped in the containers is a function of the ratio of materials, the waste activity, and the shipping shield to be used to meet transportation regulations.

VEPCO contracts for waste disposal transportation and burial services. Since there are variations in overpacks between contractors, specific details of their construction are not incorporated herein. These details of construction, packing, and permissible levels of activity, and a copy of required special permit for overpacks, are maintained on file by VEPCO. VEPCO uses only approved containers for shipment, in accordance with the requirements of applicable regulations.

The radioactivity level on contact with the surface of the disposal liner or shipping shield is measured, recorded, and attached to the outside surface in accordance with applicable Federal regulations. The shipping containers are stored until such time as they are shipped off the site for ultimate disposal.

11.5.6 Shipment

The normal mode of shipment of radioactive wastes from the North Anna Power Stations is by truck; however, shipment by rail is also possible. All shipments will conform to applicable DOT and NRC regulations.

The ultimate solid waste disposal site is dependent on specific contract requirements formulated for waste disposal.

11.5 REFERENCE DRAWINGS

The list of Station Drawings below is provided for information only. The referenced drawings are not part of the UFSAR. This is not intended to be a complete listing of all Station Drawings referenced from this section of the UFSAR. The contents of Station Drawings are controlled by station procedure.

	Drawing Number	Description
1.	11715-FM-086B	Flow/Valve Operating Numbers Diagram: Boron Recovery System, Unit 1
2.	11715-FM-087A	Flow/Valve Operating Numbers Diagram: Waste Disposal System, Unit 1
3.	11715-FM-087D	Flow/Valve Operating Numbers Diagram: Waste Disposal System, Unit 1

Table 11.5-1
SOLID WASTE DISPOSAL EQUIPMENT DESIGN DATA

Spent Resin Holdup Tank	
Number	1
Capacity	1800 gal
Design pressure	90 psig and full vacuum
Design temperature	250°F
Operating pressure	50 psig
Operating temperature	120°F
Material	SS 316L
Design Code	ASME VIII, Division 1, 1968
Spent Resin Dewatering Tank	
Number	1
Capacity	500 gal
Design pressure	90 psig and full vacuum
Design temperature	200°F
Operating pressure	Atmospheric
Operating temperature	120°F
Material	SS 316L
Design Code	ASME VIII, Division 1, 1968
Spent Resin Dewatering Tank Pump	
Number	1
Type	Horizontal centrifugal
Motor horsepower	10
Seal type	Mechanical
Capacity	50 gpm
Head at rated capacity	184 ft
Design pressure	220 psig
Materials	
Pump casing	SS 316
Shaft	SS 316
Impeller	SS 316
Resin Recirculation Pump	
Number	1
Type	Centrifugal
Seal type	Double mechanical
Motor horsepower	7.5
Capacity	70 gpm
Head at rated capacity	50 ft
Design pressure	100 psig

Table 11.5-1 (continued)
SOLID WASTE DISPOSAL EQUIPMENT DESIGN DATA

Resin Recirculation Pump (continued)	
Materials	
Pump casing	SS 316
Shaft	SS 316
Impeller	SS 316
Radioactive Waste Metering Pump	
Number	1
Type	Centrifugal, Recessed Impeller
Seal type	Mechanical
Motor horsepower	2.0
Capacity	28 gpm
Head at rated capacity	10 ft
Design pressure	150 psig
Materials	
Pump casing	CD4Mcu
Shaft	DURCO DC8
Impeller	CD4Mcu

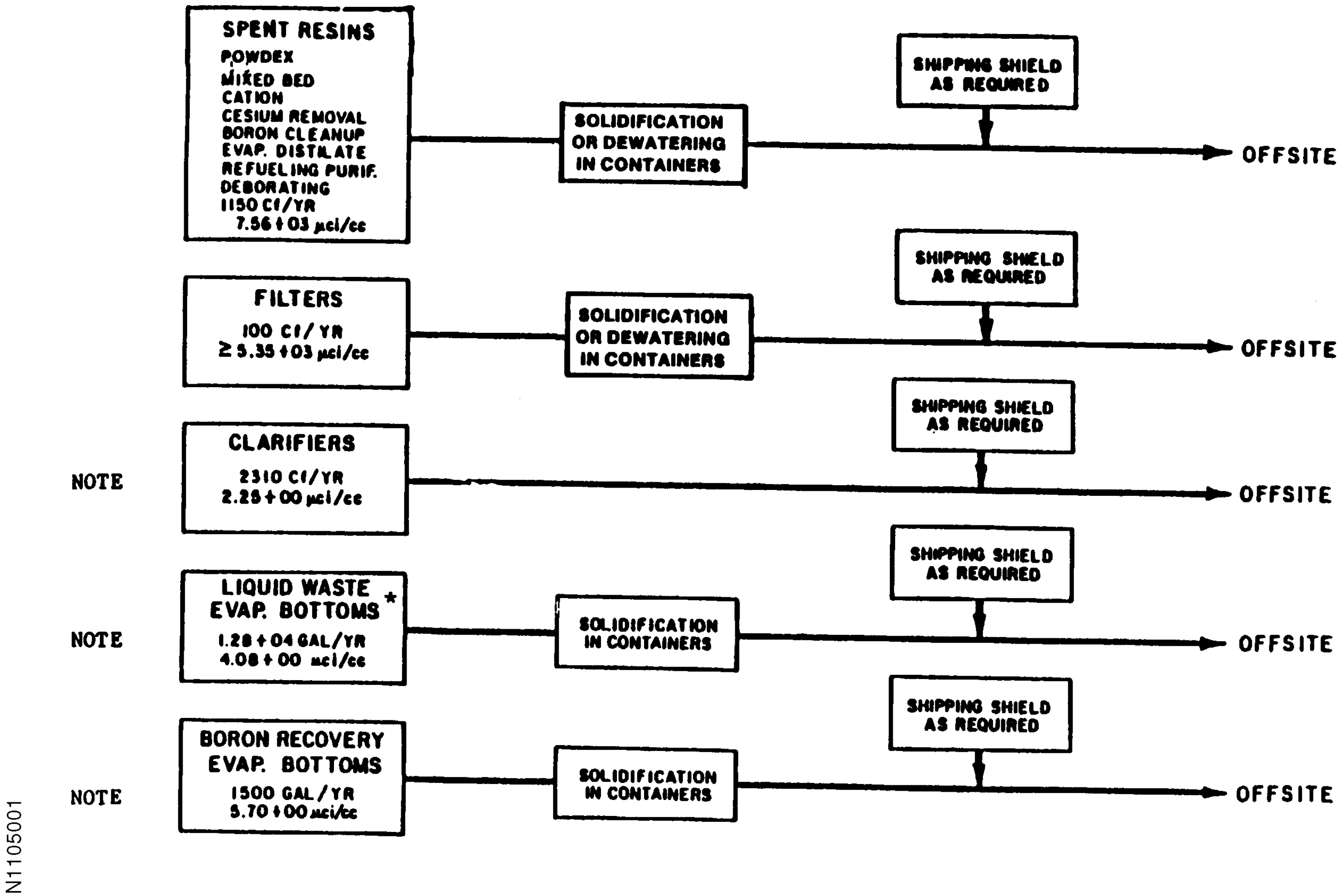
Table 11.5-2
SOLID WASTE ESTIMATES

Principal Isotopes	Curies per Year to Solid Waste System Liquid Waste Evaporator [a,b]	Curies per Year to Solid Waste System Boron Recovery Evaporator [a]	Ion Exchange Spent Resin [a]
I-131	4.8+01	1.3+01	3.7+05
I-132	5.3+00	4.3-01	1.7+04
I-133	2.1+01	5.1-01	6.4+02
I-134	7.5-02	1.2-19	3.9+02
I-135	2.4+00	2.6-03	1.1+04
Sr-89	4.2-01	1.0-01	3.5+03
Sr-90	2.0-02	6.5-03	6.4+02
Sr-91	3.4-02	1.7-05	1.4+01
Y-90	2.0-02	6.5-05	6.4+02
Y-91	7.1-01	1.8-01	6.2+03
Y-92	4.8-04	2.2-08	3.3+00
Zr-95	8.2-02	2.1-02	8.2+00
Nb-95	7.6-02	2.7-02	1.3+03
Mo-99	8.7+02	6.9+00	2.5+05
Tc-99	8.2+01	6.6+00	2.4+05
Tel-32	5.0+00	4.2-01	1.6+04
Cs-134	3.6+01	1.2+01	8.6+05
Cs-136	9.7-01	4.8-02	2.8+02
Cs-137	1.8+02	6.2+01	4.5+05
Ba-140	2.8-01	3.7-02	1.0+03
La-140	2.9-01	4.4-02	1.0+03
Ce-144	4.3-02	1.4-02	1.0+03
Cr-51	6.3+00	1.6-02	9.4+01
Mn-54	1.7+01	3.1-02	4.8+02
Mn-56	1.7-02	3.4-09	1.1+01
Co-58	1.3+01	7.4-01	6.2+03
Fe-59	2.4+02	2.5-02	1.7+02
Co-60	1.4+01	3.3+00	6.4+02

a. Based on original evaporator/clarifier/UF system.

b. Abandoned in-place.

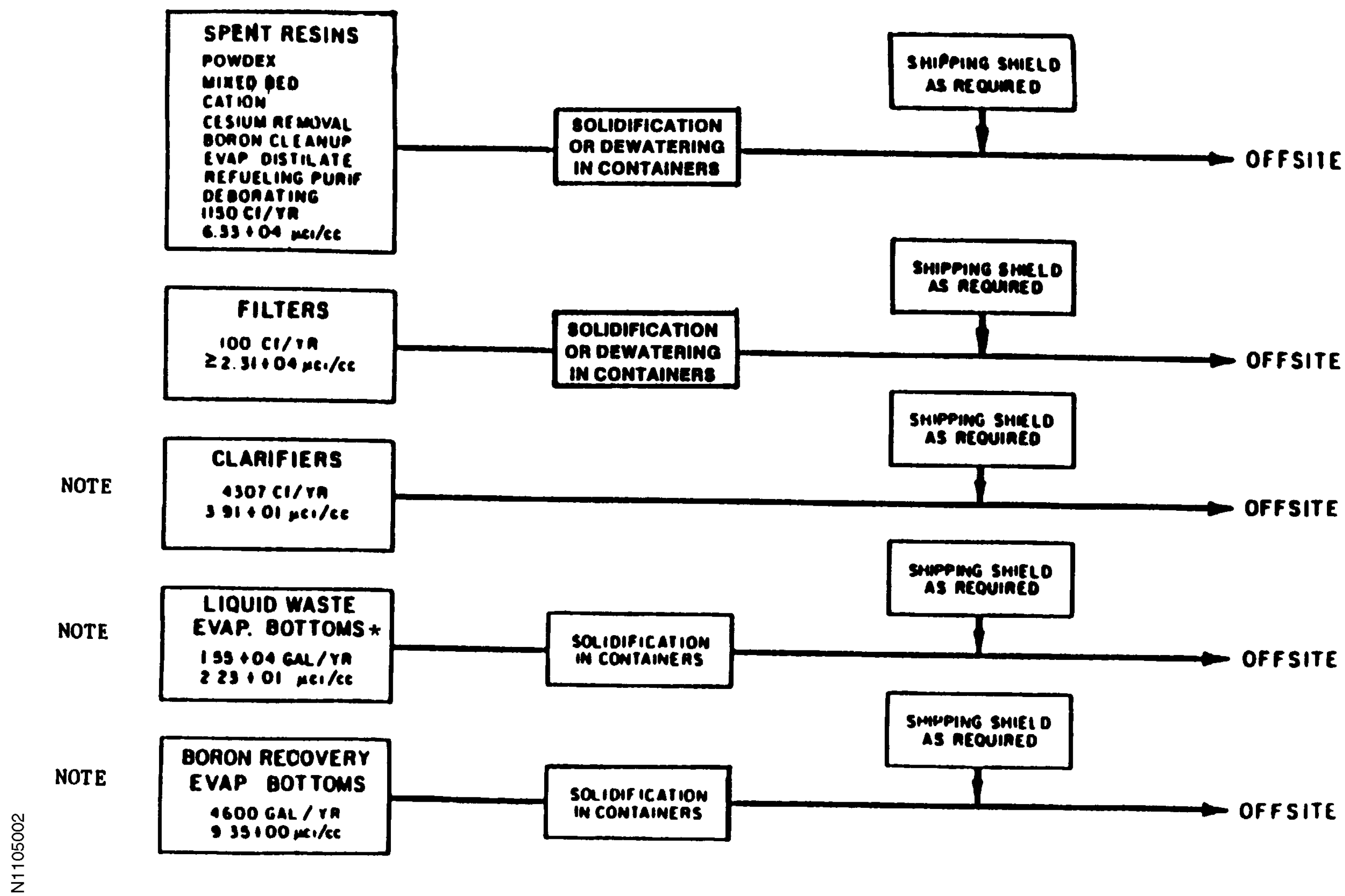
Figure 11.5-1
FLOW CHART—ESTIMATED QUANTITIES SOLID WASTE DISPOSAL SYSTEM—EXPECTED



NOTE: CLARIFIERS AND EVAPORATORS ARE NORMALLY NOT USED. VALUES STATED ARE FOR THE ORIGINAL DESIGN ONLY.

*Abandoned In-place

Figure 11.5-2
FLOW CHART—ESTIMATED QUANTITIES SOLID WASTE DISPOSAL SYSTEM—DESIGN



NOTE: CLARIFIERS AND EVAPORATORS ARE NORMALLY NOT USED. VALUES STATED ARE FOR THE ORIGINAL DESIGN ONLY.

*Abandoned In-place

11.6 OFFSITE RADIOLOGICAL MONITORING PROGRAM

11.6.1 Background

Actual background radiation and radioactivity levels in the environment surrounding the North Anna site were measured and recorded during the preoperational Environmental Radiological Monitoring Program, which commenced in early 1973. Analysis and periodic reports were done by Teledyne Isotopes. With the advent of power operations, an operational Radiological Environmental Monitoring Program (REMP) was instituted. These programs and their relationship are discussed in Section 11.6.3.

11.6.2 Critical Pathways

The pathways of human exposure from plant operation likely to account for most of the exposure, and the mathematical models used to evaluate these pathways, are given in Appendix 11B. In evaluating the effects of actual radioactive releases after the commencement of station operation, the mathematical models in Appendix 11B, or analogous models, are used.

11.6.3 Sampling Media, Locations, and Frequency

The environmental radiological monitoring sampling frequencies and sampling locations are presented in Table 11.6-1 and Figure 11.6-1 for the pre-operational stage of the monitoring program. The operational Radiological Environmental Monitoring Program (REMP) is based on NUREG-0472 and the Branch Technical Position Revision 1, *Acceptable Radiological Environmental Monitoring Program*, and is implemented in the Offsite Dose Calculation Manual (ODCM). The pre-operational and operational monitoring program incorporates measurements to evaluate the possible effects from plant operation and ensure that changes in the environmental radioactivity can be detected.

Measurements obtained during station operation are compared with background data collected before station operation. The sensitivities of the various sampling techniques and the sampling frequencies allow the detection of any changes in background levels that could possibly be attributed to station operation and that would be of significance to the health and safety of the public. The pre-operational environmental radiological monitoring program commenced in February 1973.

Periodically, the radiological environmental monitoring program is evaluated for adequacy in light of program results and changes in technology. Any necessary changes are incorporated into the program. Additional details on the pre-operational and operational radiological environmental monitoring program samples are given in the sections that follow.

11.6.3.1 Air Monitoring - Radiogas and Air Particulate

Normally, during operational monitoring, the gaseous wastes discharged from the station consist almost entirely of the noble gases, xenon and krypton. The radiation hazard from these gases, due to their inertness, is external exposure. Radiation surveillance is maintained by using thermoluminescent dosimeters to measure total radiation levels in the station environs. The dosimeters are read periodically to optimize statistical sensitivity and document seasonal fluctuations.

Continuous duty air particulate samplers monitor airborne activity in accordance with the Offsite Dose Calculation Manual. These samples are indicative of radioactivity levels and reflect any transient conditions that may arise.

11.6.3.2 **Milk**

Milk is sampled in accordance with the Offsite Dose Calculation Manual. Milk is one of the best and most direct biosamplers for determining the radiocesium, radiostrontium, and radioiodine levels in the environment. Since the levels of radiostrontium and cesium are well below protection standard levels, and radioiodine was essentially nonexistent in the samples, the samples were adequate to establish background levels and document future trends.

Milk continues to be sampled during the operational REMP. Milk samples are obtained at a predetermined frequency from selected locations surrounding the site.

11.6.3.3 **Vegetation, Crops, and Feed**

Vegetation samples are collected during the preoperational environmental radiological monitoring program and continue to be collected during the operational REMP. They reflect the uptake of radionuclides from the soil. However, the actual relationship of activity uptake to population doses is unpredictable because of the many variables involved.

Under the REMP, crops (such as corn), feed (such as alfalfa), and/or edible broad leaf vegetation are collected during the growing seasons and can be used as indicators of potential increases in doses to humans through the food chain.

11.6.3.4 **Soil, Surface Water, and Wells**

The pre-operational environmental radiological monitoring program samples reflected the radiological state of the environment. Gamma isotopic analysis of soil gives evidence of the original source of any increased contamination that may be found. These samples are intended as long-range indicators.

11.6.3.5 **Precipitation**

During the environmental radiological monitoring program, rainwater samples indicated widespread or global activity concentrations and were one method of detecting activity not attributable to station operation. Monthly samples were obtained during this period.

Rainwater continues to be sampled during the operational REMP. The frequency and location of the sampling is sufficient to keep the program current yet practical.

11.6.3.6 **Silt and Fish**

These samples (in addition to Lake Anna water samples) act as indicators in that they have the property to concentrate certain nuclides. One of the first signs of lake buildup of activity will be increased levels in fish.

11.6.4 Analytical Sensitivity

Details of sample analysis and detection capability are given in the Offsite Dose Calculation Manual and in the Annual Radiological Environmental Operating Report. The determination of the activity levels of the samples collected in the REMP may be determined by forwarding the samples to a consultant.

During the initial year of the environmental radiological monitoring program the analyses was performed by a consultant. The equipment used by the consultant for the first year of the monitoring program is listed in Table 11.6-2. Similar equipment has been used in the succeeding years.

11.6.5 Data Analysis and Presentation

The results of the REMP sampling program are summarized in quarterly and annual reports. These reports include a professional evaluation of the results. Results are normally reported in tabular form and include 1 or 2 sigma counting error.

Statistical analyses are performed on these samples, such as air particulate, with sufficient data and/or levels above background radiation levels to be statistically meaningful.

11.6.6 Program Statistical Sensitivity

Sufficient background statistical data were obtained on air particulate samples, in the pre-operational monitoring program that was completed before the commencement of station operation. This, in conjunction with the selection and analysis of environmental samples known to concentrate radionuclides and radioassay of radioactive gaseous and liquid waste released from the station, will allow an estimate of the probable exposure to man from station operation.

It is anticipated that the results obtained from the environmental sampling program, together with source activity release data, will show relatively little or no increase in the background activity of the environs. Sections 11.2.5.1 and 11.3.8 discuss the anticipated release and dose potential in more detail.

Table 11.6-1
NORTH ANNA POWER STATION
RADIOLOGICAL MONITORING PROGRAM (PREOPERATIONAL)

Sample	Station No.	Type	Frequency	Analysis
Air particulate	1 through 7	Continuous (2 hr on, 1 hr off)	Biweekly	Gross alpha, gross beta
			Quarterly	Isotopic gamma scan (composite)
				Iodine-131 (charcoal cartridges)
Radiogas	1 through 7	Continuous	Quarterly	Mrem exposure
Milk	12 through 15	Grab	Quarterly	Sr-90, Cs-137, I-131, total Ca isotopic gamma scan
Fish	8 through 10	Grab	Quarterly	Flesh gross beta, and K-40 isotopic gamma scan, Sr-89, Sr-90
Surface water	8 through 11	Grab	Quarterly	Gross beta
			Semiannual	H-3, isotopic gamma scan on quarterly composites
Soil	1 through 7	Grab	Annual	Isotopic gamma scan
Crop (corn)	19 and 20	Grab	Three-year annual	Isotopic gamma scan Sr-90 (on mature corn)
Crop (leaf)	13, 15, 18	Grab	Semiannual	Isotopic gamma scan, Sr-89, Sr-90
Wells	1, 3, 16, 17	Grab	Semiannual	Gross alpha, gross beta, H-3 isotopic gamma scan
Vegetation	At 3 air particulate monitoring stations	Grab	3 per year	Isotopic gamma scan
Aquatic vegetation	Two stations where and if available	Grab	Semiannual annual composite	Isotopic gamma scan Sr-89, Sr-90

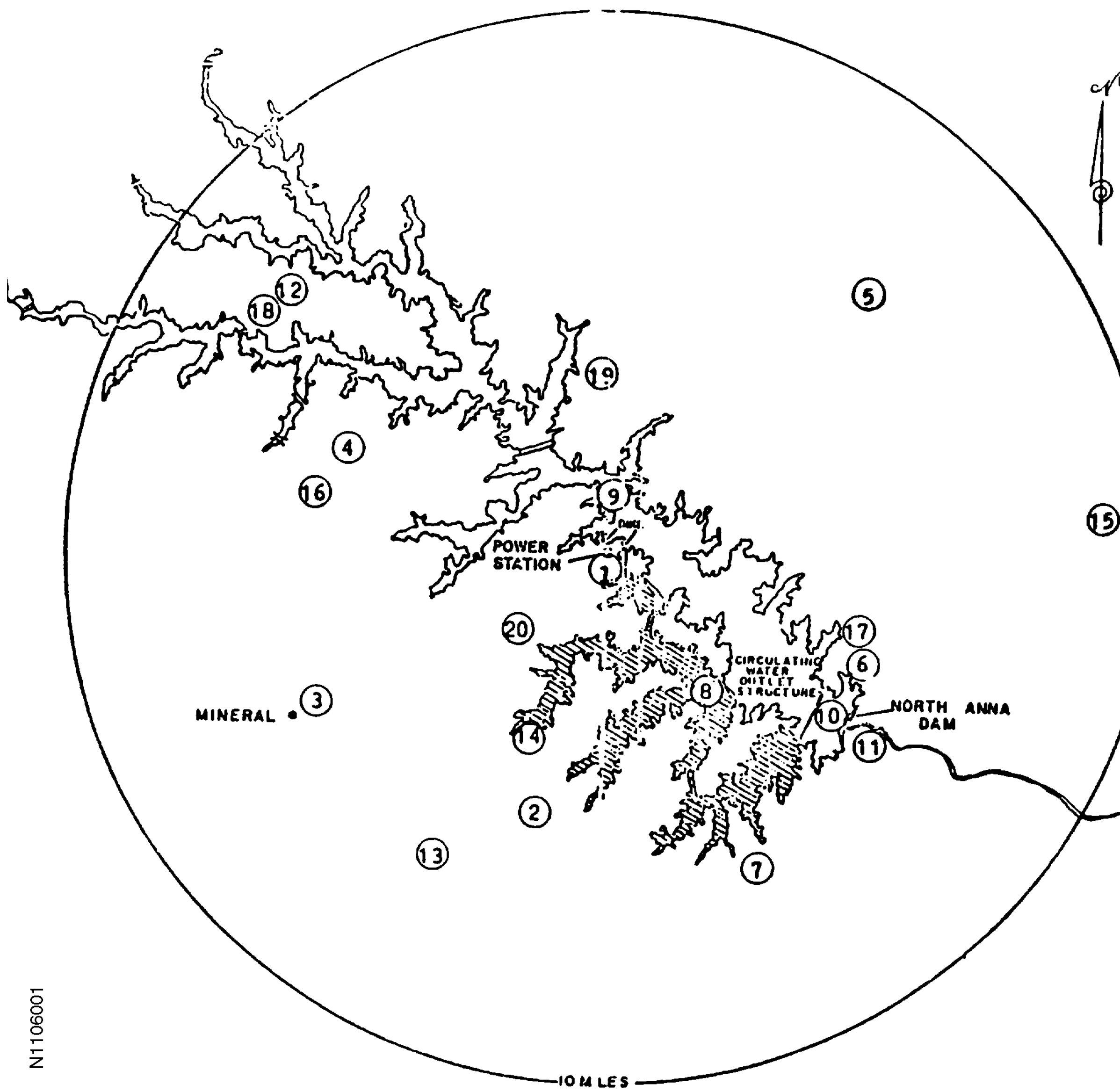
Table 11.6-1 (continued)
NORTH ANNA POWER STATION
RADIOLOGICAL MONITORING PROGRAM (PREOPERATIONAL)

Sample	Station No.	Type	Frequency	Analysis
Benthic organisms	8 through 11 (if available)	Grab	Quarterly annual composite	Isotopic gamma scan Sr-89, Sr-90
Precipitation	1	Continuous	Monthly	Gross beta
			Semiannual	H-3, isotopic gamma scan on composite
Silt	8 through 11	Grab	Semiannual	Isotopic gamma scan, Sr-89, Sr-90

Table 11.6-2
NORTH ANNA POWER STATION ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM MEASURING EQUIPMENT, MARCH 1973 TO MARCH 1974

Equipment	Remarks
Gamma spectrometry	Consists of 4096 multichannel analyzer equipped with a nuclear diodes solid-state Ge(Li) detector having 2.34-keV resolution, a peak to Compton ratio of 22.1, and a relative efficiency at 1.33 MeV of 4.3%. Equipped with teletype and punch tape readout as well as x-y recorder spectrum representation capability.
Gamma spectrometry system	Nuclear Data Computer based type system with a solid-state Ge(Li) detector having 2.34-keV resolution. System equipped with ND812 computer, teletype, and punch tape readout as well as x-y recorder spectrum representation capability.
Alpha spectrometry system	Consists of silicon surface barrier detectors with 30-keV resolution coupled to a pulse height analyzer with teletype and x-y readout.
Liquid scintillation system	Has 65% tritium efficiency and 90% carbon-14 efficiency.
Gross alpha counting system	Consists of two windowless gas flow detectors with an alpha efficiency of 55% with a background of less than 0.1 cpm.
Low background gas proportional Beckman wide beta II (2-inch planchet) counting system	Has 2.5 cpm beta background and 0.1 cpm alpha background
Low beta gas proportional (1-inch planchet) counting system	Has 0.5 cpm beta background and detector efficiency of 50% for strontium-90.

Figure 11.6-1
PREOPERATIONAL RADIOLOGICAL ENVIRONMENTAL
SAMPLING PROGRAM SAMPLE STATION LOCATIONS



Intentionally Blank

Appendix 11A
Tritium Control

Intentionally Blank

APPENDIX 11A
TRITIUM CONTROL

The release of tritium to the environment from operating Westinghouse pressurized water reactors (PWR) has always been well below 10 CFR 20 limits. This section discusses the reduced tritium production in the North Anna plant as a result of employing Zirconium alloy-clad fuel and silver-indium-cadmium control rods.

11A.1 SYSTEM SOURCES

The principal contributors to tritium production within the PWR system are: (1) the ternary fission source, (2) the dissolved boron in the reactor coolant, and (3) secondary source assemblies. Additional small contributions are made by Li^6, Li^7, and deuterium in the reactor coolant. Tritium source terms used in the reactor system design are shown in Table 11A-1.

11A.1.1 The Fission Source

This tritium is formed within the fuel material and may:

1. Remain in the fuel rod uranium matrix.
2. Diffuse into the cladding and become hydrided and fixed there.
3. Diffuse through the clad for release into the reactor coolant.
4. Release to the coolant through macroscopic cracks or failures in the fuel cladding.

Previous Westinghouse designs have conservatively assumed that the ratio of fission tritium released into the coolant to the total fission tritium formed was approximately 30% for Zircaloy-clad fuel. The operating experience at the R. E. Ginna plant of the Rochester Gas and Electric Company, and at other operating reactors using Zircaloy-clad fuel, has shown that the tritium release through the Zircaloy fuel cladding is substantially less than predicted by the earlier estimates. Consequently, the release fraction has been revised downward from 30% to 1% on the basis of these data (Reference 1). Like Zircaloy, ZIRLO and M5 are about 98% Zirconium, so their properties relative to tritium release are not expected to differ significantly from Zircaloy (References 2 & 3).

The control rods for this plant are silver-indium-cadmium. There are no reactions in these absorber materials that would produce tritium, thus eliminating any contribution from this source.

11A.1.2 Boric Acid Source

A direct contribution to the reactor coolant tritium concentration is made by neutron reaction with the boron in solution. The concentration of boric acid varies with core life so that this is a steadily decreasing source during core life. The principal boron reactions are the B^{10} (n, 2α) H^3 and B^{10} (n, α) Li^7 (n, α) H^3 reactions.

The Li^7 reaction is controlled by limiting the maximum overall lithium concentration. Li^6 is essentially excluded from the system by using Li enriched to 99.9% Li^7.

11A.1.3 Secondary Source Assemblies

In a Secondary Source rod, the primary source of tritium generation is the irradiation of Beryllium. The neutron reactions that result in the production of tritium are:

Be^9 (n, α) He^6 (β) Li^6 (n, α) T

Be^9 (n, γ) Be^{10} (n) Li^8 + T

Be^9 (n) Li^7 + T

Li^7 (n, n α) T

Of the above reactions, the first reaction is the primary source of tritium production from the sources. The permeability of the secondary source pellets and cladding (stainless steel) to tritium is high. Secondary sources were not explicitly analyzed as a source of tritium in the reactor for the original plant design and are therefore not described in Table 11A-1. As stated in Section 11A.1.1, conservative assumptions regarding the release of tritium from the fuel were made in the original analyses. The original analyses, with this assumption, account for potential tritium release from the source rods.

11A.1.4 Burnable Poison Rod Source

Burnable poison rods were in the core during the first operating cycle and during subsequent cycles. Because the poison is fully encapsulated in sealed rods, the burnable poisons do not contribute significant amounts of tritium to the coolant.

11A.1.5 Minor Sources

Lithium and deuterium reactions contribute only minor quantities to the tritium inventory.

11A.2 DESIGN BASES

The design intent is to reduce the tritium sources in the reactor coolant system to a practical minimum. The reduction of source terms is provided by using silver-indium-cadmium control rods and the determination that the quantity of tritium released from the fuel rods with Zirconium alloy cladding is less than originally expected.

11A.3 DESIGN EVALUATION

Table 11A-1 is a comparison of a typical design-basis tritium production that was used to establish system and operational requirements of the plant, as well as expected tritium release values. The criteria used for design basis accidents (DBA) retain their original definitions based on the old 10 CFR 20 and therefore DBA analyses do not need to be recalculated based on the criteria of the revised 10 CFR 20 rule. (Reference: First Set of NRC Question/Answer #14.) The principal contributors to tritium production are: (1) the ternary fission source, (2) the dissolved boron in the reactor coolant, and (3) secondary source assemblies.

Because of the importance of this source on the operation of the plant, Westinghouse initially closely followed operating plant data for cores with Zircaloy-clad fuel. Furthermore, a program was conducted at the R. E. Ginna plant to follow this in detail.

The R. E. Ginna plant operated with a Zircaloy-clad core with silver-indium-cadmium control rods and primary and secondary source assemblies. The operating levels of boron concentration during the start-up of the plant were approximately 1100 to 1200 ppm of boron. In addition, burnable poison rods in the core contain boron that may contribute some tritium to the coolant. Data collected during the operation of the plant indicated very clearly that the design sources were conservative. The tritium released was essentially from the boron dissolved in the coolant, a ternary fission source, and the installed source assemblies. Less than 10% of the tritium was from ternary fission. In addition to the R. E. Ginna data, other operating plants with Zirconium alloy-clad cores have also reported very low tritium concentrations in the reactor coolant system after considerably longer operation.

For a leakage from the reactor coolant system into the reactor building atmosphere of 50 lb/day with an assumed tritium concentration of 3.5 μCi/g, the tritium concentration in the reactor building atmosphere would be low enough to permit access with no reactor building purge and without protective equipment by plant maintenance personnel for an average of 2 hr/week.

During refueling operations, a refueling water concentration activity of 2.5 μCi/g is expected to result in reactor building air concentrations at or below the 10 CFR 20 occupational maximum permissible concentration (MPC) value. This concentration would permit 40 hr/week access to the reactor building.

Although the actual relationship between reactor coolant activities and reactor building air concentrations will be determined by the particular operating conditions inside the reactor building (temperature, relative humidity, ventilation purge rate, etc.), field measurements indicate that the design objective of 3.5 μCi/g in the reactor coolant and 2.5 μCi/g in the refueling water are reasonable values.

The concentration of tritium in the reactor coolant system can be controlled by the release of tritium to the environment via the boron recovery and waste disposal systems as discussed in Section 11.2.5. Since containment tritium concentration during normal operation is a function of reactor coolant tritium concentration, the tritium concentration in the containment can also be controlled. Controlling this concentration to twice the MPC value requires the release of 680,000 gal/yr for both units via the boron recovery system to discharge the 1065 Ci of tritium produced. During refueling, the tritium concentration in the containment atmosphere is maintained at a safe level by the containment purge system.

Since there is no forced mixing between the water in the reactor refueling cavity and in the spent-fuel pit, evaporative tritium losses from the spent-fuel pit will be minimal.

Based on the above, the following conclusions were reached:

1. The tritium levels in plants operating with Zirconium alloy-clad cores are substantially lower than original design predictions.
2. The tritium source in the plants is reduced from the values in the original design analysis by using silver-indium-cadmium control rods.

11A REFERENCES

1. *Source Term Data for Westinghouse Pressurized Water Reactors*, WCAP-8253, Revision 1, July 1975.
2. Davidson, S. L. and Nuhfer, D. L. (Eds.), *VANTAGE+ Fuel Assembly Reference Core Report*, WCAP-12610-P-A, April 1995.
3. BAW-10227P-A, *Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel,* February 2000.

Table 11A-1
TRITIUM SOURCE TERMS FOR SYSTEM DESIGN[a]

Tritium Source	Total Produced (Ci/yr)	Expected Release to Reactor Coolant (Ci/yr)
Ternary fission	8560	856
Burnable poison rods (initial cycle) [b]	631	63
Soluble boron (initial cycle) (equilibrium cycle)	195 250	195 250
Lithium and deuterium reactions	86	86
Total initial cycle	9472	1200
Total equilibrium cycle	8896	1190

a. Tritium source terms were calculated using the following bases:

Power level	2900 MWt
Load factor	0.8
Release fraction from fuel	10%
Release fraction from burnable poison rods	10%
Burnable poison rod B-10 mass	2374g
Reactor coolant boron concentration (initial cycle)	860 ppm
Reactor coolant boron concentration (equilibrium cycle)	1100 ppm

b. Although these system design values assumed that burnable poisons would be used only in the initial operating cycle, in practice burnable absorbers have also been used in reload cycles at North Anna. As discussed in Sections 11A.1.4 and 11A.3, it has since been determined that the burnable poison rods do not significantly contribute to reactor coolant system (RCS) tritium levels, and that tritium production in general is well below the equilibrium cycle design values shown.

Appendix 11B
Radiation Exposure Evaluation for Estimated Radioactive Effluents

Intentionally Blank

APPENDIX 11B
RADIATION EXPOSURE EVALUATION FOR ESTIMATED RADIOACTIVE EFFLUENTS

11B.1 INTRODUCTION

Units 1 and 2 of the North Anna Power Station are situated approximately midway between the cities of Washington, D.C., and Richmond, Virginia. The immediate site area is characterized by its low population density and supports a mostly agricultural economy. The North Anna Reservoir is expected to be the focal point of recreational activities for a population within 50 miles of the site that is projected to total about 1,364,000 by the year 2000.

During normal operation, small quantities of radioactive liquids and gases will be discharged on a controlled basis to the environment. These discharges will be kept within the limits set by 10 CFR 20 and will be in conformance with the Offsite Dose Calculation Manual and applicable Technical Specifications that govern plant operations. It is the purpose of this section to quantify and evaluate the potential radiological impact of these releases. The evaluation considers maximum potential individual radiation exposure rates as well as the total integrated population exposure within a 50-mile radius of the site. Exposure pathways considered include all known significant environmental and biological mechanisms through which activity released from the station could conceivably reach the public. Figure 11B-1 illustrates those exposure pathways of greatest significance for central station nuclear generating plants such as North Anna. Table 11B-1 gives the distance from the Unit 1 containment to the location of various pathways, including milk cows, meat animals, milk goats, the nearest residences, vegetable gardens, and the nearest site boundary.

Since the applicable regulations are based on a consideration of average annual dose, this study is directed at determining the doses averaged over a year. The estimated doses to individuals and population are compared to existing and proposed dose guidelines, to normal background radiation doses, and to other ordinarily acceptable radiation exposure levels.

Throughout this section, many assumptions have been made because of the lack of more precise knowledge. In each case, an attempt has been made to ensure that, whatever assumptions are made, they tend to overestimate the resulting exposure. In many instances, the numerical results presented do not reflect an accurate result, but rather an upper limit, a maximum potential dose.

11B.2 SUMMARY AND CONCLUSIONS

This appendix evaluates the maximum expected radiation exposure to the general public or to individuals thereof resulting from the operation of North Anna Units 1 and 2, for cores using a

15 x 15 fuel assembly array. The quantities of the various radioisotopes released from the station in gaseous or liquid form were obtained from an assumed combination of plant operating conditions that would provide maximum expected annual average releases. These assumptions included significant fuel cladding failure and various system leakages in each unit. In addition, conservative environmental dilution and concentration factors have been used so that the annual average doses calculated in this appendix are the maximum values that could reasonably be expected to occur during the normal operation of North Anna Units 1 and 2.

All incremental human exposure levels resulting from the combined operation of North Anna Units 1 and 2 have been found to be within the normally accepted levels of radiation exposure.

11B.2.1 Maximum Individual Exposure

Of all the exposure pathways considered, the greatest potential whole-body exposure results from the external irradiation of an individual at the exclusion radius from the released noble gases, krypton and xenon. The maximum potential dose from the source is calculated to be 0.62 mrem/yr. To derive this entire dose, an individual would have to continually remain outdoors at a particular position at the exclusion radius in an unshielded condition. An adult so situated would also receive a thyroid inhalation dose of 0.070 mrem/yr from the released radioiodines.

If an individual were to depend continually and exclusively on the Waste Heat Treatment Facility for his source of potable water, he would receive an annual whole-body dose of 0.27 mrem. The associated maximum organ dose from this source is calculated to be 0.54 mrem/yr to the adult thyroid. If the water were obtained from the North Anna Reservoir, the whole-body dose would decrease slightly to 0.20 mrem/yr, while the thyroid dose would decrease to 0.21 mrem/yr.

If an adult individual were to eat an average of 50g daily of fish taken from the Waste Heat Treatment Facility, he would receive an annual whole-body dose of 1.9 mrem and a maximum organ dose of 2.6 mrem to the liver. If the fish were obtained from the North Anna Reservoir, the whole-body dose would be reduced to 1.4 mrem/yr, and the maximum organ dose would be reduced to 1.9 mrem/yr.

In general, the maximum external exposure rates due to liquid releases are insignificant in comparison to maximum internal exposure rates due to the ingestion of water or fish. Swimming 200 hours in the Waste Heat Treatment Facility yields a whole-body dose of only 3.42×10^{-4} mrem. The skin dose is 4.38×10^{-4} mrem. Swimming 200 hours in the North Anna Reservoir yields reduced doses of 1.86×10^{-4} mrem to the whole body and 2.34×10^{-4} mrem to the skin. Exposure due to boating is based on an annual exposure period of 500 hours and amounts to 4.27×10^{-4} mrem/yr in the Waste Heat Treatment Facility and 2.33×10^{-4} mrem/yr in the reservoir.

The highest potential external exposure due to liquid releases comes from sunbathing on beaches where the radioactivity may concentrate. An annual exposure period of 300 hours yields a conservatively calculated 0.061 mrem/yr based on concentrations inside the Waste Heat Treatment Facility. The dose rate from sunbathing 300 hr/yr in the much more likely locations along the North Anna Reservoir is 0.046 mrem/yr.

A potentially significant exposure pathway involves the transfer of released radioiodines to milk, which is then ingested by a young child. Gaseous radioiodine releases may be deposited on grass, ingested by a grazing cow, and subsequently secreted in commercially available milk supplies. The maximum dose from this source occurs if the receptor is a young child. Assuming no delay between production and consumption and no dilution with other milk supplies, the potential annual thyroid dose from this source is calculated to be 1.21 mrem/yr for iodine deposition at the nearest Grade A dairy farm.

If it were possible for an adult individual to simultaneously receive the maximum exposure from all the above sources, he would receive a whole-body dose of 2.8 mrem/yr and a maximum organ dose of 3.5 mrem/yr to the liver. This includes the maximum potential exposure from water ingestion, fish ingestion, swimming (200 hours), boating (500 hours), and sunbathing (300 hours), as well as external exposure from the released radiogases.

In comparison, the annual whole-body exposure from naturally occurring background radiation in the United States is about 130 mrem (Reference 2). The maximum potential individual dose rates are also small in comparison with other ordinary and acceptable individual radiation exposure levels.

The dose delivered to an individual from a single chest X-ray may be as much as 170 mrem (Reference 2). Wearing a particular kind of watch may yield an incremental annual whole-body dose of 4 mrem (Reference 2). The inhabitation of a stone or masonry dwelling rather than a frame house has been calculated to yield an average additional annual whole-body dose of 40 mrem and a maximum annual incremental exposure of over 500 mrem (Reference 3). Thus, the maximum potential incremental exposure to man from plant-contributed radioactivity represents only a small fraction of exposure increments common to ordinary experience.

11B.2.2 Population Exposure

The total integrated annual population exposure to all individuals within 50 miles, by all pathways, is estimated to amount 12.7 man-rem in the year 2000. Distributed over the 50-mile population, these exposure rates amount to only 9.32×10^{-3} mrem per capita in the year 2000. For comparison, the total population exposure in 50 miles from natural background radiation, at about 125 mrem/yr, amounts to 170,500 man-rem in the year 2000.

In the year 2000, the population exposure due to gaseous releases is estimated at 5.07 man-rem/yr. Population exposure due to liquid releases, stemming wholly from exposure of persons using the North Anna Reservoir is projected to be 7.64 man-rem/yr in the year 2000.

The maximum potential population exposure due to the use of the North Anna Reservoir and the Waste Heat Treatment Facility has been evaluated for two sources of internal exposure and three modes of external exposure. Assuming that all persons living around the reservoir and all visitors drink water from the reservoir, the estimated population exposure amounts to 3.0 man-rem in the year 2000, for all reservoir usage.

The ingestion of fish caught in the North Anna Reservoir and Waste Heat Treatment Facility at an assumed rate of 24.9 lb/acre-yr amounts to a total annual exposure of 4.15 man-rem.

Assuming that the average visitor spends 25% of his time at the North Anna Reservoir boating, 15% of his time sunbathing or walking along the beach, and 10% of his time swimming, the following conservative estimates of whole-body population exposure result:

Exposure Source	Man-rem per Year, 2000
Boating	2.40×10^{-3}
Sunbathing	0.48
Swimming	2.00×10^{-3}

All possible sources of population exposure due to the normal operation of North Anna Units 1 and 2 are insignificant in comparison to exposure levels common to ordinary experience, either from natural background radiation or from other man-made sources.

11B.2.3 Conclusions

The maximum potential radiation exposure of the general public or any individual thereof due to the normal operation of Units 1 and 2 of North Anna has been evaluated. The combined whole-body dose to the maximally exposed individual from all significant sources is estimated at less than 3 mrem/yr, amounting to only about 2.3% of the naturally occurring whole-body exposure rate. The population exposure within 50 miles due to station operation will amount to 12.7 man-rem in 2000. This is less than 0.01% of the total exposure to the same population from natural background radiation. The potential exposure due to station operation also amounts to only small fractions of other commonly experienced sources of radiation exposure such as medical X-rays and commercial air travel. It can be safely concluded that the offsite radiation exposure from North Anna Units 1 and 2 will be an insignificant source of risk in comparison to those already commonly accepted.

11B.3 RADIATION EXPOSURE FROM GASEOUS EFFLUENTS

There are a number of pathways through which offsite persons may be exposed to the gaseous radioactivity released from nuclear power plants. From Figure 11B-1, three general pathways may be identified: direct radiation exposure, inhalation exposure, and exposure through food chains. The relative importance of these exposure pathways is determined by the radionuclide spectrum, the quantities of the released radiogases, and the site environment.

11B.3.1 Projected Gaseous Effluents

The expected quantities of activity releases in gaseous form are presented in Table 11B-2. These releases represent the maximum annual average release rates expected to occur and are denoted hereafter as maximum expected values. These release rates include the effects of significant failed fuel cladding, reactor coolant system to steam system leakage, reactor coolant leakage inside and outside of the containment building, and steam leakage to the turbine and auxiliary buildings. Approximately 70% of the releases result from the assumed system leakages, almost 2900 Ci/yr resulting from steam generator tube leakage alone.

11B.3.2 External Exposure From Gaseous Effluents

From Table 11B-2, it can be observed that the chemical composition of the anticipated gaseous releases will be essentially 100% noble gases, with only trace quantities of iodine present. Since the noble gases do not react chemically with other substances under normal conditions, there is no physical basis for either transport through food chains or reconcentration within the human body for these gases. Thus, the most significant exposure pathway for released noble gases is direct external irradiation of the whole body.

The opposite is true of the released radioiodines, for which inhalation and food chain transport are the critical pathways. External radiation from iodine is generally insignificant in comparison to the internal dose derived through inhalation.

11B.3.2.1 **Maximum Individual External Exposure**

The maximum potential external dose rate depends in general on the source terms, the applicable atmospheric diffusion, and the receptor characteristics. The distance to the nearest unrestricted land area from the release point near the reactor building is nearly 1 mile at North Anna. For the purpose of estimating the potential annual exposure, a hypothetical “maximally exposed individual” will be assumed to remain continuously at the worst possible location over the full period of 1 year. The individual will be assumed to be unshielded by housing or clothing, which normally provides a dose reduction factor of two or more.

The calculational model used is the infinite-sphere model suggested by the International Commission on Radiological Protection (ICRP) (Reference 5) and the International Atomic Energy Agency (IAEA) (Reference 6). The basic assumption of the model is that the absorbed dose rate at any point inside an infinite sphere of homogeneous material of uniform radioactivity concentration is equal to the dose rate at any other point. The dose rate to a ground-level receptor from a surrounding cloud of radioactivity is taken to be one-half that assumed by the infinite-sphere approach. This is because the receptor is only irradiated from one-half the total available solid angle. The dose rate is also adjusted upward by a factor of 1.13 to account for the increased stopping power of human tissue relative to air (Reference 5). The use of this model leads to conservative results for the following reasons:

1. The surrounding cloud of radioactivity is never infinite in dimension.
2. The substantial capacity of the human body for self-shielding against fission product beta radiation is not accounted for.

With regard to item 2 above, it can be shown that the average range of the beta radiations of concern here are on the order of 1 cm or less in the human body and there is little reason to consider beta radiation as contributing to the whole-body dose.

The dose rate depends directly on the applicable value of χ/Q, the atmospheric dispersion parameter. By means of the NUS Corporation computer code WINDVANE, meteorological data were reduced and summarized, yielding tables of annual average values of χ/Q. Along the station exclusion boundary, the highest value of χ/Q overland occurs at 5000 feet to the south-southeast and is equal to 1.83×10^{-6} sec/m^3.

Dose calculations based on this value of χ/Q, the source terms and disintegration energies presented in Table 11B-2, and the mathematical equations presented in Section 11B.6 yield an external whole-body exposure rate of 0.62 mrem/yr. Virtually all of this exposure is due to the released noble gases krypton and xenon.

11B.3.2.2 **External Population Exposure**

The population distribution within 50 miles of the site is presented in the form of a population wheel. The wheel gives the number of people residing in each of 160 different land segments, a segment being defined as that area within a 22.5-degree sector (centered on one of the 16 compass points) and within one of the 10 annuli into which the area within a 50-mile radius is subdivided.

The total exposure occurring within any one segment is the product of the average dose rate for the segment and the segment population. The total population exposure within 50 miles of the site is then the sum of the population exposures within each of the 160 population segments. The segment average dose rate was taken to be the dose rate of the geometric midpoint of the segment. Following this general procedure, the NUS Corporation computer code GASDOS performed the necessary calculations. Results were obtained not only for the estimated 1970 population distribution but for the projected population distributions for the years 1980, 1990, 2000, 2010, and 2020. The results are summarized below.

Year	Population Within 50 Miles	Total Man-rem Within 50 Miles of the Site	Mrem per Capita
1970	836,250	3.115	0.00373
1980	998,408	3.709	0.00371
1990	1,176,590	4.373	0.00372
2000	1,363,945	5.066	0.00371
2010	1,566,731	5.820	0.00371
2020	1,795,944	6.655	0.00370

11B.3.3 Internal Exposure From Gaseous Effluents

Released radiogases (or their radioactive daughter products) must be either inhaled or ingested in order to yield internal radiation exposure. Ingestion requires the physical transport of the radioactive gases through some form of food chain. This is possible for the isotopes of iodine and for the noble gas particulate daughter products. Inhalation is a significant pathway only for radioiodine.

11B.3.3.1 Internal Exposure From Released Noble Gases

Since the noble gases do not react chemically with other substances, there is no physical basis for either food chain transport or reconcentration within the human body.

In terms of continued inhalation and absorption in the body, both krypton and xenon may develop in physical solution, chiefly in the body water and fat (Reference 7). Several human exposure experiments have revealed that inhalation of relatively large amounts of radioactive noble gases result in very low tissue exposures (References 8 & 9). In general, it may be estimated that the internal dose from radioactive noble gases dissolved in body tissue following inhalation from a cloud is negligible (i.e., less than 1% of the associated external whole-body dose) (Reference 10). The resultant doses from exposure to noble gases, therefore, are considered to be external whole-body doses only.

11B.3.3.2 Internal Exposure From Released Radioiodine

A small amount of radioactive iodine in addition to the noble gases is expected to be released with the gases from the station. Iodine is an insignificant contributor to the external whole-body dose but may produce potentially significant internal doses as a result of the accumulation of iodine in the human thyroid gland. Iodine may enter the body by either inhalation or ingestion. The most critical pathway for the environmental transport of the routine release of radioiodine is the pasture-cow-milk-man pathway.

11B.3.3.2.1 Iodine Inhalation Thyroid Dose

As can be seen in Table 11B-2, the total annual release of all radioactive isotopes of iodine is estimated to be much less than 1 Ci/yr. The annual induced thyroid inhalation exposure to iodine resulting from continuous residence at a location 1 mile south-southeast of the reactors has been calculated to be 0.070 mrem/yr.

The largest portion of this exposure is due to the single isotope I-131. This reflects its relative abundance in comparison to the other released isotopes of iodine and its greater-dose effectiveness, which is best illustrated by the following figures:

Iodine Isotopes	Rem per Curie Inhaled (Reference 11)
I-131	1.48×10^6
I-132	5.35×10^4
I-133	4.00×10^5
I-134	2.50×10^4
I-135	1.24×10^5

The greater dose effectiveness of I-131 is primarily because of its relatively long 8.05-day half life. The calculational model used to derive doses from this source is presented in Section 11B.6.

11B.3.3.2.2 Iodine Ingestion Thyroid Dose

Although the radioiodine released will be in gaseous form initially, it may be deposited on pasture that is subsequently ingested by grazing cows. The cows will then transfer the radioiodine to milk, which is consumed as human foodstuff.

The exposure is inversely proportional to the mass of the thyroid gland. The most sensitive receptor in the population, in terms of total thyroid dose per unit intake, is thus an infant or a young child, who would have a very small thyroid. Also, the relative radiosensitivity of the thyroid decreases markedly with age (Reference 12). Since the rate of milk ingestion is important in determining the dose, the most critical receptor is not a newborn infant, but is more likely to be a child 6 months to 1 year in age.

The nearest Grade A commercial dairy farm is located about 3.6 miles south-southwest of the station. The χ/Q value applicable at this location was determined from the WINDVANE output to be equal to 1.20×10^{-7} sec/m^3. Using dose conversion parameters recommended by the International Commission on Radiological Protection (Reference 5) and the Federal Radiation Council (Reference 12), the potential thyroid dose to a child from this source was computed to be

1.21 mrem/yr. It was conservatively assumed that the cows graze on grass the entire year and that a child may drink an average of 1 liter/day of milk.

The effect of delay between the production and consumption of the milk was not included, nor was the effect of possible dilution by other milk supplies. The details of the calculational model employed are presented in Section 11B.6.

11B.3.3.3 **Internal Exposure From Particulates**

One of the gaseous radionuclides has a particulate daughter (Cs-135) that can enter the food chain and be transported to man. The decay chain of interest is as follows:

$$\text{Xe-135} \xrightarrow[\text{hour}]{9.2} \text{Cs-135} \xrightarrow[\text{year}]{2 \times 10^6} \text{Ba-135}$$

The amount of Xe-135 estimated to be released, as shown in Table 11B-2, is relatively small (70 Ci/yr). Assuming that all of this activity decayed immediately to Cs-135, the equivalent Cs-135 release rate is 3.7×10^{-8} Ci/yr. The potential dose contribution from this route of exposure is insignificant.

11B.4 RADIATION EXPOSURE FROM LIQUID EFFLUENTS

This section of the report is directed at an evaluation of the potential radiation exposure occurring as a result of the expected release of radioactive liquid waste from the North Anna Power Station. Liquid radwaste will be discharged via the discharge tunnel to the Waste Heat Treatment Facility and will then enter the main North Anna Reservoir. Thus, the Waste Heat Treatment Facility and the reservoir, which together constitute the cooling water storage system, will both contain radioactive liquid waste from the North Anna station. The anticipated maximum equilibrium concentrations of all significant radionuclides are presented in Table 11B-3 for both the Waste Heat Treatment Facility and the reservoir. The assumptions regarding system leakages, failed fuel cladding, etc., are the same as for gaseous source terms.

11B.4.1 Maximum Individual Radiation Exposure From Liquid Effluents

At this time, it is planned that the North Anna Reservoir will become a center for recreational activities in the region of the site. Activities that will bring the public into close contact with the waters of the reservoir, such as fishing, swimming, and boating, will cause some amount of radiation exposure. In order to evaluate the maximum potential individual radiation exposure due to North Anna Units 1 and 2, a “maximally exposed individual” is hypothesized. This individual does the following:

1. He consumes 1.2 liters of water daily from the Waste Heat Treatment Facility. This water ingestion represents the total direct daily water intake that will adequately sustain an average adult male, as determined by the International Commission on Radiological Protection (Reference 5).
2. He consumes an average of 50 g/day of fish taken from the Waste Heat Treatment Facility.
3. He swims 200 hr/yr, boats 500 hr/yr, and sunbathes 300 hr/yr at the Waste Heat Treatment Facility.

Other less significant exposure pathways are also considered.

11B.4.1.1 **Internal Exposure From Water Ingestion**

It is not presently planned that any individual will use either the North Anna Reservoir or the Waste Heat Treatment Facility as a source of potable water. At this time, there are ample ground-water supplies to serve the needs of the community for the foreseeable future. Putting aside all reasons for not doing so, it is assumed that an individual drinks daily from the cooling water storage system.

The ingestion of radionuclides will generally cause an uneven distribution of radioactivity within the human body. Some elements, hydrogen in particular, become rather evenly distributed. Others, such as iodine or cesium, are preferentially taken up by certain body organs. This phenomenon produces particular body-organ doses, which can be either higher or lower than the associated whole-body dose.

The array of particular body-organ doses due to the hypothesized water ingestion has been calculated using the SWEC computer code IND1109E. The results of this calculation are summarized in Table 11B-4. Calculational methods used in IND1109E are those from Regulatory Guide 1.109, Revision 1, *Calculation of Doses to Man from Routine Releases or Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I*. Section 11B.7 contains a detailed description of the mathematical model employed.

11B.4.1.2 **Internal Exposure From Fish Ingestion**

Aquatic organisms, through biological processes, have the ability to concentrate radionuclides released from the plant. This concentration of activity in aquatic organisms, which may be ingested by man, must be considered in determining the possible dose to man. The ratio of the concentration of a radionuclide in an aquatic organism to that in the ambient water is known as the concentration factor. The concentration factor varies among the different species of aquatic life and, for a given species, varies with the different radionuclides. Also, the activity distribution may vary considerably between different organs of an organism. For the dose calculation in this report, appropriate concentration factors were used for the edible portions of the fish, as shown in Table 11B-5.

In order to determine the dose to humans, the quantity of fish eaten must be estimated. The dose model used postulates that the maximally exposed individual consumes 50g/day of fish flesh. This is about equal to the seafood consumption reported for commercial fisherman (Reference 14) and about four times the annual per capita consumption of seafood in the United States (Reference 15).

The various maximum doses to an individual have been calculated by the SWEC computer code IND1109E and are presented in Table 11B-6. The ingested fish was assumed to have concentrations of all radionuclides in the edible flesh equal to the applicable equilibrium concentrations times the appropriate concentration factors, as presented in Table 11B-5. The calculational model employed is described in Section 11B.7.

11B.4.1.3 **External Exposure From Swimming or Boating**

The external exposure of an individual by submersion in waters containing the radioactive effluents of the North Anna Power Station is only a minor exposure pathway. The radionuclide that will be present in the highest concentration is tritium, which yields only weak beta radiation upon decay. The beta particles emitted from decaying tritium nuclei do not have sufficient energy to penetrate the human skin and, therefore, cannot contribute to an external whole-body dose. All other nuclides are assumed to irradiate the whole body.

The external exposure to swimmers may be conservatively estimated by assuming that the swimmer is completely immersed in an infinite medium of uniform concentration and receives the same dose as the water itself. The expression for the dose rate is given for each radionuclide by the following equation:

$$R_{aipj} = \frac{C_{iw}}{K_p} U_{pa} D_{aipj}$$

where:

R_{aipj} = the radiation dose from nuclide i for either swimming or boating pathway to organ j for age group a (mrem/yr)

C_{iw} = concentration in water of radionuclide i, (pCi/liter)

U_{pa} = the swimming or boating use factor for age group a (hr/yr)

D_{aipj} = the dose conversion factor for age group a (mrem/yr per pCi/liter)

K_p = geometry factor equal to 1 for swimming and 2 for boating.

Table 11B-7 presents the computational results for exposure due to swimming. Also included are estimated exposure rates for boaters. The calculational model above, with slight modifications, was used to compute boating exposure. Since a man in a boat is always at the surface of the water, the geometry factor for gamma radiation was taken to be 2.0; that is, radiation is received from only half the total solid angle.

11B.4.1.4 **External Exposure From Sunbathing**

A potential external exposure pathway exists for persons sunbathing or walking along the shores of the cooling water storage system. The effluent radionuclides in the liquid wastes can be expected to accumulate to some degree in bottom sediments and shoreline sands. The affected beach area would be limited to approximately the area of the beach between the low- and high-water marks.

The concentrations of the radionuclides on the shore will be influenced by the chemical composition of the effluent, the aquatic environment, and the sorptive capacity of the shoreline. The ability of soils to concentrate radioactive materials differs widely from one element to another. Radionuclides are removed from solution primarily by adsorption and ion exchange. Generally, the fine-grained bottom sediments are more effective sorbers of radionuclides than are the coarser-grained shoreline sands.

It was assumed that an individual lying on the shore would receive half the dose that he would receive if he were completely immersed in the sand. The geometry factor is taken to be 0.5 from this source. A calculation similar to the swimming dose calculation with sand as the infinite medium results in a whole-body dose rate of 2.0×10^{-7} rem/hr for sunbathing along the shore of the Waste Heat Treatment Facility. At the North Anna Reservoir, the dose rate is reduced to 1.5×10^{-7} rem/hr. Assuming an exposure period of 300 hr/yr, the annual dose to a sunbather would be 6.1×10^{-5} rem at the Waste Heat Treatment Facility and 4.6×10^{-5} rem at the reservoir.

11B.4.1.5 **Radiation Exposure From Other Sources**

Several exposure pathways have been considered in addition to those discussed above. They are not discussed in great detail because of their relative insignificance. For instance, the possible uptake of radioactivity from the reservoir by land animals, and its subsequent transfer to man, is not as potentially hazardous as the direct ingestion of reservoir water already evaluated. For similar reasons, the potential hazard involved in the ingestion by man of crops irrigated with reservoir water is also ignored.

11B.4.2 Population Radiation Exposure From Liquid Effluents

There are currently no withdrawals of North Anna River waters for public or private water supplies within the immediate region of the site. The Environmental Report prepared to support the licensing of North Anna concluded that there are no known potable water withdrawals along the entire course at the North Anna River downstream to West Point, about 65 miles southeast of the site. Hence, all significant sources of population exposure due to the liquid effluents of North Anna Units 1 and 2 involve the public use of the cooling water storage system. Potential sources of exposure considered significant are the use of the system as a source of potable water and fish and its use as a location for the recreational activities of swimming, boating, and sunbathing.

11B.4.2.1 **Population Exposure From Water Ingestion**

Although it is not currently planned that the North Anna Reservoir will be used as a water source for the surrounding community, there are no physical impediments to such use in the future. Because of this, it is assumed that a community development in the immediate area of the reservoir will use the reservoir as a water source. This development is expected to include a permanent-resident population of up to 4000 in the year 2000.

Summer residents can be accounted for by conservatively assuming that for each vacation residence in the area there are four persons present for one quarter of the year. This is equivalent to one permanent resident per vacation dwelling. The number of vacation homes expected ranges up to 6000 by the year 2000 (Reference 19). This represents a building rate of about 1200 for each 5-year period based on a 1975 to 2000 building program.

The visitors to the North Anna Reservoir must also be considered. It has been estimated that as many as 3.5 million “visits” will occur in the year 2000 (Reference 19). Assuming that during each visit an individual consumes half his required daily drinking water (1.2 liters), this yields the annual volume of water consumption that can be equated to an equivalent number of permanent residents. The water ingestion due to visitors in 2000 is that which would be expected for about 4795 permanent residents.

Considering all potential sources of water ingestion, the maximum population exposure that might occur from this source is estimated to be 3.0 man-rem/yr. in the year 2000. These values should be regarded only as upper limits of the actual exposure, which will in all probability be much lower.

11B.4.2.2 **Population Exposure From Fish Ingestion**

In order to calculate the eventual total annual fish catch from the proposed North Anna Reservoir and Waste Heat Treatment Facility, a figure of 24.9 lb/acre-yr (Reference 20) was applied. This figure, abstracted from a survey undertaken by the National Reservoir Research Program, represents the average harvest of 103 major reservoirs within the continental United States. The average size of the reservoirs from which this number was deduced is 14,650 acres, roughly equal to the area of the North Anna Reservoir. The total catch per year over the reservoir water surface area of 13,000 acres is thus estimated at 324,000 lb. For fish, it is estimated that only about one-third of the gross (landed) weight is edible as food (Reference 21). Therefore, the total edible amount of fish was obtained by multiplying the gross pounds of edible fish by this conversion factor. It was conservatively assumed that 73% of the fish were caught in the reservoir and 27% in the Waste Heat Treatment Facility, based on the relative surface areas.

On this basis, the total annual whole-body population exposure from fish ingestion is estimated at 4.2 man-rem. Since this exposure depends only on how much fish is eaten and not on the population, the population exposure should remain relatively constant in time.

11B.4.2.3 Population Exposure From Swimming, Boating, and Sunbathing

The exposure of the public from recreational activities at the North Anna Reservoir can be computed with the aid of the estimated number of recreational visits per year and a few assumptions. It is necessary to determine the total number of man-hours per year spent at the various activities. Then these values can be multiplied by the dose per hour to obtain the annual population exposure. The following arbitrary assumptions have been used:

1. About 6 hours per visit will be spent at the reservoir.
2. Half of this time will be spent on land-based activities involving no exposure, such as picnicking, hiking, and camping.
3. The remaining time will be divided (on the average) between boating (50%), swimming (20%), and sunbathing (30%).

Using these assumptions and the previously obtained maximum individual dose rates applicable to activities in the reservoir, the annual population exposures for the activities of concern were established. The values are given below:

	Annual Population Exposure (man-rem)
Activity	2000
Swimming	2.00×10^{-3}
Boating	2.40×10^{-3}
Sunbathing	0.48

Of the three sources considered, only the exposure derived from sunbathing is of any importance.

11B.5 DOSE TOTALS AND COMPARISON WITH FEDERAL REGULATIONS AND NATURAL BACKGROUND

The doses calculated to occur as a result of the operation of Units 1 and 2 of the North Anna Power Station may best be brought into perspective by a comparison with exposure levels already present from naturally occurring background radiation.

The Environmental Protection Agency (Reference 2) has conducted a state-by-state survey of natural background radiation levels and has made the results available to the public. The report issued through the Special Studies Group of the Division of Criteria and Standards, Office of Radiation Programs, lists statewide average whole-body radiation doses from three sources: (1) cosmic ray radiation, (2) naturally occurring terrestrial radiation, and (3) internal radiation from naturally occurring radioisotopes incorporated into the human body. For the State of Virginia, the respective annual doses from these three sources are (1) 45 mrem, (2) 55 mrem, and (3) 25 mrem (Reference 2). Thus in Virginia, the average whole-body dose from natural background radiation amounts to 125 mrem/yr, slightly lower than the national average of 130 mrem/yr (Reference 2).

In other states, the annual whole-body background dose is reported to range upward from 100 mrem/yr in Louisiana to 250 mrem/yr in Colorado. The Special Studies Group has also found that medical exposure in the United States averaged 90 mrem/yr in 1970 (Reference 2). The annual average exposure from television sets is reported to be 0.1 mrem (Reference 2). The total whole-body population exposure occurring as a result of increased cosmic radiation during commercial air travel is estimated at 90,000 man-rem in the United States during 1969 (Reference 22).

The evaluation of population doses reported in Table 11B-8 is based on the member of the public dose criteria in the original 10 CFR 20 dated 1960. In the revised rule dated May 21, 1991 the annual dose limit to a member of the public was changed from 500-mrem whole body to 100-mrem Total Effective Dose Equivalent (TEDE). NRC guidance indicates that evaluations performed under the old 10 CFR 20 criteria do not require recalculation. Historical operational data demonstrates doses to members of the public are maintained below the new federal limits.

Whole-body and body-organ doses to the maximally exposed individual for all significant organs from all significant sources are presented and totaled in Table 11B-9. It is extremely improbable that any of these maximum individual exposure rates will ever occur. The probability that a single individual will experience them all simultaneously is negligible. The totals are presented only as certain upper limits of the potential exposure.

11B.6 COMPUTATIONAL METHODS FOR DOSES RESULTING FROM GASEOUS EFFLUENTS

11B.6.1 Whole-Body Noble Gas Immersion Dose

As indicated in the body of the report, the gaseous radioactive effluents consist primarily of the noble gases krypton and xenon. Exposure of a man to an atmosphere contaminated with radioactive isotopes of these elements results only in an external, whole-body dose from submersion in the radioactive cloud. Since these elements are not incorporated into the human body to a significant degree, there are no resulting internal doses.

For releases at ground level, the resulting dose is proportional to the ground-level concentration of radioactivity and can be computed using the International Commission on Radiological Protection (ICRP) recommended semi-infinite sphere model (Reference 5). The following relationship was used to determine the dose rate from this source:

$$D\ (\text{rem/yr}) = 0.259 \times (\chi/Q) \times \sum E_i Q_i$$

where:

χ/Q = applicable annual average atmospheric dispersion parameter, sec/m^3

E_i = average total disintegration energy of the ith radionuclide[1]

Q_i = annual average activity release for the ith radionuclide, Ci/yr

0.259 = constant necessary to yield the dose rate in rem/yr

The normalization constant, 0.259, is given by the following equation:

$$0.259 = \left(\frac{1}{2} \times 1.6 \times 10^{-6} \frac{\text{ergs}}{\text{MeV}}\right)(10^{-2}\text{gr} - \text{rads/erg})(1\text{rem/rad}) \times (1.13)3.7 \times 10^{10} \frac{\text{dis}}{\text{sec}-\text{Ci}} \frac{1}{1293.\text{g/m}^3\text{air}}$$

where:

1/2 = geometry factor accounting for the fact that the receptor is not irradiated from the total available solid angle

1.13 = a factor to account for the increased stopping power of tissue relative to air for β s and secondary electrons produced by x- and γ-radiation (Reference 1)

The above formula for the external whole-body dose rate was used for maximum individual exposure and for population exposure. The estimated population distributions within 50 miles of the station for the years 1970, 1980, 1990, 2000, 2010 and 2020 were used for this purpose. For each of the 160 population segments (16 sectors, 10 annuli) into which the 50-mile population is distributed, an annual average segment dose rate was established. This was taken to be the dose rate at the geometric midpoint of the segment. The annual segment population exposure is thus the product of the segment population and the segment average dose rate. Summing the individual segment population exposures over all 160 segments yields the total population exposure within 50 miles of the station.

The average value of χ/Q for a specific segment was taken to be that for the distance of the midpoint of that segment from the station. For example, the average χ/Q for a sector 10 to 20 miles in a given direction was taken to be that for a distance of 15 miles in the given direction. The numerical values for χ/Q used in this evaluation were obtained from the onsite

1. The value of E_i for each radionuclide of interest was obtained from Meek and Gilbert (Reference 4).

meteorological data collected during the period September 16, 1971, through September 15, 1972. The necessary data reduction was performed with the NUS computer code WINDVANE.

11B.6.2 Thyroid Inhalation Dose

A small amount of radioactive iodine will be released during normal operation. The external whole-body dose resulting from submersion in a cloud of radioactive iodine is negligible; however, iodine taken into the body produces an internal dose as the iodine is preferentially concentrated in the thyroid gland. The thyroid dose was calculated by the following equation:

$$D\ (\text{rem/yr}) = (\chi/Q) \times (BR) \times (DCF) \times (S)$$

where:

χ/Q = applicable annual average atmospheric diffusion factor, sec/m^3

S = total I-131 "dose equivalent" release rate, Ci/yr [1]

BR = breathing rate for the "standard man," 2.31×10^{-4} m^3/sec

DCF = dose conversion factor, 1.48×10^6 rem/Ci I-131 inhaled (Reference 11)

11B.6.3 Child Thyroid Milk Ingestion Dose Model

The critical pathway for iodine ingestion following gaseous releases is the pasture-cow-milk-man pathway, with the thyroid being the critical organ. The most sensitive receptor in the population in terms of a thyroid dose from milk ingestion is a young child 6 months to 1 year of age. The following model (References 23 & 24) was used to compute the child thyroid milk dose from I-131:

$$D\ (\text{rem/yr}) = (\chi/Q)(V_g K_c I_d)(D\alpha/A_T)(S/\lambda_g)$$

where:

χ/Q = applicable annual average atmospheric diffusion factor

V_g = 0.01 m/sec: deposition velocity of iodine onto pasture (Reference 24)

K_c = 0.09: milk/grass activity ratio, (μCi/l)/(μCi/m^2) (Reference 24)

I_d = 1.0 liter/day: child's milk ingestion rate (Reference 25)

$D\alpha/A_T$ = 13.97×10^6 rem/Ci: dose/activity ratio for child's I-131 ingestion[2] (References 12 & 26)

$(\lambda_g)^{-1}$ = 7.19 days: mean lifetime for I-131 on the ground

S = annual average I-131 release rate, Ci/yr

1. For iodine isotopes other than I-131, a "dose equivalent" release rate of I-131 is obtained by the method outlined by DiNunno (Reference 11).
2. In the case of an adult, the value of $D\alpha/A_T$ is 1.530×10^6 rem/Ci of I-131 ingested (References 11 & 12).

11B.7 COMPUTATIONAL METHODS FOR DOSES RESULTING FROM LIQUID EFFLUENTS

11B.7.1 Whole-Body and Body-Organ Exposure From Water Ingestion

The International Commission on Radiological Protection (ICRP) has established the maximum daily average drinking water intake of the standard man at 1.2 liters (Reference 5).

The annual dose from the ingestion of water is calculated using the following equation:

$$R_{apj} = 1100 \frac{U_{ap}M_p}{F} \sum_i Q_i D_{aipj} \exp(-\lambda_i \tau_p)$$

where:

R_{apj} is the annual dose to organ j of an individual of age group a, via pathway p (mrem/year).

U_{ap} is the intake rate (usage) associated with pathway p for age group a (liters/year).

M_p is the mixing ratio (reciprocal of the dilution factor) at the point of exposure.

F is the flow rate of the liquid effluent (ft^3/sec).

Q_i is the release rate of nuclide i (Ci/yr).

D_{aipj} is the dose factor, specific to age group a, radioisotope i, pathway p and organ j (mrem/pCi).

λ_i is the decay constant of nuclide i (hr^{-1}).

τ_p is the elapsed time between release of the nuclides and injestion (hours).

The dose factors used are from Regulatory Guide 1.109, Revision 1, Tables E-11, 12, 13 and 14.

The resultant doses are given in Table 11B-11.

11B.7.2 Whole-Body and Body-Organ Exposure From Fish Ingestion

Aquatic life forms will concentrate various elements within their bodies in proportion to the concentration of the element in the water in which they live. The ratio of the concentration of the element in the organism to the concentration in water is defined as the concentration factor. The concentration factor generally depends on the element being concentrated, the species of organism, and the environment in which it lives. Maximum concentration factors for fresh water fish have been tabulated in Table 11B-5 and are used here to estimate the maximum activity of individual radioisotopes in fish.

For the purpose of estimating the maximum dose an individual might obtain from eating fish, it was assumed that an individual might consume a maximum average of 50g/day of fish.

The annual internal dose resulting from human consumption of aquatic foods is calculated using the following equation.

$$R_{apj} = 1100 \frac{U_{ap}M_p}{F} \sum_i Q_i B_{ip} D_{aipj} \exp(-\lambda_i \tau_p)$$

where all of the variables are as defined in Section 11B.7.1 except:

B_{ip} which is the equilibrium bioaccumulation factor for nuclide i in pathway p (liters/kg).

The resultant doses are given in Table 11B-6.

11B REFERENCES

1. *Standards for Protection Against Radiation* (Part 20) in Code of Federal Regulations, Title 10.
2. U. S. Environmental Protection Agency, Special Studies Group, Office of Radiation Programs, *Estimates of Ionizing Radiation Doses in the United States, 1960-2000*, 2nd printing.
3. H. Blatz, *Radiation Hygiene Handbook*, McGraw-Hill, 1959.
4. M. E. Meek and R. S. Gilbert, *Summary of Gamma and Beta Energy and Intensity Data*, NEDO-12037, Nucleonics Laboratory, General Electric Company, 1970.
5. International Commission on Radiological Protection, *Publication 2: Report of Committee II on Permissible Dose for Internal Radiation*, Pergamon Press, New York, 1959.
6. International Atomic Energy Agency, *Radioactive Waste Disposal into the Sea*, Safety Series No. 5, Vienna, 1961.
7. R. E. Hytten, K. Taylor, and N. Taggart, *Measurement of Total Body Fat in Man by Absorption of Kr-35*, Clinical Science, Vol. 31, 1966.
8. C. A. Tobias, H. B. Jones, J. H. Lawrence, and J. G. Hamilton, *The Uptake and Elimination of Krypton and Other Inert Gases by the Human Body*, Journal of Clinical Investigation, Vol. 28, pp. 1375-1385.
9. N. A. Lassen, *Assessment of Tissue Radiation Dose in Clinical Use of Radioactive Inert Gases, with Examples of Absorbed Doses from $3_{H,}$ 85_{Kr}, and 133_{Xe},* Minerva-Nucleare, Vol. 8, 1964.
10. M. M. Hendrickson, "The Dose from 85_{Kr} Released to the Earth's Atmosphere," in *Environmental Aspects of Nuclear Power Stations*, IAEA Symposium, New York, August 1970.
11. J. J. DiNunno, et al., *Calculation of Distance Factors for Power and Test Reactor Sites*, TID-14844, U. S. Atomic Energy Commission, 1962.
12. Federal Radiation Council, *Background Material for the Development of Radiation Protection Standards*, Report No. 5, July 1964.
13. W. H. Chapman et al., *Concentration Factors of Chemical Elements in, Edible Aquatic Organisms*, UCRL-50564, December 1968.
14. K. W. Cowser and W. S. Snyder, *Safety Analysis of Radionuclide Release to the Clinch River*, ORNL-3721, Supplement 3, 1966.

15. F. Riley, *Fisheries of the United States*, NMFS-5600, National Oceanic and Atmospheric Administration, U. S. Department of Commerce, March 1971.

16. W. H. Laugham and E. A. Pinson, *Physiology and Toxicology of Tritium in Man*, Journal of Applied Physiology, Vol. 10, January-May 1957.

17. A. Preston and D. F. Jefferies, "Aquatic Aspects in Chronic and Acute Contamination Situations," in *Environmental Contamination by Radioactive Materials*, IAEA Symposium, Vienna, 1969.

18. E. Clueckauf, editor, *Atomic Energy Waste*, Interscience Publishers, Inc., New York, 1961.

19. Theodore J. Wirth and Associates; *North Anna Reservoir*, prepared for the Virginia Commission of Outdoor Recreation, 1971.

20. R. M. Jenkins and D. T. Morais, "Reservoir Sport Fishing Effort and Harvest in Relation to Environmental Variables," *Reservoir Fisheries and Limnology*, No. 8, American Fisheries Society, Washington, D. C., 1971.

21. Letter from R. H. Wheeland, Statistics and Marketing News Division, National Marine Fisheries Service, Washington, D. C., dated August 11, 1971.

22. M. I. Goldman, *Statement by Dr. Morton I. Goldman on Behalf of the Consolidated Utility Group in the U. S. Atomic Energy Commission Rulemaking Hearing on Proposed Appendix I*, Germantown, Md., March 17, 1972.

23. A. P. Hull, "Comments on a Derivation of the 'Factor of 700' for I-131," *Health Physics*, Vol. 19, No. 5, November 1970.

24. K. D. George, "I-131 Reconcentration Factor," *Health Physics*, Vol. 19, No. 5, November 1970.

25. J. J. Burnett, "A Derivation of the 'Factor of 700' for I-131," *Health Physics*, Vol. 18, No. 1, January 1970.

26. P. M. Bryant, "Data for Assessments Concerning Controlled and Accidental Releases of I-131 and Cs-137 to Atmosphere," *Health Physics*, Vol. 17, No. 1, July 1969.

27. W. S. Spector, *Handbook of Biological Data*, W. B. Saunders Company, 1961.

Table 11B-1
RADIATION EXPOSURE PATHWAY LOCATIONS

Sector	Milk Cow	Meat Animal	Milk Goat	Nearest Residence	Vegetable Garden	Nearest Site Boundary
N	3.25 km	3.00 km		2.50 km	3.25 km	1.40 km
	2.02 mi	1.86 mi		1.55 mi	2.02 mi	0.87 mi
NNE	6.75 km	5.25 km		2.25 km	4.25 km	1.36 km
	4.19 mi	3.26 mi		1.40 mi	2.64 mi	0.85 mi
NE		2.25 km		2.00 km	2.00 km	1.32 km
		1.40 mi		1.24 mi	1.24 mi	0.82 mi
ENE		4.00 km	4.00 km	3.25 km	3.50 km	1.31 km
		2.49 mi	2.49 mi	2.02 mi	2.18 mi	0.81 mi
E	3.00 km	5.00 km		2.00 km	3.00 km	1.33 km
	1.86 mi	3.11 mi		1.24 mi	1.86 mi	0.83 mi
ESE		7.75 km		2.75 km	3.00 km	1.37 km
		4.82 mi		1.71 mi	1.86 mi	0.85 mi
SE		2.25 km	7.00 km	2.25 km	2.25 km	1.41 km
		1.40 mi	4.35 mi	1.40 mi	1.40 mi	0.88 mi
SSE		2.25 km		3.25 km	3.25 km	1.47 km
		1.40 mi		2.02 mi	2.02 mi	0.91 mi
S		2.50 km		1.75 km	2.50 km	1.52 km
		1.55 mi		1.09 mi	1.55 mi	0.94 mi
SSW	4.80 km	3.25 km		2.25 km	2.25 km	1.62 km
	3.00 mi	2.02 mi		1.40 mi	1.40 mi	1.01 mi
SW		2.50 km		2.25 km	2.25 km	1.70 km
		1.55 mi		1.40 mi	1.40 mi	1.06 mi
WSW	4.75 km	2.75 km		2.25 km	2.75 km	1.75 km
	2.95 mi	1.71 mi		1.40 mi	1.71 mi	1.09 mi
W		6.75 km		2.75 km	4.25 km	1.71 km
		4.19 mi		1.71 mi	2.64 mi	1.06 mi
WNW	5.00 km	6.25 km		1.75 km	5.00 km	1.64 km
	3.11 mi	3.88 mi		1.09 mi	3.11 mi	1.02 mi
NW		4.00 km		1.75 km	3.25 km	1.56 km
		2.49 mi		1.09 mi	2.02 mi	0.97 mi
NNW	3.50 km	3.75 km		3.50 km	3.50 km	1.45 km
	2.18 mi	2.33 mi		2.18 mi	2.18 mi	0.90 mi

Table 11B-2
ESTIMATED GASEOUS EFFLUENTS AND ISOTOPIC DISINTEGRATION ENERGIES

Isotope	Units 1 and 2 Release Rate (Ci/yr)[a]	Average Disintegration Energy (MeV)[b]
Noble gases		
Kr-85m	24	0.257
Kr-85	1900	0.2301
Kr-87	13	1.870
Kr-88	42	2.307
Xe-131m	1.9	0.157
Xe-133m	35	0.215
Xe-133	3400	0.1988
Xe-135m	2.8	0.530
Xe-135	70	0.551
Xe-138	7.5	1.497
Halogens		
I-131	0.086	0.584
I-132	0.012	2.711
I-133	0.083	1.039
I-134	0.002	3.066
I-135	0.024	1.932

a. Reference 5.
b. Reference 6.

Table 11B-3
MAXIMUM EXPECTED RADIOACTIVITY CONCENTRATIONS
IN THE NORTH ANNA WASTE HEAT TREATMENT FACILITY AND RESERVOIR

	Equilibrium Concentration (μCi/cc)	
Isotope	Waste Heat Treatment Facility	Reservoir
H-3	5.3×10^{-6}	4.1×10^{-6}
Cr-51	3.2×10^{-12}	7.4×10^{-13}
Mn-54	2.8×10^{-12}	1.8×10^{-12}
Co-58	5.1×10^{-11}	2.1×10^{-11}
Co-60	2.2×10^{-11}	1.7×10^{-11}
Fe-59	2.9×10^{-12}	9.1×10^{-13}
Sr-89	1.0×10^{-12}	3.5×10^{-13}
Sr-90	9.7×10^{-14}	7.6×10^{-14}
Sr-91	1.4×10^{-14}	6.3×10^{-17}
Y-90	8.7×10^{-14}	7.4×10^{-14}
Y-91	1.9×10^{-13}	7.0×10^{-14}
Y-93	7.6×10^{-16}	3.7×10^{-18}
Nb-95	5.0×10^{-13}	2.1×10^{-13}
Zr-95	4.2×10^{-13}	1.6×10^{-13}
Mo-99	2.3×10^{-11}	7.1×10^{-13}
Tc-99m	2.1×10^{-11}	6.3×10^{-13}
I-131	3.4×10^{-10}	2.9×10^{-11}
I-132	7.2×10^{-12}	2.4×10^{-13}
I-133	5.2×10^{-11}	5.3×10^{-13}
I-134	4.8×10^{-14}	2.0×10^{-17}
I-135	5.8×10^{-12}	1.9×10^{-14}
Te-132	6.6×10^{-12}	2.4×10^{-13}
Cs-134	2.7×10^{-10}	1.9×10^{-10}
Cs-136	1.7×10^{-11}	2.2×10^{-12}
Cs-137	2.7×10^{-10}	2.2×10^{-10}
Ba-140	2.2×10^{-13}	2.8×10^{-14}
La-140	2.3×10^{-13}	2.8×10^{-14}
Ce-144	1.6×10^{-12}	9.9×10^{-13}
Total	5.3×10^{-6}	4.1×10^{-6}
Non-Tritium Total	1.4×10^{-9}	7.0×10^{-10}

Table 11B-4
MAXIMUM INDIVIDUAL INTERNAL BODY-ORGAN EXPOSURE FROM INGESTION OF WATER

	Exposure by Water Source (mrem/yr)	
Body Organ	Waste Heat Treatment Facility	North Anna Reservoir
Whole body	0.27	0.20
Lungs	0.25	0.19
Kidney	0.25	0.20
Bone	0.018	0.013
Thyroid	0.54	0.21
Lower large intestine	0.24	0.19

Table 11B-5
CONCENTRATION FACTOR FOR EFFLUENT RADIONUCLIDES IN FISH[A]

Element	Concentration Factor in Fresh Water Fish
H	0.90
Cr	200
Mn	400
Co	50
Fe	100
Sr	30
Y	25
Nb	30,000
Zr	3.3
Mo	10
I	15
Te	400
Ba	4
La	25
Ce	1
Br	420
Rb	2000
Tc	15
Ru	10
Cs	2000
Pr	25
Np	10

a. Concentration factors used in this report for fresh water are from Table A-1, Regulatory Guide 1.109, Rev. 1, Page 1.109-13.

Table 11B-6
MAXIMUM INDIVIDUAL INTERNAL BODY-ORGAN
EXPOSURE FROM INGESTION OF FISH

	Exposure by Water Source (mrem/yr)	
Body Organ	Waste Heat Treatment Facility	North Anna Reservoir
Whole body	1.9	1.4
Lungs	0.29	0.22
Liver	2.6	1.9
Kidney	0.86	0.64
Bone	1.4	1.1
Thyroid	0.20	0.022
Lower large intestine	0.070	0.046

Table 11B-7
MAXIMUM INDIVIDUAL EXPOSURE FROM SWIMMING AND BOATING

Exposure Category	Swimming Exposure		Boating Exposure	
	Waste Heat Treatment Facility	North Anna Reservoir	Waste Heat Treatment Facility	North Anna Reservoir
Whole-body exposure, rem/hr	6.84×10^{-10}	9.30×10^{-10}	8.54×10^{-10}	1.17×10^{-9}
Maximum hr/yr for this activity	200	200	500	500
Annual whole-body exposure, rem/yr	3.42×10^{-7}	1.86×10^{-7}	4.29×10^{-7}	2.33×10^{-7}
Annual skin exposure, rem/yr	4.38×10^{-7}	2.34×10^{-7}	5.47×10^{-7}	2.93×10^{-7}

Table 11B-8
POPULATION EXPOSURE TOTALS: COMPARISON WITH FEDERAL REGULATIONS AND NATURAL BACKGROUND

Exposure Category	Population Exposure in 50 Miles (man-rem/yr) In 2000
Exposure due to gaseous releases	5.066
Exposure due to liquid releases:	
From water ingestion	3.0
From fish ingestion	4.2
From boating	2.4×10^{-3}
From swimming	2.0×10^{-3}
From sunbathing	0.48
Exposure totals:	
From the operation of North Anna Units 1 & 2	12.7
From natural background (125 mrem/person)	1.705×10^{5}
Maximum allowable under 10 CFR 20 (170 mrem/person)	2.319×10^{5}

Table 11B-9
MAXIMUM INDIVIDUAL WHOLE-BODY AND BODY-ORGAN DOSE TOTALS (mrem/yr)

Exposure Category	Whole Body	Liver	Bone	Thyroid
Exposure due to gaseous releases				
From noble gas immersion	0.616	0.616	0.616	0.616
From radioiodine inhalation	n[a]	n	n	0.0697
From radioiodine ingestion via cow-milk-man pathway[b]	n	n	n	1.21
Exposure due to liquid releases, Waste Heat Treatment Facility				
From the ingestion of water	0.27	0.27	0.018	0.54
From the ingestion of fish	1.9	2.6	1.4	0.20
From boating, 500 hr	0.0004	0.0004	0.0004	0.0004
From swimming, 200 hr	0.0003	0.0003	0.0003	0.0003
From sunbathing, 300 hr	0.061	0.061	0.061	0.61
Dose totals from above sources	2.23	2.93	1.48	0.80
Exposure due to liquid releases, North Anna Reservoir				
From the ingestion of water	0.20	0.21	0.013	0.21
From the ingestion of fish	1.4	1.9	1.1	0.022
From boating, 500 hr	0.0002	0.0002	0.0002	0.0002
From swimming, 200 hr	0.0002	0.0002	0.0002	0.0002
From sunbathing, 300 hr	0.046	0.046	0.046	0.046

a. n = negligible.
b. The thyroid exposure that would be received by a child at the nearest Grade A dairy farm is presented here.

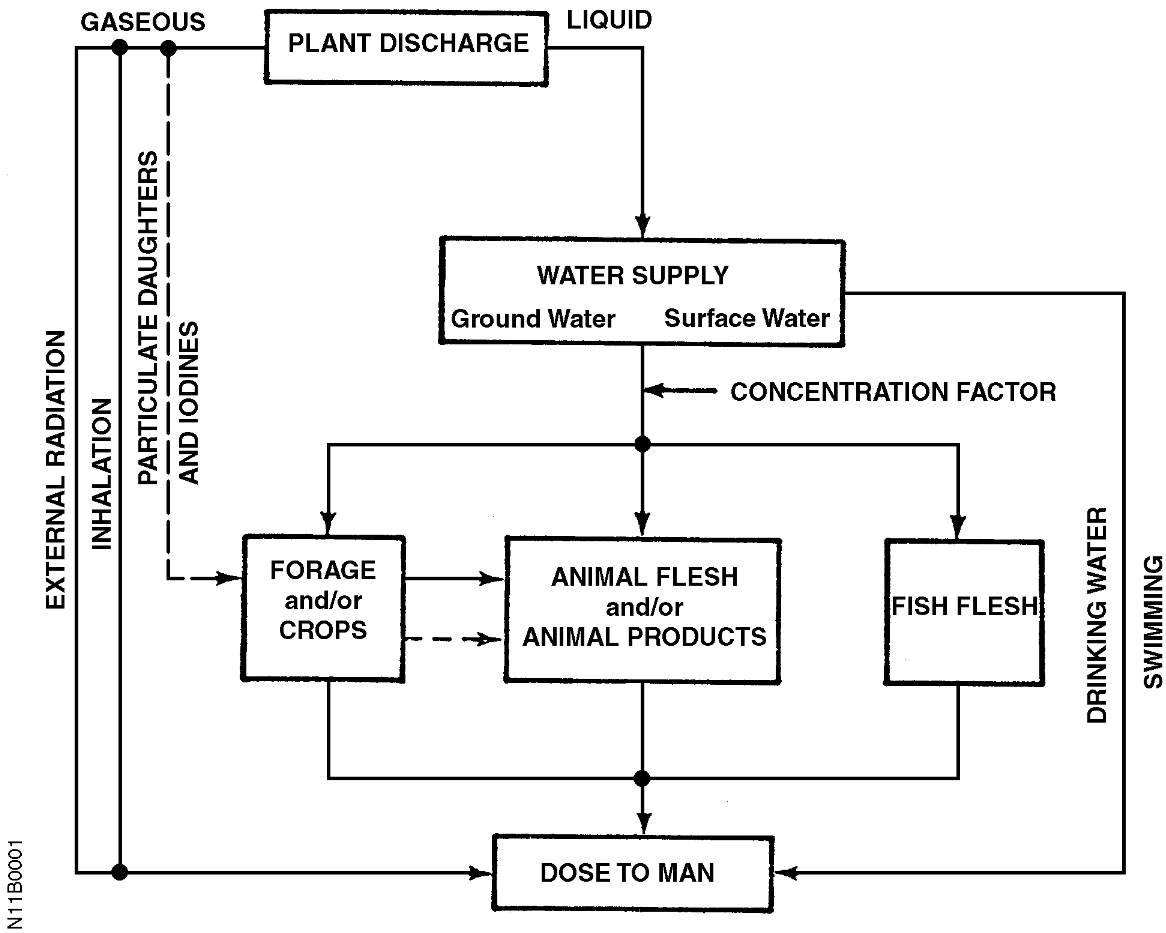
Table 11B-10
ORGANS OF INTEREST FOR EFFLUENT RADIONUCLIDES

Element	Whole Body	Body Water	Lungs	Liver	Spleen	Kidney	Bone	Muscle	Pacreas	Thyroid	Testes	Ovaries	Prostate	Stomach	Small Intestine	Upper Large Intestine	Lower Large Intestine
Tritium	X	X															
Chromium	X		X			X				X			X				X
Manganese	X			X		X			X								X
Cobalt	X			X	X	X			X								X
Iron	X		X	X			X										X
Strontium	X						X									X	X
Yttrium	X						X									X	X
Niobium	X						X										X
Zirconium	X						X										X
Molybdenum	X			X		X											X
Iodine	X			X	X	X	X			X	X			X	X		X
Tellurium	X			X	X	X	X			X	X						X
Cesium	X		X	X	X	X	X	X							X		
Barium	X		X	X	X	X	X	X			X	X					X
Lanthanum	X			X			X										X
Cerium	X			X		X	X										

Table 11B-11
DOSE CONVERSION FACTORS FOR SWIMMING (MREM/HR PER pCi/LITER)

Isotope	Skin	T. Body	Isotope	Skin	T.Body
Cr51	6.4E-08	5.2E-08	Te127	1.7E-07	2.8E-07
Mn54	1.8E-06	1.5E-06	Te129m	7.4E-07	2.1E-07
Fe55	3.6E-10	6.4E-11	Te129	7.0E-07	1.7E-07
Fe59	2.6E-06	2.2E-06	Te131m	2.7E-06	2.2E-06
Co58	2.3E-06	1.8E-06	Te131	1.6E-06	7.4E-07
Co60	5.4E-06	4.6E-06	Te132	4.8E-07	4.0E-07
Br83	3.1E-07	1.7E-08	I130	4.8E-06	3.9E-06
Br84	5.3E-06	3.5E-06	I131	7.3E-07	6.8E-07
Br85	1.1E-06	1.4E-08	I132	5.5E-06	4.4E-06
Rb86	8.5E-07	1.7E-07	I133	1.5E-06	9.6E-07
Rb88	3.6E-06	1.2E-06	I134	5.5E-06	4.2E-06
Sr89	5.4E-07	4.6E-09	I135	4.0E-06	3.3E-06
Sr90	1.5E-07	5.4E-10	Cs134	3.5E-06	2.9E-06
Sr91	2.9E-06	1.9E-06	Cs136	4.8E-06	4.1E-06
Y90	9.6E-07	1.3E-08	Cs137	1.4E-06	1.0E-06
Y91m	1.2E-06	1.0E-06	Ba140	7.6E-07	4.9E-07
Y91	5.7E-07	6.7E-09	La140	5.3E-06	4.1E-06
Y93	1.4E-06	1.9E-07	Ce141	2.4E-07	1.3E-07
Zr95	1.8E-06	1.5E-06	Ce143	1.0E-06	5.7E-07
Nb95	1.6E-06	1.4E-06	Ce144	1.4E-06	8.6E-08
Mo99	9.1E-07	4.7E-07	Pr143	2.8E-07	1.6E-09
TC99m	2.7E-07	2.4E-07	Pr144	1.3E-06	5.6E-08
Ru103	1.1E-06	8.9E-09	Np239	3.7E-07	2.4E-07
Ru106	1.9E-06	3.8E-07	H3	0.0	0.0
TE125m	1.5E-08	3.6E-09			
Te127m	1.8E-09	2.6E-10			

Figure 11B-1
EXPOSURE PATHWAYS



Intentionally Blank

Appendix 11C
Evaluation of Compliance With Proposed 10 CFR 50, Appendix I

Note: The information contained in Appendix 11C is HISTORICAL and was provided as part of the North Anna Operating License application as a one-time evaluation of compliance to the requirements of the “Proposed” 10 CFR 50, Appendix I. It was accurate at the time the plant was originally licensed but was not intended or expected to be updated for the life of the plant. Continued compliance with 10 CFR 50, Appendix I is ensured through the Technical Specifications which require the Offsite Dose Calculation Manual (ODCM) and the Radioactive Effluent Controls Program. The ODCM contains the Radiological Environmental Monitoring Program which includes a Land Use Census. Sections 11.2, 11.3, and Appendix 11B of the UFSAR maintain a current description of the expected liquid and gaseous releases and dose assessments to demonstrate continued compliance with federal regulations including 10 CFR 50 Appendix I.

The original Appendix 11C in the North Anna FSAR included data for the proposed Units 3 and 4. This is consistent with the Environmental Report submitted as part of the North Anna Power Station licensing process. This information is retained as historical information in Appendix 11C even though Units 3 and 4 were never built.

Intentionally Blank

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

APPENDIX 11C
EVALUATION OF COMPLIANCE WITH PROPOSED 10 CFR 50, APPENDIX I

11C.1 SUMMARY AND CONCLUSIONS

The Nuclear Regulatory Commission (NRC) letter of February 19, 1976, provided guidance to evaluate the North Anna Power Station with respect to its ability to meet the requirements of proposed Appendix I to 10 CFR 50. This guidance substituted the requirements of RM 50-2 (issued on February 20, 1974) for those of Section II.D of Appendix I. Section II of RM 50-2 sets forth the following design objectives:

1. For radioactive material above background in liquid effluents released to unrestricted areas:
   a. The calculated annual total quantity of all radioactive material from all light-water-cooled nuclear power reactors at a site should not result in an annual dose or dose commitment to the total body or to any organ of an individual in an unrestricted area from all pathways of exposure in excess of 5 mrem.
   b. Five curies of radioactive material release per reactor.
2. For radioactive material above background in gaseous effluents released to the atmosphere by all light-water-cooled nuclear power reactors at a single site:
   a. The calculated annual dose due to gamma radiation at any location near ground level that could be occupied by individuals at or beyond the boundary of the site should not exceed 10 mrads.
   b. The calculated annual air dose due to beta radiation at any location near ground level that could be occupied by individuals at or beyond the boundary of the site should not exceed 20 mrads.
   c. Notwithstanding the guidance in item 2, for a particular site:
      1) The NRC may specify, as guidance on design objectives, a lower quantity of radioactive material above background in gaseous effluents to be released to the atmosphere if it appears that the use of the design objectives described in item 2 is likely to result in an annual dose to an individual in an unrestricted area in excess of 5 mrem to the total body or 15 mrem to the skin.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

3. For radioactive iodine and radioactive material in particulate form above background released to the atmosphere:

   a. The calculated annual total quantity of all radioactive iodine and radioactive material in particulate form from all light-water-cooled nuclear power reactors at a site should not result in an annual dose or dose commitment to any organ of an individual in an unrestricted area from all pathways of exposure in excess of 15 mrem. In determining the dose or dose commitment, the portion thereof due to intake of radioactive material via the food pathways may be evaluated at the locations where the food pathways actually exist.

   b. The calculated annual total quantity of iodine-131 in gaseous effluents should not exceed 1 Ci for each light-water-cooled nuclear power reactor at a site.

The evaluation shows that potential releases and doses are within these objectives. A comparison of the above design objectives with the numerical results of this analysis is provided in Table 11.C-1. Three sets of results have been obtained for (1) Units 1 and 2 together, (2) Units 3 and 4 together, and (3) Units 1, 2, 3, and 4 together.

Radioactive release estimates for this analysis are provided in Section 11C.5 for Units 1 and 2 (based on the guidance of Regulatory Guide 1.112, except as noted). Release rates for Units 3 and 4 were obtained from the North Anna Final Environmental Statement (FES) of April 1973 (Reference 1).

Meteorological dispersion and deposition analyses were based on models, assumptions, and parameter values as provided in Regulatory Guide 1.111 (March 1976). Liquid pathway doses were based on equilibrium activity concentrations for Lake Anna and the waste heat treatment facility calculated using the model given in Appendix 3.1 of the FES. Hydrologic data describing average flows and evaporation rates were obtained from Table 3.13 of the FES (pp. 3-52).

All dose calculations were performed using models and assumptions consistent with Regulatory Guide 1.109 (March 1976). The NRC LADTAP and GASPAR codes were used for liquid and gaseous dose calculations, respectively. The NUS Corporation FIDOS code was used for determining ground-level gamma doses from elevated noble gas releases.

All results indicate that plant operation will not result in radiation exposure in excess of the design objectives of proposed Appendix I even considering operation of all four units. Compliance with the per-unit dose limits of RM 50-2 as implemented has also been established.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

11C.2 DOSES FROM LIQUID EFFLUENTS

Maximum individual doses from liquid effluents were calculated using the NRC LADTAP computer code, using models given in Regulatory Guide 1.109 (March 1976). Dose factors, bioaccumulation factors, and the shore-width factors as given in Regulatory Guide 1.109 and in the LADTAP code were used, as were use factors for water and fish ingestion and water-related activities.

The source-term data provided in Section 11C.5 were used in conjunction with equations for equilibrium concentrations given in Appendix 3.1 of the North Anna FES to determine the equilibrium concentration estimates provided in Table 11.C-2. The hydrologic data entering into the concentration calculations were obtained from Table 3.13 of the FES. Table 11.C-2 provides estimates for equilibrium conditions of concentrations in the discharge canal (including recirculation effects), in the waste heat treatment facility, and in Lake Anna.

Maximum individual doses were calculated for water and fish ingestion and for external exposure for shoreline use, swimming, and boating. The nearest potential potable water intake was considered to be Lake Anna, although it appears likely that the area ground-water supply will be sufficient for all local requirements for many years (Reference 2). There is also some doubt as to the capability of Lake Anna to support any sizable supply system (Reference 2). All other dose pathways were conservatively evaluated at discharge canal concentrations.

Because the analysis was based on equilibrium concentrations, all dilution factors were input into the LADTAP code as ones; transit times were input as zeros. Whereas source terms are normally input to LADTAP in units of curies per year, the source terms in this analysis were input in microcuries per cubic centimeter, as presented in Table 11.C-2. The input values of the variables for constant source-term multiplier (UML) and discharge flow (cfs) were adjusted so that the code routines that normally convert curies per year per cubic feet per second to picocuries per liter would convert the input concentrations in microcuries per cubic centimeter to picocuries per liter.

Table 11.C-3 lists the pertinent LADTAP dose results.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

11C.3 DOSES FROM GASEOUS EFFLUENTS

Maximum individual doses from gaseous effluents were evaluated using the NRC GASPAR and NUS Corporation FIDOS computer codes, using models given in Regulatory Guide 1.109 (March 1976). The FIDOS code was used to calculate external gamma dose rates at ground level resulting from elevated activity releases. All other dose calculations were performed using the GASPAR code. The source-term data entering into the calculations are provided in Section 11C.4. The meteorological data are provided in Section 11C.4.3 (χ/Q and D/Q values: used in GASPAR) and in Section 11C.4.4 (joint frequency data: used in FIDOS).

Calculations of maximum individual doses from gaseous effluents have been made for the following exposure pathways:

1. External gamma doses at ground level to air and tissue.
2. External beta doses at ground level to air and tissue.
3. External exposure to materials deposited at ground level.
4. Internal exposure via food chain pathways, including vegetation, meat, cow milk, and goat milk.
5. Internal exposure via inhalation.

The GASPAR code was used exclusively for pathways 2, 3, 4, and 5, above. All standard or default GASPAR parameter values were used, including dose conversion factors, food intake rates, stable element transfer coefficients, and time delays.

Both the GASPAR and FIDOS codes were used to calculate external gamma dose rates at ground level. The process vents, located on top of the containment structures, were considered as mixed-mode release points. Process vent releases were thus considered as partially elevated and partially ground level. The GASPAR code was used to compute gamma doses at ground level (based on ground-level air concentrations) for all releases. The external gamma doses at ground level due to the elevated portion of the mixed-mode releases were calculated separately by the FIDOS code and added to the GASPAR results. Thus, for external gamma doses, GASPAR results account for all strictly ground-level releases and the ground-level portion of the mixed-mode releases. The total external gamma dose is therefore the sum of the GASPAR and FIDOS results. Table 11.C-4 lists the gaseous source terms used in the analysis, indicating release rates and release mode.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

The locations of the existence of the various exposure pathways, provided in Section 11C.4, were analyzed to determine the individual location where each pathway would result in the maximum dose. For each specific pathway, the location where the maximum dose occurs, for the combined releases of all four units, is as given below:

Exposure Pathway	Location of Maximum Exposure	
	Distance (m)	Direction
Gamma air dose, elevated portion of mixed-mode releases	1351	NE
Gamma air dose, ground level and ground-level portion of mixed-mode releases	1377	ESE
Beta air dose, all releases	1377	ESE
Plume, all releases	1750	S
Vegetation	2000	NE
Meat	2250	NE
Cow milk	3250	N
Goat milk	4000	ENE
Inhalation	2000	E

The maximum gamma air dose due to the elevated portion of the mixed-mode releases for all four units combined was determined to be 0.304 mrad/yr, occurring at 1351 m northeast. Of this total, the Units 1 and 2 contribution is 0.303 mrad/yr, with Units 3 and 4 contributing the remaining 0.001 mrad/yr.

The maximum gamma air dose due to ground-level releases and the ground-level portion of the mixed-mode releases was determined to be 1.44 mrad/yr for all four units combined, occurring at 1377 m east-southeast. Of this total, 0.88 mrad/yr is from Units 1 and 2 while 0.56 mrad/yr is from Units 3 and 4. At this location, the gamma air dose from the elevated portion of the mixed-mode releases is 0.211 mrad/yr, essentially all from Units 1 and 2. Maximum total gamma air doses are thus 1.09 mrad/yr from Units 1 and 2, 0.56 mrad/yr from Units 3 and 4, and 1.65 mrad/yr from all four units combined.

The maximum beta air dose due to all releases from all four units was determined to be 2.67 mrad/yr (1.65 mrad/yr from Units 1 and 2 and 1.02 mrad/yr from Units 3 and 4), occurring at 1377 m east-southeast.

Maximum doses for each separate pathway of human exposure are provided in Table 11.C-5. A grazing season length of 7 months per year has been assumed (Reference 1).

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

The maximum organ dose to an individual from all exposure pathways existing at any single location has been determined to be the thyroid dose to an infant at the location of the maximum cow milk exposure pathway dose, 3250 m north. The internal exposure pathways of vegetation and meat ingestion have also been assumed to exist at this location. Table 11.C-6 provides a summary of doses at this location.

Maximum total body and skin doses occur at 1750 m south, arising mostly from external exposure to the passing plume and from external exposure to materials deposited on the ground. Table 11.C-7 provides a summary of doses at this location.

11C.4 DATA AND METHODOLOGY

11C.4.1 Plant Characteristics

The plant characteristics needed for the radiological evaluation of North Anna are presented below, as requested in Appendix D of Draft Regulatory Guide 1.BB.

11C.4.1.1 **General**

1. The maximum core thermal power evaluated for safety considerations in the safety analysis report (SAR): 2900 MWt.
2.
    a. The total mass of uranium and plutonium in an equilibrium core: 181,205 lb UO_2, no plutonium.
    b. The percent enrichment of uranium in reload fuel: varies—2.10, 2.60, and 3.10 weight percent.
    c. The percent of fissile plutonium in reload fuel: none.
3. The methods and parameters used in estimating the source terms in the primary coolant are the same as those given in Regulatory Guide 1.BB.
4. The quantity of tritium released in liquid and gaseous effluents:
   0.4×2900 MWt = 1160 Ci/yr/unit.

11C.4.1.2 **Primary System**

1. The total mass of coolant in the primary system, excluding the pressurizer and primary coolant purification system, at full power: 4.34×10^5 lb.
2. The average primary system letdown rate to the primary coolant purification system: 60 gpm.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

3. The average flow rate through the primary coolant purification system cation demineralizers: 6 gpm.
4. The average shim bleed flow: 6.9 gpm.

11C.4.1.3 **Secondary System**

1. Each unit has three U-tube steam generators. Carryover factors of 1% for iodine and 0.1% for non-volatiles were used per draft Regulatory Guide 1.BB, p. B58.
2. The total steam flow in the secondary system: 12.2×10^6 lb/hr.
3. The mass of steam in each steam generator at full power: 4238.6 lb.
4. The mass of liquid in each steam generator at full power: 1.67×10^5 lb.
5. The total mass of coolant in the secondary system at full power excluding the coolant in the condenser hotwell: 1.0685×10^6 lb.
6. The primary-to-secondary system leakage: 100 lb/day per draft Regulatory Guide 1.BB, p. B57.
7. The average steam generator blowdown rate: 30,000 lb/hr.

   Each steam generator is provided with blowdown connections for the control of the solids concentration on the shell (secondary) side of the steam generator.

   Each blowdown line contains three normally open trip valves: two inside the containment and one outside. The steam generator blowdown system is divided into two parallel systems. Either can be isolated from the other or both can be operated simultaneously. The first of these systems is called the low-capacity system, in which the rate of blowdown is manually regulated by hand control valves and the utilities blowdown tank BD-TK-1.

   Blowdown from any or all of the three steam generators passes to and flashes in the blowdown tank. The blowdown tank is equipped with a vent condenser that condenses the vapor discharged from the tank. Condensate from the blowdown tank and vent condenser is drained to the liquid waste disposal system, and noncondensibles are vented to the atmosphere.

   Using the low-capacity system, the three steam generators can blow down 10,900 lb/hr of water to the blowdown tank and subsequently to the liquid waste disposal system.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

The other blowdown system is called the high-capacity blowdown system, in which the rate of blowdown is controlled by flow control valves and the utilities flash tank BD-TK-2. It is used in conjunction with the chemical feed portion of the feedwater system and the condensate polishing system to control the chemical composition and solids concentration of the feedwater supply to the steam generators. The design of this system allows for heat recovery by use of a flash tank that returns steam to the third-point feedwater heaters and condensate to the condenser hotwell.

Normal blowdown will be approximately 30,000 lb/hr with a system design rate of 100,000 lb/hr.

During blowdown, the liquid passes to the flash tank, where the steam is drawn off to the third-point feedwater heaters and the liquid is drained to the condenser hotwell.

A manual bypass is provided around the flash tank for use during tank and control valve maintenance. A pressure control valve on the flash tank vent line is provided to keep a minimum backpressure on the tank to limit the amount of flashing during reduced load operation.

The blowdown from each steam generator is individually monitored for radioactivity. If the radiation monitor detects contamination exceeding a set limit in the blowdown sample, an alarm is initiated in the main control room.

Blowdown is automatically terminated for any of the following abnormal conditions:

a. High-high flash tank level.

b. High liquid level in the third-point feedwater heaters.

c. High flash tank pressure.

d. High condenser pressure.

e. Turbine trip.

f. Containment isolation signal.

8. The fraction of the steam generator feedwater processed through the condensate demineralizers: 0.6593.

   The decontamination factors for the condensate demineralizer system: 10 for iodine, 2 for Cs and Rb, and 10 for others.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

9. Condensate demineralizers:

    a. Average flow rate 8.1+06 lb/hr.

    b. Demineralizer type: powdered resin type.

    c. There are five vessels, each containing 300 to 400 lb of resin.
    Tank capacity: 2200 gallons = 300 ft^3.

    d. Regeneration frequency: 20 days per vessel, normal operation.

    e. Ultrasonic resin cleaning is not used.

    f. Regenerant volume: 15,000 gallons of water per event. There is no activity associated with the liquid, most of which is filtered and returned to the hotwell.

11C.4.1.4 **Liquid Waste Processing System**

1.

    a. Source, flow rates, and expected activities (fraction of primary coolant activity) for all inputs to each system: Table 11.C-8.

    b. Holdup times associated with collection, processing, and discharge of all liquid streams: Table 11.C-8.

    c. Capacities of all tanks and processing equipment considered in calculating holdup times: Table 11.C-8 and Figure 11C-1.

    d. Decontamination factors for each processing step: Table 11.C-8.

    e. Fraction of each processing stream expected to be discharged over the life of the plant: Table 11.C-8.

    f. Demineralizer regeneration: time between regenerations—60 days; regenerant volumes—15,000 gallons of water and 300 lb of resin; regenerant activities—most of the water is filtered and returned to the hotwell with no significant activity. 200 gallons of water slurry is sent to solid waste.

    g. Liquid source term by radionuclide for normal operation including anticipated occupational occurrences: Table 11.C-9.

2. North Anna Figures 9.3.5-1 through 9.3.5-4 and 11.2.2-1 through 11.2.2-5 (*original FSAR*).

11C.4.1.5 **Gaseous Waste Processing System**

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

1. The volumes of gases stripped from the primary coolant: 2×10^4 ft^3/yr.
2. Section 11.3.3 (*original FSAR*), Table 11.3-1 (*original FSAR*), and Figure 11.3.2-1 (*original FSAR*).
3. The gaseous waste disposal system consists primarily of a closed loop of two waste gas compressors, two waste decay tanks, one catalyst recombiner, and connecting piping to collect and filter vapors from tanks containing radioactive liquids. The recombiner system, containing two catalyst beds, reduces the hydrogen content of the gas to be stored, thereby reducing the storage volume as well as the hazard inherent in storing hydrogen. A holdup time of 60 days was used.
4. Decontamination factor for HEPA filter: 100.
5. No charcoal delay system.
6. Figures 11.3.2-1 and 11.3.2-2 (*original FSAR*).

11C.4.1.6 **Ventilation and Exhaust Systems**

1. The steam generator blowdown system vent exhaust is equipped with a vent condenser.

   The discharge from the gaseous waste system, the containment purge system, and the containment vacuum system, is mixed with filter air from the auxiliary building and is drawn through charcoal and HEPA filters.
2. Charcoal filter decontamination factor: 10.
   HEPA filter decontamination factor: 100.
3. Release rates for radioiodine, noble gases, and radioactive particulates, and the bases: Tables 11.C-10 and 11.C-11.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

4.

	Height	Height Adjacent Building	Flow Rate	Velocity (ft/sec)	Size Dia. (in.)	Shape
Process vent	El. 428 ft. 6 in.	407 ft. 6 in.	330 cfm	100	3	Circular
			143,900	55	90	Circular
Ventilation vents	El. 386 ft. 9 in.	376 ft. 2 in.	108,700	41	90	Circular
Turbine building vents	El. 380 ft.	325 ft. 8 in.	10 at 70,000 cfm each, 1 at 8000 cfm	28 3	77 in^2	Square
Temperature: Ambient.						

5. Containment building free volume: 1.84 + 06 ft^3.
   Recirculation rate: 4000 cfm.

   Two 2-inch layers with an air space between, per tray.

   Mixing efficiency: 70%.

   Four cold purges per year of 6 weeks duration.

11C.4.1.7 **Solid Waste Processing Systems**

1. Refer to Section 11.5.4 (*original FSAR*).
2. Refer to Section 11.5.6 (*original FSAR*).
3. Refer to Figure 11.5-3 (*original FSAR*).

11C.4.2 Distances to Radiologically Significant Locations

Table 11.C-12 provides the distances from the centerline of the first nuclear unit to the following for each of the 22.5-degree radial sectors centered on the 16 cardinal compass directions:

1. Nearest milk cow (to a distance of 5 miles).
2. Nearest meat animal (to a distance of 5 miles).
3. Nearest milk goat (to a distance of 5 miles).
4. Nearest residence (to a distance of 5 miles).

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

5. Nearest vegetable garden greater than 500 ft^2 (to a distance of 5 miles).
6. Nearest site boundary.

Elevation data for each specific location are also provided.

11C.4.3 Atmospheric Dilution (χ/Q) and Deposition (D/Q) Parameters

The annual average χ/Q and D/Q values were computed for the North Anna site based on onsite delta $T_{150\ ft\text{-}35\ ft}$, 35-foot and 150-foot wind data. Calculations were made at three release points, two of which were assumed to be at ground level, and one assumed to be a mixed-release mode. The delta T and 150-foot wind data were recorded on the main 150-foot meteorological tower located approximately 1000 feet north-northeast of the nearest containment unit. The 35-foot wind data were recorded on a satellite tower located just north of the main tower. The data period is May 1, 1974, through April 30, 1975. A more detailed description of this facility, including sensor accuracy, is contained in Section 2.3 (*original FSAR*).

The distances used in the calculation of χ/Q and D/Q values are given by exposure direction in Table 11.C-12. The χ/Q and D/Q values for the two ground-level release points are presented in Table 11.C-13. Since the results are identical for both release points, only one set of tables is presented. The χ/Q and D/Q values for the mixed release mode are presented in Table 11.C-14.

The straight-line airflow model outlined in Regulatory Guide 1.111 (March 1976), which assumes a uniform horizontal distribution of the effluent within a 22.5-degree sector width, was used to compute annual average χ/Q values. 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 are considered most appropriate.

The ground-level release mode calculation was based on delta $T_{150\ ft\text{-}35\ ft}$ and 35-foot wind data. The mixed-release mode was determined as a function of the ratio of vent exit velocity and wind speed at the 150-foot level such that χ/Q and D/Q values were determined from two different sets of joint frequency distributions of wind speed, direction, and stability class. The portions of the release characterized as ground-level were based on delta $T_{150\ ft\text{-}35\ ft}$ and 35-foot wind data, and the portions characterized as elevated were based on delta $T_{150\ ft\text{-}35\ ft}$ and 150-foot wind data.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

The ground-level release calculations contain a building wake factor for a containment height of 136.5 feet; no building wake is applied to elevated releases. The effective release height used in the elevated release calculations was based on a vent release height of 157.5 feet and plume rise due to momentum for a vent diameter of 3 inches and plume exit velocity of 100 ft/sec with appropriate adjustments for terrain rise and stack downwash as per Regulatory Guide 1.111 guidance. The process vent release stack is located atop the Unit 1 containment, well removed from higher solid structures. For the mixed release mode, the annual average χ/Q value for each downwind distance is based on the sum of contributions from elevated and ground release levels.

The onsite wind and differential temperature data for the period May 1, 1974, through April 30, 1975, were reviewed for their representativeness as compared to the previously reported onsite data for September 16, 1971, through September 15, 1972 [Section 2.3.2 (*original FSAR*)] and Richmond, Virginia, local climatological data (Reference 1) for the current period.

The onsite differential temperature monthly averages indicated more stable values for the months of February, March, and April. For the remainder of the year, the current onsite monthly differential temperature values indicate more unstable conditions than for the previous period. This is reflected in an increased annual frequency of occurrence of stability classes A and B with a corresponding annual decrease in the frequency of occurrence of stability classes E and D.

A review of the temperature data for Richmond, Virginia, for the two period shows a 0.9°F lower annual average temperature for the period May 1975 through April 1976 than that for the September 1971 to September 1972 period. This is reflected in cooler seasonal averages for winter, spring, and fall for the more recent period. The summer average was higher by 0.8°F than the previous period. The Richmond annual average temperature for the current period was also 1.3°F cooler than the annual climatological norm of 57.8°F.

The annual average wind speed of 6.8 mph for the 35-foot low-threshold wind sensor is 0.4 mph less than the 7.2 mph reported for the period of September 16, 1971, to September 15, 1972. The onsite current period average of 6.8 mph compares favorably with the Richmond, Virginia, annual average of 7.0 mph for the same period. It should be noted that the Richmond annual average was 0.6 mph lower than the climatological normal 7.6 mph, and was 0.5 mph lower than the Richmond annual average for September 1971 to September 1972.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

The annual wind direction distribution from the 35-foot wind sensor for the May 1974 through April 1975 period compared favorably with the onsite distribution for the September 1971 to September 1972 period and the Richmond, Virginia, monthly climatological prevailing wind directions. The current period onsite data show a prevailing southerly wind flow with an almost equivalent northerly flow. The westerly components of these cardinal directions were more prevalent than the easterly components. This same wind flow pattern was seen in the onsite data for September 1971 to September 1972. On an annual basis, the more recent period shows a slight increase of the occurrence of south-southwest and southwest winds over the earlier period. The annual prevailing climatological wind flow at Richmond, Virginia, is southerly.

The annual average wind speed and the annual wind direction distribution of the 150-foot wind sensor agree favorably with the 35-foot sensor. The wind direction distribution showed a slightly stronger north-south orientation than the lower level. The annual wind speed was 7.2 mph.

Based upon the above analysis, the May 1974 through April 1975 onsite wind speed and wind direction data are representative of the onsite conditions. The onsite data reflect the same decrease in average wind speed, when compared to the onsite September 1971 to September 1972 data, as observed in the Richmond data for the same periods. The May 1974 through April 1975 onsite data maintain the same prevailing wind directions found in the earlier onsite data and agree with the prevailing normal flow at Richmond.

The representativeness of the differential temperature data is also representative of the onsite conditions for the period May 1974 through April 1975. The increased occurrence of stability Class A is attributed to potential increased influences of plant construction and land-lake interaction than that experienced in the earlier reporting period. With the installation of the upgraded meteorological system as described in Section 2.3.3.2 (*original FSAR*), it is anticipated that all significant influences of permanent and temporary plant structures and continuing construction activities will be eliminated from the meteorological monitoring system.

11C.4.4 Meteorological Data

The annual and monthly joint frequency distributions of wind speed and wind direction by atmospheric stability class for the period May 1, 1974, through April 30, 1975, are provided in Table 11.C-15. The stability classes were determined from differential temperature between the 35-foot and 150-foot instrument levels of the current meteorological tower. The lower-level wind sensor is the 35-foot low-threshold sensor located on the satellite wind mast. The upper-level wind sensor is the 150-foot sensor located on the current tower.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

The onsite and near-site atmospheric transport and diffusion conditions at the plant are primarily related to synoptic weather systems and local microscale effects. Since the meteorological tower is located between the plant and the lake [see the location of the met tower, Figure 2.3.3.2-1 (*original FSAR*)], the data obtained from the meteorological system are representative, within the limits of the instrumentation accuracies, of the onsite diffusion conditions. The data may include the occurrences of weak lake breezes that may form during weak synoptic wind conditions. Since the lake adjacent to the plant site is narrow (distance to opposite shore varies from approximately 5400 feet toward the north, 2800 feet toward the northeast, to 7200 feet toward the east), and considering its complex configuration and size, it is not expected that the lake breeze that may be experienced at the plant site would extend inland to any great extent. See Section 2.3.2.3 (*original FSAR*) for additional discussion. The predominant westerly flow at the 35-foot level for F and G stabilities during light wind speeds reflects drainage flow from the higher terrain (maximum elevation 400 feet MSL) south through northwest of the plant. This drainage is to be expected and was discussed previously in Section 2.3.2.4 (*original FSAR*).

The wind speed and wind direction data collected from the meteorological tower site are also representative of the near-site area since the area consists mainly of gently rolling terrain that allows synoptic scale weather conditions to predominate over local terrain influences for all conditions except light wind speeds and temperature extremes. Within a 5-mile radius of the plant, the greatest variation of ground elevation above the surface of the lake along the centerline of each 22.5-degree wind sector centered on north, is 190 feet. As discussed in Section 2.3.2.4 (*original FSAR*), this is typical of the area.

The near-site representativeness of the differential temperature data may decrease as the distance between the point of interest and the lake increases. Potential influences from the temporary construction buildings and storage yard to the southeast of the tower may also affect the representativeness of the differential temperature data for the near-site area. This potential influence will not exist at the upgraded meteorological system discussed in Section 2.3.3.2 (*original FSAR*).

The wind speed and wind direction data being reported are expected to be representative of the general long-term conditions at and near the power station. Future plant additions of Units 3 and 4 will not alter the representativeness of the differential temperature data for the area near the plant site. The new structures will alter the microscale flow in the vicinity of the current structures, but these influences should not be significant beyond 1365 feet of each new containment.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

The location of the onsite meteorological tower is discussed in Section 2.3.3.1.1 (*original FSAR*) and shown in Figure 2.3.3.2-1 (*original FSAR*). The accuracy of the instrumentation used is discussed in Section 2.3.3.1.1 (*original FSAR*).

The data were collected on strip-chart recorders at the base of the tower. These strip charts were later digitized into 1-hour averages by manually averaging the signal trace for 1 hour with the time period centered on the hour.

The data being submitted were collected by the original onsite meteorological program. An upgraded, onsite meteorological monitoring system is currently under operation and is discussed in Section 2.3.3.2 (*original FSAR*). The upgraded system meets the recommendations and intent of Regulatory Guide 1.23, dated February 17, 1972.

Table 11.C-15 presents the monthly and annual joint frequency distributions of wind speed and direction by atmosphere stability class (based on delta T measurements) for the ground (35-foot) and elevated (150-foot) levels derived from onsite measurements at North Anna during the period May 1, 1974, to April 30, 1975.

11C.4.5 Topography

With a plant elevation of 271 feet MSL, the maximum variation of terrain elevation from this level, along the radials for which dose calculations were made, is 129 feet, and is found in the west-southwest sector. Of the remaining sectors, six have terrain variations from the 271-foot level of less than or equal to 40 feet, six have variations between 40 feet and 60 feet, and three have variations between 80 feet and 100 feet. The higher terrain variations occur in the north-northeast, west-southwest, west, and west-northwest sectors. As discussed in Section 2.3.2.4 (*original FSAR*), in the Central Piedmont area of Virginia, the terrain varies between 200 to 500 feet MSL. With the exception of the lake, the near-site area does not have topographic features significantly different from the general area.

Of the 16 trajectories, those into the west-southwest and southwest do not pass over water. Of the remaining trajectories, five have over-water segments totaling less than or equal to 0.5 miles, four have over-water segments totaling between 0.5 and 1 mile, three have over-water segments totaling 1 mile to 1.5 miles, and two, those into the east-southeast and southeast sectors, have over-water segments totaling from 2 to 2.5 miles. It should be noted that many of these over-water segment totals consist of several shorter segments that are separated by terrain.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

For the annual period, the prevailing wind flow was southerly with a secondary major flow from the north. The westerly components of both of these directions were more prevalent than the easterly. This pattern is in good agreement with the expected synoptic flow and with the prevailing wind direction pattern reported for the period September 16, 1971, through September 15, 1972.

The Regulatory Guide 1.111 open-terrain correction factor as determined by Figure 2 of the Regulatory Guide was used based upon the gently rolling characteristic of the terrain, the shortness of the majority of the over-water trajectory segments, and the good agreement between the onsite wind flow and the expected synoptic flow (except during low wind speeds).

Three sets of original U. S. Geographic Survey (USGS) maps showing detailed topographic features within a 10-mile radius have been submitted separately. Elevation data pertaining to specific locations where doses are calculated have been included in Table 11.C-12. The maximum elevation, by sector, within 1-mile increments out to 10 miles, is provided in Table 11.C-16.

11C.5 SOURCE-TERM INFORMATION

The Appendix I evaluation presented in Section 11C.1 is based on radioactive release rates for Units 3 and 4 as presented in the North Anna FES (Reference 1). The following discussion pertains to the calculation of new source terms for Units 1 and 2 based on revised calculational models and related guidance as contained in Draft Regulatory Guide 1.BB.

The source terms (primary coolant and secondary-side liquid and steam radioactivities) and the resulting radioactive releases (liquid and gaseous) are calculated using the basic assumptions and approaches contained in Draft Regulatory Guide 1BB.

The PWR-GALE code used by the NRC staff is not used in these analyses. However, the procedures that are used provide essentially the same mathematical treatments. Values of parameters, such as flow rates, are based on the North Anna Units 1 and 2 design as described in the main body of the FSAR. In some instances, standard NRC staff assumptions are used in lieu of the designer's values in order to fit the Draft Regulatory Guide 1.BB analysis for North Anna Units 1 and 2 as closely as possible to the NRC staff's analytical approach. The staff's model is inflexible in some respects and is expected to lead necessarily to slightly different results than those from this analysis.

VEPCO has reported expected liquid and gaseous release values in the main body of the FSAR. The data described herein represent an attempt to analyze the releases using the NRC model and assumptions as closely as VEPCO could configure them.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-17 contains the parameters used in determining source terms; Table 11.C-18 lists the source terms.

In Section 11C.4, Table 11.C-10 contains the parameters used in determining gaseous releases; Table 11.C-11 lists the gaseous releases. As shown in Table 11.C-10, the gaseous releases from the containment are based on four cold purges per year. Also, before purging, the two 4000-cfm recirculation fans are run for a period of 16 hours with a HEPA filter efficiency of 99%, a charcoal adsorber efficiency of 90%, and a mixing efficiency of 70%. The purges are at a rate of 22,000 cfm and are passed through HEPA filters and charcoal adsorbers with efficiencies of 99% and 90%, respectively.

The calculated gaseous releases from the turbine building, the auxiliary building, and the main condenser air ejector are based on the assumption that gaseous releases are unfiltered.

Table 11.C-8 contains the parameters used in determining liquid releases, and Table 11.C-9 lists the liquid releases.

Figure 11C-1 is a diagram of the liquid waste system that augments Table 11.C-8.

11C REFERENCES

1. U. S. Atomic Energy Commission, *Final Environmental Statement Related to the Continuation of Construction and the Operation of Units 1 and 2 and the Construction of Units 3 and 4*, *North Anna Power Station, Virginia Electric and Power Company*, Docket Nos. 50-338, 50-339, 50-404, and 50-405, Directorate of Licensing, 1973.

2. T. J. Wirth and Associates, *A Land Use Plan for North Anna Reservoir, Virginia*, Chevy Chase, Md., 1971.

3. National Oceanic and Atmospheric Administration, *Local Climatological Data*, *1975, Richmond, Virginia*, Environmental Data Service, National Climatic Center, Asheville, N.C., 1975.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-1

COMPARISON OF RESULTS WITH DESIGN OBJECTIVES CONTAINED IN RM 50-2

Applicable Section of RM 50-2	Evaluation	Design Objectives	Analysis Results: Units 1 and 2	Analysis Results: Units 3 and 4	Analysis Results: Units 1-4[a]
A.1	Maximum dose from liquid effluents: any organ (mrem/yr)	5	0.82	3.21	4.05
A.2	Quantity of liquid effluent (Ci/yr less H_3 and gases)	5	0.22	1.0	1.22
B.1	Maximum gamma air dose (mrad/yr)	10	1.09	0.56	1.65
B.2	Maximum beta air dose (mrad/yr)	20	1.65	1.02	2.67
B.3	Maximum doses from gaseous effluents:				
	Total body (mrem/yr)	5	1.93	0.09	2.03
	Skin (mrem/yr)	15	2.58	0.26	2.84
C.1	Maximum dose from iodine and particulates in gaseous effluents: any organ (mrem/yr)	15	7.46	1.28	8.74
C.2	Maximum I-131 gaseous release (Ci/yr/reactor)	1	0.097	0.018	--

a. Slight discrepancies in totals for all four units because of round-off error.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-2

RADIOACTIVITY CONCENTRATIONS DUE TO LIQUID EFFLUENTS (µCi/cc)

	Units 1 and 2 Combined			Units 3 and 4 Combined			Units 1-4 Combined		
Isotope	Discharge	WHTF	Lake Anna	Discharge	WHTF	Lake Anna	Discharge	WHTF	Lake Anna
Cr-51	1.86-13	1.54-13	1.35-13	2.35-14	1.96-14	1.73-14	1.81-13	1.74-13	1.53-13
Mn-54	3.82-13	3.66-13	3.54-13	8.63-14	8.28-14	8.00-14	4.51-13	4.49-13	4.34-13
Fe-55	8.24-13	7.98-13	7.76-13	2.50-13	2.42-13	2.36-13	1.04-12	1.04-12	1.01-12
Fe-59	1.73-13	1.51-13	1.38-13	3.49-14	3.07-14	2.81-14	1.87-13	1.82-13	1.66-13
Co-58	3.50-12	3.18-12	2.97-12	1.33-12	1.21-12	1.13-12	4.46-12	4.39-12	4.11-12
Co-60	3.77-12	3.66-12	3.56-12	1.19-13	1.15-13	1.12-13	3.78-12	3.77-12	3.67-12
Sr-89	5.81-14	5.13-14	4.73-14	4.04-14	3.59-14	3.31-14	8.94-14	8.73-14	8.03-14
Sr-90	4.75-15	4.62-15	4.51-15	5.06-15	4.93-15	4.81-15	9.56-15	9.55-15	9.31-15
Sr-91	8.22-16	1.06-16	1.19-17	5.81-16	7.78-17	8.71-18	7.11-16	1.84-16	2.06-17
Y-90	2.59-16	1.07-16	4.86-17	0.0	0.0	0.0	1.52-16	1.07-16	4.86-17
Y-91m	5.03-16	7.31-18	8.01-20	2.29-16	3.46-18	3.79-20	3.64-16	1.08-17	1.18-19
Y-91	3.16-13	2.83-13	2.62-13	5.07-15	4.57-15	4.24-15	2.93-13	2.87-13	2.66-13
Y-93	3.52-16	4.79-17	5.71-18	4.23-17	5.98-18	7.14-19	1.98-16	5.39-17	6.42-18
Zr-95	1.64-13	1.48-13	1.38-13	7.79-15	7.07-15	6.59-15	1.58-13	1.55-13	1.44-13
Nb-95	1.54-13	1.31-13	1.18-13	5.46-15	4.69-15	4.21-15	1.40-13	1.36-13	1.22-13
Mo-99	3.75-11	1.56-11	7.24-12	4.55-13	1.96-13	9.05-14	2.24-11	1.58-11	7.33-12
Tc-99m	1.96-11	1.75-12	1.30-13	3.67-13	3.41-14	2.53-15	9.88-12	1.79-12	1.33-13
Ru-103	1.61-14	1.39-14	1.26-14	4.19-15	3.64-15	3.30-15	1.81-14	1.76-14	1.59-14
Ru-106	5.76-13	5.53-13	5.35-13	3.78-15	3.64-15	3.52-15	5.59-13	5.57-13	5.39-13
Rh-103m	3.30-15	5.38-17	6.63-19	9.37-16	1.59-17	1.96-19	2.10-15	6.97-17	8.59-19

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-2 (continued)

RADIOACTIVITY CONCENTRATIONS DUE TO LIQUID EFFLUENTS (µCi/cc)

	Units 1 and 2 Combined			Units 3 and 4 Combined			Units 1-4 Combined		
Isotope	Discharge	WHTF	Lake Anna	Discharge	WHTF	Lake Anna	Discharge	WHTF	Lake Anna
Rh-106	4.43-14	6.64-18	7.36-22	2.60-16	4.05-20	4.49-24	2.19-14	6.68-18	7.40-22
Te-125m	2.06-14	1.85-14	1.71-14	4.73-14	4.26-14	3.95-14	6.23-14	6.11-14	5.66-14
Te-127m	5.04-13	4.68-13	4.45-13	5.47-13	5.11-13	4.85-13	9.91-13	9.79-13	9.30-13
Te-127	7.67-14	9.82-15	1.09-15	6.87-14	9.12-15	1.01-15	7.38-14	1.89-14	2.10-15
Te-129m	1.36-12	1.15-12	1.03-12	2.43-12	2.08-12	1.86-12	3.34-12	3.23-12	2.88-12
Te-129	2.05-13	4.15-15	6.37-17	3.90-13	8.20-15	1.26-16	3.00-13	1.23-14	1.89-16
Te-131m	3.46-13	9.65-14	2.74-14	8.50-15	2.45-15	6.96-16	1.89-13	9.89-14	2.81-14
Te-131	5.94-14	4.41-16	2.44-18	1.46-14	1.12-16	6.20-19	3.67-14	5.53-16	3.06-18
Te-132	5.73-17	2.57-12	1.30-12	2.85-12	1.32-12	6.64-13	5.25-12	3.89-12	1.96-12
Ba-137m	1.08-12	8.28-16	4.70-19	4.94-13	3.93-16	2.23-19	7.83-13	1.22-15	6.93-19
Ba-140	1.23-14	8.81-15	6.94-15	1.94-14	1.41-14	1.11-14	2.50-14	2.29-14	1.80-14
La-140	4.39-15	1.44-15	4.97-16	7.66-15	2.59-15	8.98-16	6.76-15	4.03-15	1.39-15
Ce-141	9.40-15	7.93-15	7.08-15	5.42-15	4.61-15	4.11-15	1.30-14	1.25-14	1.12-14
Ce-143	3.98-16	1.17-16	3.55-17	1.72-16	5.24-17	1.59-17	3.09-16	1.69-16	5.14-17
Ce-144	1.12-12	1.07-12	1.03-12	1.04-14	1.00-14	9.67-15	1.08-12	1.08-12	1.04-12
Pr-143	2.68-15	1.94-15	1.55-15	2.39-15	1.75-15	1.40-15	4.01-15	3.69-15	2.94-15
Pr-144	8.65-14	4.45-16	1.70-18	7.81-16	4.17-18	1.60-20	4.29-14	4.49-16	1.72-18
Np-239	3.17-14	1.23-14	5.23-15	4.39-15	1.76-15	7.48-16	2.09-14	1.41-14	5.98-15
Br-83	2.33-14	9.28-16	2.88-17	0.0	0.0	0.0	1.14-14	9.28-16	2.88-17
Br-84	1.68-15	1.56-17	1.09-19	0.0	0.0	0.0	8.23-16	1.56-17	1.09-19
Br-85	1.89-17	1.63-20	1.04-23	0.0	0.0	0.0	9.30-18	1.63-20	1.04-23

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-2 (continued)

RADIOACTIVITY CONCENTRATIONS DUE TO LIQUID EFFLUENTS (µCi/cc)

	Units 1 and 2 Combined			Units 3 and 4 Combined			Units 1-4 Combined		
Isotope	Discharge	WHTF	Lake Anna	Discharge	WHTF	Lake Anna	Discharge	WHTF	Lake Anna
I-130	7.18-14	1.13-14	1.60-15	2.56-13	4.18-14	5.92-15	1.70-13	5.31-14	7.53-15
I-131	5.74-11	3.61-11	2.55-11	7.15-10	4.59-10	3.24-10	5.65-10	4.95-10	3.50-10
I-132	4.54-12	1.73-13	5.12-15	2.50-11	9.89-13	2.92-14	1.50-11	1.16-12	3.44-14
I-133	1.93-11	4.31-12	9.32-15	8.22-11	1.90-11	4.11-12	5.39-11	2.33-11	5.04-12
I-134	5.94-14	9.11-16	1.05-17	0.0	0.0	0.0	2.92-14	9.11-16	1.05-17
I-135	3.32-12	3.21-13	2.59-14	1.15-11	1.16-12	9.35-14	7.58-12	1.48-12	1.19-13
Rb-86	9.70-15	7.50-15	6.29-15	1.82-14	1.43-14	1.20-14	2.31-14	2.18-14	1.83-14
Rb-88	7.56-15	3.99-17	1.56-19	1.87-13	1.02-15	4.02-18	9.93-14	1.06-15	4.17-18
Cs-134	1.95-11	1.89-11	1.84-11	4.25-11	4.12-11	4.00-11	6.03-11	6.01-11	5.84-11
Cs-136	1.13-12	8.12-13	6.42-13	2.08-11	1.52-11	1.20-11	1.74-11	1.60-11	1.26-11
Cs-137	2.32-11	2.26-11	2.21-11	3.58-11	3.49-11	3.41-11	5.76-11	5.76-11	5.61-11
H-3	4.52-06	4.34-06	4.21-06	7.77-06	7.49-06	7.25-06	1.19-05	1.18-05	1.15-05

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-3

MAXIMUM INDIVIDUAL DOSES FROM LIQUID EFFLUENTS

LADTP Dose Results (mrem/yr)

	Adults			Children			Infants		
	Total Body	Liver	Thyroid	Total Body	Liver	Thyroid	Total Body	Liver	Thyroid
I. Units 1 and 2									
Fish ingestion	1.81-1	2.40-1	4.52-2	4.21-2	2.04-1	3.70-2	--	--	--
Water ingestion	4.15-1	4.16-1	4.47-1	4.37-1	4.43-1	5.04-1	6.61-1	6.76-1	8.24-1
Shoreline use	2.12-4	2.12-4	2.12-4	2.47-4	2.47-4	2.47-4	--	--	--
Swimming	2.30-5	2.30-5	2.30-5	2.30-5	2.30-5	2.30-5	--	--	--
Boating	5.99-6	5.99-6	5.99-6	3.34-6	3.34-6	3.34-6	--	--	--
Totals	5.96-1	6.56-1	4.92-1	4.79-1	6.47-1	5.41-1	6.61-1	6.76-1	8.24-1
II. Units 3 and 4									
Fish ingestion	3.59-1	4.70-1	4.28-1	8.50-2	3.88-1	3.85-1	--	--	--
Water ingestion	7.15-1	7.18-1	1.15	7.55-1	7.66-1	1.61	1.14	1.17	3.21
Shoreline use	3.14-4	3.14-4	3.14-4	3.66-4	3.66-4	3.66-4	--	--	--
Swimming	2.03-4	2.03-4	2.03-4	2.03-4	2.03-4	2.03-4	--	--	--
Boating	5.27-5	5.27-5	5.27-5	2.94-5	2.94-5	2.94-5	--	--	--
Totals	1.07	1.19	1.58	8.41-1	1.15	2.00	1.14	1.17	3.21
III. Units 1-4									
Fish ingestion	5.23-1	6.87-1	3.52-1	1.23-1	5.75-1	3.11-1	--	--	--
Water ingestion	1.13	1.14	1.60	1.20	1.21	2.12	1.81	1.85	4.05
Shoreline use	5.10-4	5.10-4	5.10-4	5.95-4	5.95-4	5.95-4	--	--	--
Swimming	9.32-5	9.32-5	9.32-5	9.32-5	9.32-5	9.32-5	--	--	--
Boating	2.42-5	2.42-5	2.42-5	1.35-5	1.35-5	1.35-5	--	--	--
Totals	1.65	1.83	1.95	1.32	1.79	2.43	1.81	1.85	4.05

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-4

GASEOUS SOURCE TERMS BY ISOTOPE AND RELEASE MODE (Ci/yr released)

	Units 1 and 2		Units 3 and 4	
Isotope	Ground Level	Mixed-Mode	Ground Level	Mixed-Mode
Kr-83m	1.52	8.80-1	4.00	0.0
Kr-85m	7.64	1.06+1	2.00+1	0.0
Kr-85	2.33+1	4.00+2	8.00	1.47+3
Kr-87	4.50	1.76	1.20+1	0.0
Kr-88	1.46+1	1.28+1	3.20+1	0.0
Kr-89	3.64-1	6.20-3	2.00	0.0
Xe-131m	1.26+1	2.40+2	1.00+1	8.00
Xe-133m	1.74+1	1.86+2	2.60+1	0.0
Xe-133	1.64+3	2.60+4	1.85+3	1.40+1
Xe-135m	9.80-1	7.80+2	2.00	0.0
Xe-135	2.49+1	7.00+1	5.40+1	0.0
Xe-137	6.80-1	1.34-2	0.0	0.0
Xe-138	3.28	2.40-1	8.00	0.0
I-131	1.95-1	0.0	3.60-2	0.0
I-133	2.50-1	0.0	3.80-2	0.0
Co-58	1.22-1	0.0	0.0	0.0
Co-60	5.48-2	0.0	0.0	0.0
Mn-54	3.65-2	0.0	0.0	0.0
Fe-59	1.22-2	0.0	0.0	0.0
Sr-89	2.64-3	0.0	0.0	0.0
Sr-90	4.07-4	0.0	0.0	0.0
Cs-134	3.65-2	0.0	0.0	0.0
Cs-137	6.09-2	0.0	0.0	0.0
Ar-41	5.00+1	0.0	0.0	0.0
C-14	0.0	1.60+1	0.0	0.0
H-3	1.16+3	0.0	0.0	0.0

a. Some small Units 1 and 2 mixed-mode particulate releases were conservatively assumed to be ground-level releases for simplicity.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-5

MAXIMUM DOSES FOR PATHWAYS OF EXPOSURE TO GASEOUS RELEASES

		Maximum Total-Body Dose (mrem/yr)				Maximum Thyroid Dose (mrem/yr)			
Exposure Pathway	Location of Maximum	Age Group	Units 1 and 2	Units 3 and 4	Units 1-4	Age Group	Units 1 and 2	Units 3 and 4	Units 1-4
Plume	1750 m S	All	4.47-1	9.16-2	5.39-1	All[a]	8.66-1	2.63-1	1.13
Ground plane	1750 m S	All	1.37	2.26-4	1.37	All[a]	1.60	2.75-4	1.60
Vegetation	2000 m NE	Child	6.80-1	5.92-4	6.81-1	Child	1.89	2.57-1	2.14
Meat	2250 m NE	Adult	7.24-2	2.66-5	7.24-2	Child	1.34-1	1.58-2	1.50-1
Cow milk	3250 m N	Infant	2.54-1	2.26-3	2.56-1	Infant	6.97	1.25	8.22
Goat milk	4000 m ENE	Infant	1.77-1	8.58-4	1.78-1	Infant	2.71	4.74-1	3.18
Inhalation	2000 m E	Adult	1.55-1	1.05-4	1.55-1	Infant	7.80-1	1.21-1	9.01-1

a. For the plume and ground-plane exposure pathways, skin doses are shown instead of thyroid doses.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-6

MAXIMUM ORGAN DOSE FROM GASEOUS RELEASES[a]

	Annual Dose (mrem)		
Exposure Pathway	Units 1 and 2	Units 3 and 4	Units 1-4
Plume (noble gases)	1.78-1	3.25-2	2.11-1
Ground plane	2.81-1	4.63-5	2.81-1
Vegetation	0.0	0.0	0.0
Meat	0.0	0.0	0.0
Cow milk	6.97	1.25	8.22
Inhalation	2.09-1	3.25-2	2.42-1
Total non-noble gas	7.46	1.28	8.74
Overall total	7.64	1.31	8.95

a. Receptor location: 3250 m N; receptor, organ: infant, thyroid.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-7

MAXIMUM TOTAL BODY AND SKIN DOSES FROM GASEOUS RELEASES[a]

	Annual Dose (mrem)					
	Units 1 and 2		Units 3 and 4		Units 1-4	
Exposure Pathway	Total Body	Skin	Total Body	Skin	Total Body	Skin
Plume	4.47-1	8.66-1	9.16-2	2.63-1	5.39-1	1.13
Ground plane	1.37	1.60	2.26-4	2.75-4	1.37	1.60
Inhalation	1.17-1	1.12-1	8.16-5	0.0	1.17-1	1.12-1
Totals	1.93	2.58	9.19-2	2.63-1	2.03	2.84

a. Receptor location: 1750 m S; receptor: adult.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-8

LIQUID WASTE PROCESSING SYSTEM

Stream Number	Stream	Feed, gpd	Collection Time, hr	Process Time, hr	Discharge Time, hr	Total Time, hr	Density, 6H/6AL	Type of Activity	Fraction of Activity
1	Steam generator blowdown	7.20+03	0	0	25.7	25.7	3745	Secondary liquid	1.0
2	Sampling sinks	4.52+01						P.C.	1.0
3	Primary coolant leakage	1.78+01						P.C.	1.0
4	Laboratory wastes	5.52+01						P.C.	1.0
5	Spent-resin flush	3.47+01	628	11.1	25.7	664.8	3745	P.C	1.0
6	Laundry drains	5.21+02	0	0	25.7	25.7	3745	See Reg. Guide 1.BB, Table B-18	1.0
7	Boron recovery system (reactor coolant letdown)	1.07+04						P.C	1.0
								-	1.0
8	Boron recovery system (reactor coolant drains)	3.00+02	209	80.0	25.7	314.7	3745	P.C.	1.0
9	Condensate leakage to turbine building sumps	1.95+03	0	0	0	0	3745	Secondary steam	1.0

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11C-8 (continued)
LIQUID WASTE PROCESSING SYSTEM

Stream Number	Stream	Flow Rate to Tank 1, gpd	Capacity of Tank 1, gal	Flow Rate to Last Tank, gpd	Capacity of Last Tank, gal	Fraction Expected To Be Discharged	Number of Batches Per Year	System Dfs, Total
1	Steam-generator blowdown	7.20+03	25,000	NA	NA	1.0	340	10 I, MO, TE, 10^2
2	Sampling sinks							
3	Primary coolant leakage							10^4 2
4	Laboratory wastes							10^5 MO TE, 10^6,
5	Spent-resin flush	1.529+02	5000	8640	25,000	1.0	14	Others
6	Laundry drains blowdown	5.21+02	250,000	NA	NA	1.0	340	10 I, MO, TE, 10^2 Others
7	Boron recovery system (reactor coolant letdown)							10^5 I, 20 Cs, Rb 10^6 MO, TE, 10 Others
8	Boron recovery system (reactor coolant drains)	1.10+04	120,000	2304	25,000	1.0	41.8	10^5 I, 10^6 MO, TE, 10^6, Others
9	Condensate leakage to turbine building sumps	NA	NA	NA	NA	1.0	1.0	1.0 All

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-9

TOTAL LIQUID RELEASES

Isotope	Activity (µCi/g)	Release (Ci)
Cr-51	2.6E-14	9.4E-05
Mn-54	1.4E-14	5.3E-05
Fe-55	2.4E-14	8.9E-05
Fe-59	1.7E-14	6.4E-05
Co-58	2.7E-13	9.7E-04
Co-60	1.0E-13	3.8E-04
Sr-89	5.5E-15	2.0E-05
Sr-90	1.2E-16	4.5E-07
Sr-91	4.2E-16	1.5E-06
Y-90	1.1E-16	3.9E-07
Y-91m	2.5E-16	9.3E-07
Y-91	2.7E-14	9.9E-05
Y-93	1.8E-16	6.4E-07
Zr-95	1.3E-14	4.8E-05
Nb-95	1.8E-14	6.7E-05
Mo-99	1.5E-11	5.6E-02
Tc-99m	9.7E-12	3.6E-02
Ru-103	1.8E-15	6.5E-06
Ru-106	2.1E-14	7.6E-05
Rh-103m	1.7E-15	6.1E-06
Rh-106	2.2E-14	8.2E-05
Te-125m	1.8E-15	6.5E-06
Te-127m	2.9E-14	1.1E-04
Te-127	3.9E-14	1.4E-04
Te-129m	1.7E-13	6.1E-04
Te-129	1.0E-13	3.8E-04
Te-131m	1.6E-13	5.9E-04
Te-131	2.9E-14	1.1E-04
Te-132	2.2E-12	8.2E-03
Ba-137m	5.5E-13	2.0E-03
Ba-140	2.8E-15	1.0E-05

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-9 (continued)

TOTAL LIQUID RELEASES

Isotope	Activity (µCi/g)	Release (Ci)
La-140	2.0E-15	7.2E-06
Ce-141	1.2E-15	4.3E-06
Ce-143	1.8E-16	6.7E-07
Ce-144	4.3E-14	1.6E-04
Pr-143	5.7E-16	2.1E-06
Pr-144	4.2E-14	1.6E-04
Np-239	1.3E-14	4.9E-05
Br-83	1.2E-14	4.3E-05
Br-84	8.5E-16	3.1E-06
Br-85	9.6E-18	3.5E-08
I-130	3.5E-14	1.3E-04
I-131	1.6E-11	5.9E-02
I-132	2.3E-12	8.4E-03
I-133	9.2E-12	3.4E-02
I-134	3.1E-14	1.1E-04
I-135	1.7E-12	6.1E-03
Rb-86	1.7E-15	6.3E-06
Rb-88	3.8E-15	1.4E-05
Cs-134	6.0E-13	2.2E-03
Cs-136	2.5E-13	9.1E-04
Cs-137	6.0E-13	2.2E-03
H-3	3.5E-02	5.8E+02
Grams released		3.7E+15

Notes: Isotope releases of less than 1.E-10 Ci/yr are set to 0.0.
Anticipated operational occurrences: 1.50E-01 Ci added to release.
Blowdown rate: 3.66+15 g/yr.
Total release (excluding tritium) is 2.2E-01 Ci.
Total release (excluding tritium) is 6.0E-11 µCi/g.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-10
GASEOUS RELEASES FOR NORTH ANNA UNITS 1 AND 2

Input Parameters	Value
Plant capacity factor	0.8
Containment building	
Noble gas release to containment building (fraction per day of primary coolant activity)	0.01
Iodine release to containment building (fraction per day of primary coolant activity)	0.00001
Following recirc. program assumes instant cold purge	
Following recirc. exhaust ventilation rate used for hot purge	
Purge exhaust ventilation rate, cfm	2.20E+04
Purge exhaust ventilation time, hr	1.01E+03
Iodine exhaust filter efficiency, %	9.00E+0l
Particulate exhaust filter efficiency	9.90E+0l %
Number of hot purges per year	0.0
Number of cold purges per year	4.00E+00
Continuous ventilation exhaust rate, cfm	0.0
Continuous ventilation exhaust rate set to zero during purge	
Containment volume, ft^3	1.84E+06
Containment internal cleanup system	
Containment internal clean system operates	
Prior to purging cold shutdown	1.60E+0l
Prior to purging hot shutdown	1.60E+0l
Containment internal cleanup system mixing efficiency	0.70
Recirculation rate, cfm	4.00E+3
Iodine filter efficiency, %	9.00E+0l
Particulate filter efficiency, %	9.90E+0l
Auxiliary building	
Iodine exhaust filter efficiency	0.0%
Particulate exhaust filter efficiency	0.0%
Primary coolant leakage rate into building, lb/day	1.60E+02
Iodine partition factor	7.50E-03

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-10 (continued)

GASEOUS RELEASES FOR NORTH ANNA UNITS 1 AND 2

Input Parameters	Value
Turbine building	
No special design to collect valve leakage (2.5 inches or larger)	
Iodine exhaust filter efficiency, %	0.0
Particulate exhaust filter efficiency, %	0.0
Steam leakage, lb/hr	1700
Main condenser air ejector	
Volatile iodine/total iodine in primary system (Volatile iodine is treated as noble gas in steam generator)	0.05
Primary to secondary leak rate, lb/day	100
MC/AE volatile iodine partition factor	0.15
Iodine exhaust filter efficiency, %	0.0
Particulate exhaust filter efficiency, %	0.0
Condenser bypass fraction	0.0
Steam generator blowdown flash tank is vented through the main condenser	
Offgas system	
No process	
Holdup time prior to offgas process, min	8.64E+04
Exhaust filter iodine efficiency, %	90.0
Exhaust filter particulate efficiency, %	99.10
Decay schemes	
Kr-85m to Kr-85 (branching fraction 0.218)	
Xe-133m to Xe-133 (branching fraction 1.000)	

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-11

GASEOUS RELEASES (Ci/yr/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Main Condenser/ Air Ejector	Blowdown Flash Tank	Offgas System	Total
Kr-83m	4.9E-05	4.7E-01	4.1E-05	2.9E-01	0.0	4.4E-01	1.2E+00
Kr-85m	2.0E-02	2.3E+00	2.1E-04	1.5E+00	0.0	5.3E+00	9.1E+00
Kr-85	1.1E+01	4.0E-01	3.5E-05	2.5E-01	0.0	2.0E+02	2.1E+02
Kr-87	6.2E-06	1.4E+00	1.1E-1	8.5E-01	0.0	8.8E-01	3.1E+00
Kr-88	5.4E-03	4.5E+00	3.8E-04	2.8E+00	0.0	6.4E+00	1.4E+01
Kr-89	0.0	1.1E-01	1.0E-05	7.2E-02	0.0	3.1E-03	1.9E-01
Xe-131m	5.0E+00	8.1E-01	7.0E-05	5.0E-01	0.0	1.2E+02	1.3E+02
Xe-133m	3.2E+00	3.4E+00	3.0E-04	2.1E+00	0.0	9.3E+01	1.0E+02
Xe-133	5.0E+02	2.0E+02	1.7E-02	1.2E+02	0.0	1.3E+04	1.3E+04
Xe-135m	0.0	3.0E-01	2.6E-05	1.9E-01	0.0	3.9E+02	3.9E+02
Xe-135	4.5E-01	7.4E+00	6.5E-04	4.6E+00	0.0	3.5E+01	4.8E+01
Xe-137	0.0	2.1E-01	1.8E-05	1.3E-01	0.0	6.7E-03	6.7E-03
Xe-138	0.0	1.0E+00	8.7E-05	6.4E-01	0.0	1.2E-01	1.8E+00
I-131	8.5E-04	5.9E-02	5.9E-04	3.7E-02	0.0	0.0	9.7E-02
I-133	7.4E-05	7.6E-02	7.6E-04	4.8E-02	0.0	0.0	1.2E-01
Co-58	7.5E-04	6.0E-02	0.0	0.0	0.0	2.0E-04	6.1E-02
Co-60	3.4E-04	2.7E-02	0.0	0.0	0.0	7.1E-05	2.7E-02
Mn-54	2.2E-04	1.8E-02	0.0	0.0	0.0	4.8E-05	1.8E-02
Fe-59	7.5E-05	6.0E-03	0.0	0.0	0.0	2.5E-05	6.1E-03
Sr-89	1.7E-05	1.3E-03	0.0	0.0	0.0	5.1E-06	1.3E-03

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-11 (continued)

GASEOUS RELEASES (Ci/yr/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Main Condenser/ Air Ejector	Blowdown Flash Tank	Offgas System	Total
Sr-90	3.0E-06	2.0E-04	0.0	0.0	0.0	6.0E-07	2.0E-04
Cs-134	2.2E-04	1.8E-02	0.0	0.0	0.0	4.6E-05	1.8E-02
Cs-137	3.8E-04	3.0E-02	0.0	0.0	0.0	7.5E-05	3.0E-02
C-14	0.0	0.0	0.0	0.0	0.0	8.0E+00	8.0E+00
Ar-41	2.5E+01	0.0	0.0	0.0	0.0	0.0	2.5E+01
H-3	0.0	0.0	0.0	0.0	0.0	0.0	5.8E+02
	Releases via Ventilation Vent[a]						
Kr-83m	4.9E-05	4.7E-01	0.0	2.9E-01	0.0	0.0	7.6E-01
Kr-85m	2.0E-02	2.3E+00	0.0	1.5E+00	0.0	0.0	3.8E+00
Kr-85	1.1E+01	4.0E-01	0.0	2.5E-01	0.0	0.0	1.1E+01
Kr-87	6.2E-06	1.4E+00	0.0	8.5E-01	0.0	0.0	2.2E+00
Kr-88	5.4E-03	4.5E+00	0.0	2.8E+00	0.0	0.0	7.2E+00
Kr-89	0.0	1.1E-01	0.0	7.2E-02	0.0	0.0	1.9E-01
Xe-131m	5.0E+00	8.1E-01	0.0	5.0E-01	0.0	0.0	6.3E+00
Xe-133m	3.2E+00	3.4E+00	0.0	2.1E+00	0.0	0.0	8.8E+00
Xe-133	5.0E+02	2.0E+02	0.0	1.2E+02	0.0	0.0	8.2E+02
Xe-135m	0.0	3.0E-01	0.0	1.9E-01	0.0	0.0	4.8E-01
Xe-135	4.5E-01	7.4E+00	0.0	4.6E+00	0.0	0.0	1.3E+01

a. H-3 has been added to this release point.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-11 (continued)

GASEOUS RELEASES (Ci/yr/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Main Condenser/ Air Ejector	Blowdown Flash Tank	Offgas System	Total
	Releases via Ventilation Vent[a] (continued)						
Xe-137	0.0	2.1E-01	0.0	1.3E-01	0.0	0.0	3.3E-01
Xe-138	0.0	1.0E+00	0.0	6.4E-01	0.0	0.0	1.7E+00
I-131	8.5E-04	5.9E-02	0.0	3.7E-02	0.0	0.0	9.6E-02
I-133	7.4E-05	7.6E-02	0.0	4.8E-02	0.0	0.0	1.2E-01
Co-58	7.5E-04	6.0E-02	0.0	0.0	0.0	0.0	6.1E-02
Co-60	3.4E-04	2.7E-02	0.0	0.0	0.0	0.0	2.7E-02
Mn-54	2.2E-04	1.8E-02	0.0	0.0	0.0	0.0	1.8E-02
Fe-59	7.5E-05	6.0E-03	0.0	0.0	0.0	0.0	6.1E-03
Sr-89	1.7E-05	1.3E-03	0.0	0.0	0.0	0.0	1.3E-03
Sr-90	3.0E-06	2.0E-04	0.0	0.0	0.0	0.0	2.0E-04
Cs-134	2.2E-04	1.8E-02	0.0	0.0	0.0	0.0	1.8E-02
Cs-137	3.8E-04	3.0E-02	0.0	0.0	0.0	0.0	3.0E-02
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ar-41	2.5E+0l	0.0	0.0	0.0	0.0	0.0	2.5E+0l
H-3	0.0	0.0	0.0	0.0	0.0	0.0	5.8E+02

a. H-3 has been added to this release point.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-11 (continued)

GASEOUS RELEASES (Ci/yr/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Main Condenser/ Air Ejector	Blowdown Flash Tank	Offgas System	Total
Releases via Turbine Building							
Kr-83m	0.0	0.0	4.1E-05	0.0	0.0	0.0	4.1E-05
Kr-85m	0.0	0.0	2.1E-04	0.0	0.0	0.0	2.1E-04
Kr-85	0.0	0.0	3.5E-05	0.0	0.0	0.0	3.5E-05
Kr-87	0.0	0.0	1.1E-04	0.0	0.0	0.0	1.1E-04
Kr-88	0.0	0.0	3.8E-04	0.0	0.0	0.0	3.8E-04
Kr-89	0.0	0.0	1.0E-05	0.0	0.0	0.0	1.0E-05
Xe-131m	0.0	0.0	7.0E-05	0.0	0.0	0.0	7.0E-05
Xe-133m	0.0	0.0	3.0E-04	0.0	0.0	0.0	3.0E-04
Xe-133	0.0	0.0	1.7E-02	0.0	0.0	0.0	1.7E-02
Xe-135m	0.0	0.0	2.6E-05	0.0	0.0	0.0	2.6E-05
Xe-135	0.0	0.0	6.5E-04	0.0	0.0	0.0	6.5E-04
Xe-137	0.0	0.0	1.8E-05	0.0	0.0	0.0	1.8E-05
Xe-138	0.0	0.0	8.7E-05	0.0	0.0	0.0	8.7E-05
I-131	0.0	0.0	5.9E-04	0.0	0.0	0.0	5.9E-04
I-133	0.0	0.0	7.6E-04	0.0	0.0	0.0	7.6E-04
Co-58	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Co-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mn-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fe-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-11 (continued)

GASEOUS RELEASES (Ci/yr/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Main Condenser/ Air Ejector	Blowdown Flash Tank	Offgas System	Total
Releases via Turbine Building (continued)							
Sr-89	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sr-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cs-134	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cs-137	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ar-41	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Releases via Blowdown Flash Tank							
Kr-83m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-85m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-87	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-88	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-89	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-131m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-133m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-133	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-135m	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-11 (continued)

GASEOUS RELEASES (Ci/yr/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Main Condenser/ Air Ejector	Blowdown Flash Tank	Offgas System	Total
Releases via Blowdown Flash Tank (continued)							
Xe-135	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-137	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-138	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-131	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-133	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Co-58	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Co-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mn-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fe-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sr-89	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sr-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cs-134	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cs-137	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ar-41	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-11 (continued)

GASEOUS RELEASES (Ci/yr/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Main Condenser/ Air Ejector	Blowdown Flash Tank	Offgas System	Total
Releases via Process Vent							
Kr-83m	0.0	0.0	0.0	0.0	0.0	4.4E-01	4.4E-01
Kr-85m	0.0	0.0	0.0	0.0	0.0	5.3E+00	5.3E+00
Kr-85	0.0	0.0	0.0	0.0	0.0	2.0E+02	2.0E+02
Kr-87	0.0	0.0	0.0	0.0	0.0	8.8E-01	8.8E-01
Kr-88	0.0	0.0	0.0	0.0	0.0	6.4E+00	6.4E+00
Kr-89	0.0	0.0	0.0	0.0	0.0	3.1E-03	3.1E-03
Xe-131m	0.0	0.0	0.0	0.0	0.0	1.2E+02	1.2E+02
Xe-133m	0.0	0.0	0.0	0.0	0.0	9.3E+01	9.3E+01
Xe-133	0.0	0.0	0.0	0.0	0.0	1.3E+04	1.3E+04
Xe-135m	0.0	0.0	0.0	0.0	0.0	3.9E+02	3.9E+02
Xe-135	0.0	0.0	0.0	0.0	0.0	3.5E+01	3.5E+01
Xe-137	0.0	0.0	0.0	0.0	0.0	6.7E-03	6.7E-03
Xe-138	0.0	0.0	0.0	0.0	0.0	1.2E-01	1.2E-01
I-131	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I-133	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Co-58	0.0	0.0	0.0	0.0	0.0	2.0E-04	2.0E-04
Co-60	0.0	0.0	0.0	0.0	0.0	7.1E-05	7.1E-05
Mn-54	0.0	0.0	0.0	0.0	0.0	4.8E-05	4.8E-05
Fe-59	0.0	0.0	0.0	0.0	0.0	2.5E-05	2.5E-05

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-11 (continued)

GASEOUS RELEASES (Ci/yr/reactor)

Nuclide	Containment Building	Auxiliary Building	Turbine Building	Main Condenser/ Air Ejector	Blowdown Flash Tank	Offgas System	Total
Releases via Process Vent (continued)							
Sr-89	0.0	0.0	0.0	0.0	0.0	5.1E-06	5.1E-06
Sr-90	0.0	0.0	0.0	0.0	0.0	6.0E-07	6.0E-07
Cs-134	0.0	0.0	0.0	0.0	0.0	4.6E-05	4.6E-05
Cs-137	0.0	0.0	0.0	0.0	0.0	7.5E-05	7.5E-05
C-14	0.0	0.0	0.0	0.0	0.0	8.0E+00	8.0E+00
Ar-41	0.0	0.0	0.0	0.0	0.0	0.0	0.00.0
H-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-12

DISTANCES AND ELEVATIONS FOR SPECIAL LOCATIONS[a]

Special Location	Distance	Elevation	Maximum Elevation
Sector N			
Milk cow	3.25	290	300
Meat animal	3.00	300	-
Milk goat	-	-	-
Nearest residence	2.50	285	-
Vegetable garden	3.25	290	300
Nearest site boundary	1.417	250	-
Sector NNE			
Milk cow	6.75	325	355
Meat animal	5.25	345	-
Milk goat	-	-	-
Nearest residence	2.25	270	305
Vegetable garden	4.25	285	340
Nearest site boundary	1.374	250	-
Sector NE			
Milk cow	-	-	-
Meat animal	2.25	305	-
Milk goat	-	-	-
Nearest residence	2.00	285	-
Vegetable garden	2.00	285	-
Nearest site boundary	1.351	250	-
Sector ENE			
Milk cow	-	-	-
Meat animal	4.00	330	-
Milk goat	4.00	330	-
Nearest residence	3.25	295	-
Vegetable garden	3.50	310	-
Nearest site boundary	1.351	250	-

a. See note at end of table.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-12 (continued)
DISTANCES AND ELEVATIONS FOR SPECIAL LOCATIONS[a]

Special Location	Distance	Elevation	Maximum Elevation
Sector E			
Milk cow	3.00	280	-
Meat animal	5.00	260	310
Milk goat	-	-	-
Nearest residence	2.00	250	275
Vegetable garden	3.00	280	-
Nearest site boundary	1.352	250	275
Sector ESE			
Milk cow	-	-	-
Meat animal	7.75	255	300
Milk goat	-	250	-
Nearest residence	2.75	255	285
Vegetable garden	3.00	255	285
Nearest site boundary	1.377	250	285
Sector SE			
Milk cow	-	-	-
Meat animal	2.25	255	295
Milk goat	7.00	250	295
Nearest residence	2.25	255	295
Vegetable garden	2.25	255	295
Nearest site boundary	1.422	250	295
Sector SSE			
Milk cow	-	-	-
Meat animal	2.25	295	-
Milk goat	-	-	-
Nearest residence	3.25	250	300
Vegetable garden	3.25	250	300
Nearest site boundary	1.483	250	295

a. See note at end of table.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-12 (continued)

DISTANCES AND ELEVATIONS FOR SPECIAL LOCATIONS[a]

Special Location	Distance	Elevation	Maximum Elevation
Sector S			
Milk cow	-	-	-
Meat animal	2.50	280	315
Milk goat	-	-	-
Nearest residence	1.75	265	310
Vegetable garden	2.50	280	315
Nearest site boundary	1.554	250	310
Sector SSW			
Milk cow	4.80	250	320
Meat animal	3.25	250	320
Milk goat	-	-	-
Nearest residence	2.25	295	320
Vegetable garden	2.25	295	320
Nearest site boundary	1.658	280	320
Sector SW			
Milk cow	-	-	-
Meat animal	2.50	305	325
Milk goat	-	-	-
Nearest residence	2.25	315	325
Vegetable garden	2.25	315	325
Nearest site boundary	1.730	305	325
Sector WSW			
Milk cow	4.75	365	400
Meat animal	2.75	355	-
Milk goat	-	-	-
Nearest residence	2.75	345	350
Vegetable garden	2.75	355	-
Nearest site boundary	1.781	330	350

a. See note at end of table.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-12 (continued)

DISTANCES AND ELEVATIONS FOR SPECIAL LOCATIONS[a]

Special Location	Distance	Elevation	Maximum Elevation
Sector W			
Milk cow	-	-	-
Meat animal	6.75	300	370
Milk goat	-	-	-
Nearest residence	2.75	350	370
Vegetable garden	4.25	250	370
Nearest site boundary	1.740	260	305
Sector WNW			
Milk cow	5.00	345	365
Meat animal	6.25	375	-
Milk goat	-	-	-
Nearest residence	1.75	330	-
Vegetable garden	5.00	345	365
Nearest site boundary	1.656	310	-
Sector NW			
Milk cow	-	-	-
Meat animal	4.00	250	325
Milk goat	-	-	-
Nearest residence	1.75	285	295
Vegetable garden	3.25	260	325
Nearest site boundary	1.552	265	295
Sector NNW			
Milk cow	3.50	310	325
Meat animal	3.75	290	325
Milk goat	-	-	-
Nearest residence	3.50	310	325
Vegetable garden	3.50	310	325
Nearest site boundary	1.477	250	260

a. See note at end of table.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11C-12 (continued)

DISTANCE AND ELEVATIONS FOR SPECIAL LOCATIONS [a]

Notes:

1. Distances are given in kilometers from the center point of containment 1 to the item indicated.
2. The elevation of the point of interest is given in feet, mean sea level.
3. The elevation of the highest terrain along the cardinal compass radial between the plant and the point of interest is given in feet, mean sea level, if the high point has a greater elevation than the point of interest.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-13

ANNUAL AVERAGE χ/Q (sec/m^3), D/Q (m^{-2}), AND TERRAIN CORRECTION FACTOR (TCF) AT SITE BOUNDARIES AND OFFSITE EXPOSURE LOCATIONS FOR GROUND-LEVEL RELEASES AT NORTH ANNA (May 1, 1974 through April 30, 1975)

Exposure Direction	Parameter	Site Boundary	Nearest Residence	Nearest Garden	Nearest Meat Animal	Nearest Milk Cow	Nearest Milk Goat
N	χ/Q	6.8-06	1.9-06	1.1-06	1.3-06	1.1-06	-
	D/Q	3.3-08	8.0-09	4.1-09	5.0-09	4.1-09	-
	TCF	3.4	2.2	1.8	1.9	1.8	-
NNE	χ/Q	5.4-06	1.7-06	4.4-07	3.0-07	1.8-07	-
	D/Q	3.6-08	9.9-09	2.1-09	1.3-09	7.3-10	-
	TCF	3.5	2.3	1.5	1.4	1.2	-
NE	χ/Q	4.7-06	1.8-06	1.8-06	1.4-06	-	-
	D/Q	3.0-08	1.0-08	1.0-08	7.7-09	-	-
	TCF	3.6	2.5	2.5	2.3	-	-
ENE	χ/Q	4.8-06	6.6-07	5.6-07	4.4-07	-	4.4-07
	D/Q	2.0-08	2.2-09	1.8-09	1.3-09	-	1.3-09
	TCF	3.6	1.8	1.7	1.6	-	1.6
E	χ/Q	1.0-05	4.1-06	1.8-06	6.4-07	1.8-06	-
	D/Q	3.0-08	1.1-08	4.0-09	1.2-09	4.0-09	-
	TCF	3.6	2.5	1.9	1.4	1.9	-
ESE	χ/Q	1.2-05	2.7-06	2.3-06	4.1-07	-	-
	D/Q	3.1-08	5.3-09	4.3-09	5.0-10	-	-
	TCF	3.5	2.0	1.9	1.2	-	-

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-13 (continued)

ANNUAL AVERAGE χ/Q (sec/m^3), D/Q (m^{-2}), AND TERRAIN CORRECTION FACTOR (TCF) AT SITE BOUNDARIES AND OFFSITE EXPOSURE LOCATIONS FOR GROUND-LEVEL RELEASES AT NORTH ANNA (May 1, 1974 through April 30, 1975)

Exposure Direction	Parameter	Site Boundary	Nearest Residence	Nearest Garden	Nearest Meat Animal	Nearest Milk Cow	Nearest Milk Goat
SE	χ/Q	6.6-06	2.3-06	2.3-06	2.3-06	-	2.6-07
	D/Q	2.8-08	8.5-09	8.5-09	8.5-09	-	5.9-10
	TCF	3.4	2.3	2.3	2.3	-	1.2
SSE	χ/Q	2.7-06	4.9-07	4.9-07	1.0-06	-	-
	D/Q	2.0-08	2.7-09	2.7-09	6.6-09	-	-
	TCF	3.3	1.8	1.8	2.3	-	-
S	χ/Q	4.3-06	3.1-06	1.5-06	1.5-06	-	-
	D/Q	2.9-08	2.0-08	8.5-09	8.5-09	-	-
	TCF	3.3	2.8	2.2	2.2	-	-
SSW	χ/Q	1.6-06	7.4-07	7.4-07	3.3-07	1.6-07	-
	D/Q	1.3-08	5.7-09	5.7-09	2.4-09	9.7-10	-
	TCF	3.1	2.3	2.3	1.8	1.5	-
SW	χ/Q	1.1-06	6.1-07	6.1-07	5.0-07	-	-
	D/Q	8.7-09	4.3-09	4.3-09	3.5-09	-	-
	TCF	2.9	2.3	2.3	2.2	-	-
WSW	χ/Q	9.2-07	5.5-07	3.6-07	3.6-07	1.2-07	-
	D/Q	6.0-09	3.4-09	2.1-09	2.1-09	5.9-10	-
	TCF	2.7	2.3	2.0	2.0	1.5	-

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-13 (continued)

ANNUAL AVERAGE χ/Q (sec/m^3), D/Q (m^{-2}), AND TERRAIN CORRECTION FACTOR (TCF) AT SITE BOUNDARIES AND OFFSITE EXPOSURE LOCATIONS FOR GROUND-LEVEL RELEASES AT NORTH ANNA (May 1, 1974 through April 30, 1975)

Exposure Direction	Parameter	Site Boundary	Nearest Residence	Nearest Garden	Nearest Meat Animal	Nearest Milk Cow	Nearest Milk Goat
W	χ/Q	1.7-06	6.2-07	2.5-07	1.0-07	-	-
	D/Q	8.9-09	2.9-09	9.8-10	3.4-10	-	-
	TCF	2.8	2.0	1.5	1.2	-	-
WNW	χ/Q	2.0-06	1.7-06	1.9-07	1.3-07	1.9-07	-
	D/Q	9.8-09	8.0-09	6.3-10	3.9-10	6.3-10	-
	TCF	3.1	2.8	1.4	1.3	1.4	-
NW	χ/Q	4.0-06	2.8-06	7.4-07	4.9-07	-	-
	D/Q	1.7-08	1.1-08	2.5-09	1.5-09	-	-
	TCF	3.3	2.8	1.8	1.6	-	-
NNW	χ/Q	4.9-06	7.2-07	7.2-07	6.5-07	7.2-07	-
	D/Q	2.1-08	2.4-09	2.1-09	2.1-09	2.4-09	-
	TCF	3.3	1.7	1.7	1.7	1.7	-

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-14

ANNUAL AVERAGE χ/Q (sec/m^3), D/Q (m^{-2}), AND TERRAIN CORRECTION FACTOR (TCF) AT SITE BOUNDARIES AND OFFSITE EXPOSURE LOCATIONS FOR MIXED RELEASE MODES AT NORTH ANNA (May 1, 1974 through April 30, 1975)

Exposure Direction	Parameter	Site Boundary	Nearest Residence	Nearest Garden	Nearest Meat Animal	Nearest Milk Cow	Nearest Milk Goat
N	χ/Q	9.5-07	4.4-07	3.0-07	3.4-07	3.0-07	-
	D/Q	1.2-08	3.2-09	1.7-09	2.0-09	1.7-09	-
	TCF	3.4	2.2	1.8	1.9	1.8	-
NNE	χ/Q	1.1-06	5.7-07	2.1-07	1.6-07	9.9-08	-
	D/Q	1.8-08	5.2-09	1.1-09	7.4-10	4.3-10	-
	TCF	3.5	2.3	1.5	1.4	1.2	-
NE	χ/Q	1.1-06	6.4-07	6.4-07	5.6-07	-	-
	D/Q	1.5-08	5.6-09	5.6-09	4.3-09	-	-
	TCF	3.6	2.5	2.5	2.3	-	-
ENE	χ/Q	6.0-07	1.9-07	1.7-07	1.5-07	-	1.5-07
	D/Q	6.4-09	7.7-10	6.4-10	4.8-10	-	4.8-10
	TCF	3.6	1.8	1.7	1.6	-	1.6
E	χ/Q	6.2-07	3.7-07	2.1-07	1.0-07	2.1-07	-
	D/Q	7.4-09	2.8-09	1.1-09	3.2-10	1.1-09	-
	TCF	3.6	2.5	1.9	1.4	1.9	-
ESE	χ/Q	7.1-07	2.8-08	2.5-07	6.8-08	-	-
	D/Q	6.4-09	1.2-09	1.0-09	1.4-10	-	-
	TCF	3.5	2.0	1.9	1.2	-	-

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-14 (continued)

ANNUAL AVERAGE χ/Q (sec/m^3), D/Q (m^{-2}), AND TERRAIN CORRECTION FACTOR (TCF) AT SITE BOUNDARIES AND OFFSITE EXPOSURE LOCATIONS FOR MIXED RELEASE MODES AT NORTH ANNA (May 1, 1974 through April 30, 1975)

Exposure Direction	Parameter	Site Boundary	Nearest Residence	Nearest Garden	Nearest Meat Animal	Nearest Milk Cow	Nearest Milk Goat
SE	χ/Q	9.5-07	4.9-07	4.9-07	4.9-07	-	8.8-08
	D/Q	1.2-08	3.8-09	3.8-09	3.8-09	-	3.0-10
	TCF	3.4	2.3	2.3	2.3	-	1.2
SSE	χ/Q	8.1-07	2.5-07	2.5-07	4.3-07	-	-
	D/Q	1.0-08	1.5-09	1.5-09	3.7-09	-	-
	TCF	3.3	1.8	1.8	2.3	-	-
S	χ/Q	1.0-06	8.0-07	4.8-07	4.8-07	-	-
	D/Q	1.7-08	1.2-08	5.0-09	5.0-09	-	-
	TCF	3.3	2.8	2.2	2.2	-	-
SSW	χ/Q	7.0-07	4.0-07	4.0-07	2.2-07	1.2-07	-
	D/Q	8.2-09	3.7-09	3.7-09	1.5-09	6.3-10	-
	TCF	3.1	2.3	2.3	1.8	1.5	-
SW	χ/Q	5.7-07	3.7-07	3.7-07	3.2-07	-	-
	D/Q	5.2-09	2.6-09	2.6-09	2.1-09	-	-
	TCF	2.9	2.3	2.3	2.2	-	-
WSW	χ/Q	4.0-07	2.7-07	2.0-07	2.0-07	9.3-08	-
	D/Q	3.8-09	2.1-09	1.3-09	1.3-09	3.7-10	-
	TCF	2.7	2.3	2.0	2.0	1.5	-

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-14 (continued)

ANNUAL AVERAGE χ/Q (sec/m^3), D/Q (m^{-2}), AND TERRAIN CORRECTION FACTOR (TCF) AT SITE BOUNDARIES AND OFFSITE EXPOSURE LOCATIONS FOR MIXED RELEASE MODES AT NORTH ANNA (May 1, 1974 through April 30, 1975)

Exposure Direction	Parameter	Site Boundary	Nearest Residence	Nearest Garden	Nearest Meat Animal	Nearest Milk Cow	Nearest Milk Goat
W	χ/Q	4.5-07	2.9-07	1.3-07	6.0-08	-	-
	D/Q	3.5-09	1.2-09	4.1-10	1.5-10	-	-
	TCF	2.8	2.0	1.5	1.2	-	-
WNW	χ/Q	4.1-07	3.8-07	7.7-08	5.6-08	7.7-08	-
	D/Q	4.6-09	3.8-09	3.1-10	2.0-10	3.1-10	-
	TCF	3.1	2.8	1.4	1.3	1.4	-
NW	χ/Q	6.7-07	5.3-07	2.3-07	1.7-07	-	-
	D/Q	6.4-09	4.5-09	1.0-09	6.3-10	-	-
	TCF	3.3	2.8	1.8	1.6	-	-
NNW	χ/Q	5.9-07	1.9-07	1.9-07	1.8-07	1.9-07	-
	D/Q	5.8-09	7.1-10	7.1-10	6.3-10	7.1-10	-
	TCF	3.3	1.7	1.7	1.7	1.7	-

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	26	66	120	64	6	0	282
NNE	23	60	50	9	0	0	142
NE	20	57	34	1	0	0	112
ENE	25	40	22	4	0	0	91
E	38	71	8	2	1	0	120
ESE	12	45	29	0	0	0	86
SE	15	44	34	1	0	0	94
SSE	12	52	43	2	0	0	109
S	8	92	88	11	0		199
SSW	10	59	114	20	0	0	203
SW	3	59	65	9	1	0	137
WSW	13	29	28	12	0	0	82
W	19	27	20	11	4	1	82
WNW	15	27	21	9	1	1	74
NW	20	62	39	10	1	3	135
NNW	24	42	54	38	1	0	159
Variable	0	0	0	0	0	0	0
Totals	283	832	769	203	15	5	2107

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	7	18	9	0	0	34
NNE	1	6	5	1	0	0	13
NE	0	5	7	0	0	0	12
ENE	1	3	3	0	0	0	7
E	2	3	2	0	0	0	7
ESE	2	2	3	0	0	0	7
SE	0	9	4	1	0	0	14
SSE	1	8	2	1	0	0	12
S	3	8	8	0	0	0	19
SSW	3	6	4	0	0	0	13
SW	5	4	5	2	0	0	16
WSW	2	3	1	3	1	0	10
W	2	2	4	2	0	3	13
WNW	2	3	1	2	0	0	8
NW	1	3	4	1	0	3	12
NNW	1	5	11	1	0	0	18
Variable	0	0	0	0	0	0	0
Totals	26	77	82	23	1	6	215

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

Periods of Calms 1 Hours

VEPCO North Anna JFD 35-Foot Level—Period of Record: 1/ 5/74 - 30/ 4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	4	15	17	8	0	0	44
NNE	1	12	15	0	0	0	28
NE	3	5	4	1	0	0	13
ENE	0	6	6	3	0	0	15
E	0	11	1	0	0	0	12
ESE	2	9	4	0	0	0	15
SE	3	8	6	1	0	0	18
SSE	3	10	1	1	0	0	15
S	1	11	5	1	0	0	18
SSW	1	18	7	0	1	0	27
SW	3	8	9	0	0	0	20
WSW	1	4	2	2	4	0	13
W	2	4	6	2	2	1	17
WNW	2	4	3	6	2	6	23
NW	2	5	4	4	1	3	19
NNW	2	6	20	3	0	0	31
Variable	0	0	0	0	0	0	0
Totals	30	136	110	32	10	10	328

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	23	77	104	30	5	0	239
NNE	20	60	48	11	0	0	139
NE	21	58	21	11	1	0	112
ENE	22	28	11	1	0	1	63
E	24	53	13	0	1	3	94
ESE	10	45	17	1	0	0	73
SE	21	81	17	1	0	0	120
SSE	30	76	21	3	0	0	130
S	44	97	48	9	0	0	198
SSW	27	107	77	25	2	0	238
SW	35	64	46	11	7	0	163
WSW	32	30	32	8	5	0	107
W	27	34	19	14	7	13	114
WNW	18	37	25	31	11	6	128
NW	21	78	52	42	15	6	214
NNW	11	53	68	23	3	2	160
Variable	0	0	3	0	0	0	0
Totals	386	978	619	221	57	31	2292

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

Periods of Calms 3 Hours

VEPCO North Anna JFD 35-Foot—Level Period of Record: 1/ 5/74 - 30/ 4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	27	51	24	8	0	0	110
NNE	13	39	22	3	0	0	77
NE	6	34	9	2	0	0	51
ENE	10	29	13	0	0	0	52
E	25	34	7	2	0	0	68
ESE	14	45	13	3	4	0	79
SE	50	67	15	1	1	0	154
SSE	64	75	11	5	0	0	155
S	57	81	40	6	0	0	184
SSW	44	84	39	16	3	0	186
SW	38	66	62	8	0	0	174
WSW	38	48	20	3	2	0	111
W	81	34	16	7	1	1	140
WNW	66	38	16	18	8	4	150
NW	35	42	19	11	3	2	112
NNW	16	23	20	6	0	0	65
Variable	0	0	0	0	0	0	0
Totals	584	790	346	99	22	7	1848

Periods of Calms 15 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	12	1	3	1	0	0	17
NNE	4	1	0	0	0	0	5
NE	5	1	0	0	0	0	6
ENE	4	5	1	0	0	0	10
E	8	7	3	0	0	0	18
ESE	13	10	1	0	0	0	24
SE	21	10	1	0	0	0	32
SSE	30	29	1	0	0	0	60
S	38	26	3	0	0	0	67
SSW	16	12	2	0	0	0	30
SW	18	12	3	0	0	0	33
WSW	28	13	2	0	0	0	43
W	75	58	5	1	1	0	140
WNW	68	37	2	0	0	0	107
NW	28	24	3	0	0	0	55
NNW	11	6	2	0	0	0	19
Variable	0	0	0	0	0	0	0
Totals	379	252	32	2	1	0	666

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

Periods of Calms 15 Hours

VEPCO North Anna JFD 35-Foot Level—Period of Record: 1/5/74 - 30/4/75

Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	36	1	0	0	0	0	37
NNE	5	2	0	0	0	0	7
NE	5	1	0	0	0	0	6
ENE	4	1	0	0	0	0	5
E	11	3	0	0	0	0	14
ESE	15	5	0	0	0	0	20
SE	16	5	0	0	0	0	21
SSE	9	5	1	0	0	0	15
S	20	10	1	0	0	0	31
SSW	13	2	0	0	0	0	15
SW	4	5	0	0	0	0	9
WSW	11	3	0	0	0	0	14
W	36	17	2	0	0	0	55
WNW	95	23	2	0	0	0	120
NW	47	11	0	1	0	0	59
NNW	17	1	1	0	0	0	19
Variable	0	0	0	0	0	0	0
Totals	344	95	7	1	0	0	447

Periods of Calms 25 Hours

Hours of Missing Data: 798

Total Observations for the Period are: 7962

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JAN 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	2	0	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	1	0	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	1	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	4	0	0	0	0	5

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	1	0	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	1	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	0	1	0	0	0	2

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JAN 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	1	0	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	1	0	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	2	0	0	0	0	0	2

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	0	7	7	3	0	19
NNE	1	5	1	0	0	0	7
NE	0	4	5	1	0	0	10
ENE	4	1	1	0	0	0	6
E	2	1	0	0	0	0	3
ESE	0	5	0	0	0	0	5
SE	1	6	0	0	0	0	7
SSE	0	4	5	0	0	0	9
S	0	6	3	2	0	0	11
SSW	1	3	2	2	0	0	8
SW	0	4	1	1	0	0	6
WSW	2	2	1	0	0	0	5
W	0	2	1	0	0	0	3
WNW	0	4	1	0	0	0	5
NW	0	5	4	1	0	0	10
NNW	0	10	7	4	1	0	22
Variable	0	0	0	0	0	0	0
Totals	13	62	39	18	4	0	136

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JAN 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	6	7	5	0	0	19
NNE	0	3	3	0	0	0	6
NE	0	7	4	0	0	0	11
ENE	2	3	4	0	0	0	9
E	3	5	1	0	0	0	9
ESE	3	6	3	0	0	0	12
SE	2	19	4	1	0	0	26
SSE	1	13	4	0	0	0	18
S	2	16	14	1	0	0	33
SSW	0	9	7	0	0	0	16
SW	2	11	15	0	0	0	28
WSW	1	6	1	0	0	0	8
W	4	0	0	1	0	0	5
WNW	5	3	0	3	2	0	13
NW	3	4	1	1	3	0	12
NNW	1	3	5	3	0	0	12
Variable	0	0	0	0	0	0	0
Totals	30	114	73	15	5	0	237

Periods of Calms 2 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	0	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	2	0	0	0	0	2
E	2	0	0	0	0	0	2
ESE	1	1	0	0	0	0	2
SE	4	2	0	0	0	0	6
SSE	1	5	0	0	0	0	6
S	3	8	1	0	0	0	12
SSW	2	0	2	0	0	0	4
SW	2	2	0	0	0	0	4
WSW	2	0	0	0	0	0	2
W	7	6	2	0	0	0	15
WNW	4	5	0	0	0	0	9
NW	2	1	0	0	0	0	3
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	32	32	5	0	0	0	69

Periods of Calms 2 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JAN 1/5/74 - 30/4/75

Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	1	1	0	0	0	0	2
ESE	2	2	0	0	0	0	4
SE	1	1	0	0	0	0	2
SSE	1	2	0	0	0	0	3
S	2	1	1	0	0	0	4
SSW	2	0	0	0	0	0	2
SW	0	1	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	2	0	0	0	0	0	2
WNW	8	4	0	0	0	0	12
NW	2	1	0	0	0	0	3
NNW	1	0	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	22	15	1	0	0	0	38

Periods of Calms 6 Hours

Hours of Missing Data: 245

Total Observations for Jan: 499

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: FEB 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	1	0	0	0	0	1
NE	0	1	0	0	0	0	1
ENE	0	0	1	0	0	0	1
E	0	2	1	0	0	0	3
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	1	0	0	0	1
S	0	1	3	0	0	0	4
SSW	0	0	1	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	1	0	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	6	7	0	0	0	14

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	1	0	0	0	1
NNE	1	0	0	0	0	0	1
NE	0	0	1	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	2	0	0	0	2
S	0	0	2	0	0	0	2
SSW	0	0	1	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	1	0	1
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	1	7	0	1	0	10

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: FEB 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	1	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	0	1	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	2	2	0	0	0	4
SSW	0	1	2	0	1	0	4
SW	0	0	1	0	0	0	1
WSW	0	0	1	0	3	0	4
W	0	0	0	0	0	0	0
WNW	0	1	1	0	0	0	2
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	0	5	9	0	4	0	18

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	4	13	5	1	0	24
NNE	5	11	11	2	0	0	29
NE	3	3	1	0	0	0	7
ENE	2	0	0	0	0	0	2
E	5	1	0	0	0	0	6
ESE	1	4	0	0	0	0	5
SE	1	0	1	0	0	0	2
SSE	0	1	0	0	0	0	1
S	0	4	4	0	0	0	8
SSW	1	9	4	6	1	0	21
SW	1	7	2	0	3	0	13
WSW	0	2	4	2	2	0	10
W	1	1	3	1	0	0	6
WNW	0	1	1	1	0	0	3
NW	1	3	4	1	0	0	9
NNW	0	1	2	3	0	0	6
Variable	0	0	0	0	0	0	0
Totals	22	52	50	21	7	0	152

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: FEB 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	9	19	5	1	0	0	34
NNE	4	19	8	0	0	0	31
NE	2	10	0	0	0	0	12
ENE	1	6	1	0	0	0	8
E	4	7	0	0	0	0	11
ESE	1	1	0	0	0	0	2
SE	9	6	2	0	0	0	17
SSE	5	7	0	3	0	0	15
S	10	14	7	1	0	0	32
SSW	4	13	2	10	0	0	29
SW	2	19	14	1	0	0	39
WSW	2	4	3	2	1	0	12
W	9	2	4	0	1	0	15
WNW	8	12	0	0	0	0	20
NW	7	4	7	3	0	0	21
NNW	5	5	3	0	0	0	13
Variable	0	0	0	0	0	0	0
Totals	82	148	56	24	2	0	312

Periods of Calms 10 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	1	0	0	0	2
NNE	1	0	0	0	0	0	1
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	1	0	0	0	0	0	1
SE	2	2	0	0	0	0	4
SSE	2	7	1	0	0	0	10
S	7	4	0	0	0	0	11
SSW	3	2	0	0	0	0	5
SW	1	1	1	0	0	0	3
WSW	3	2	1	0	0	0	6
W	5	4	1	0	0	0	10
WNW	6	2	0	0	0	0	8
NW	2	4	0	0	0	0	6
NNW	2	0	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	37	28	5	0	0	0	70

Periods of Calms 10 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: FEB 1/5/74 - 30/4/75
Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	0	0	0	0	0	3
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	4	0	0	0	0	0	4
ESE	3	0	0	0	0	0	3
SE	4	0	0	0	0	0	4
SSE	1	0	1	0	0	0	2
S	1	3	0	0	0	0	4
SSW	4	0	0	0	0	0	4
SW	1	1	0	0	0	0	2
WSW	1	0	0	0	0	0	1
W	4	0	0	0	0	0	4
WNW	12	1	0	0	0	0	13
NW	2	1	0	0	0	0	3
NNW	3	0	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	43	6	1	0	0	0	50

Periods of Calms 14 Hours

Hours of Missing Data: 10

Total Observations for FEB: 662

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: MAR 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	2	0	0	0	0	3
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	2	0	0	0	0	2
E	0	1	1	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	0	0	1
SSE	0	2	0	0	0	0	2
S	0	0	2	0	0	0	2
SSW	0	1	2	0	0	0	3
SW	0	0	0	5	1	0	6
WSW	0	0	1	1	0	0	2
W	2	0	0	2	0	0	4
WNW	0	1	0	0	0	0	1
NW	0	3	2	0	0	0	5
NNW	0	2	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	3	15	8	8	1	0	35

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	2	0	0	2
WSW	0	0	0	0	0	0	0
W	0	0	0	1	0	0	1
WNW	0	0	0	2	0	0	2
NW	0	0	0	0	0	0	0
NNW	0	1	1	1	0	0	3
Variable	0	0	0	0	0	0	0
Totals	0	3	1	6	0	0	10

Periods of Claims 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: MAR 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	2	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	1	0	0	0	0	1
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	3	1	0	0	4
SSW	0	0	0	0	0	0	0
SW	0	0	2	0	0	0	2
WSW	0	0	1	0	1	0	2
W	0	0	0	1	0	0	1
WNW	0	0	1	5	0	0	6
NW	0	0	0	0	0	0	0
NNW	0	0	1	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	0	2	10	7	1	0	20

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	5	15	3	0	0	25
NNE	0	7	7	4	0	0	18
NE	1	10	3	3	0	0	17
ENE	1	7	0	0	0	0	8
E	2	10	0	0	0	0	12
ESE	1	1	1	0	0	0	3
SE	3	2	4	0	0	0	9
SSE	1	7	10	1	0	0	19
S	1	4	8	3	0	0	16
SSW	0	5	12	5	0	0	22
SW	0	5	10	3	0	0	18
WSW	1	1	1	0	1	0	4
W	1	3	4	4	1	1	14
WNW	3	0	6	13	6	1	29
NW	0	3	3	10	1	0	17
NNW	0	0	6	10	1	0	17
Variable	0	0	0	0	0	0	0
Totals	17	70	90	59	10	2	248

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: MAR 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	5	6	1	0	0	14
NNE	1	7	3	2	0	0	13
NE	0	2	0	1	0	0	3
ENE	0	7	6	0	0	0	13
E	3	7	3	2	0	0	15
ESE	1	16	7	2	3	0	29
SE	2	10	5	0	0	0	17
SSE	5	6	1	0	0	0	12
S	3	11	7	0	0	0	21
SSW	2	3	7	0	0	0	12
SW	2	5	12	0	0	0	19
WSW	1	6	4	0	0	0	11
W	1	4	2	3	0	1	11
WNW	1	1	5	10	5	3	25
NW	1	3	1	1	0	2	8
NNW	1	1	2	1	0	0	5
Variable	0	0	0	0	0	0	0
Totals	26	94	71	23	8	6	228

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	1	0	0	1
NNE	1	0	0	0	0	0	1
NE	1	0	0	0	0	0	1
ENE	1	1	1	0	0	0	3
E	1	4	3	0	0	0	8
ESE	0	6	1	0	0	0	7
SE	0	2	1	0	0	0	3
SSE	2	4	0	0	0	0	6
S	1	1	0	0	0	0	2
SSW	0	0	0	0	0	0	0
SW	0	2	0	0	0	0	2
WSW	0	3	0	0	0	0	3
W	4	2	0	1	1	0	8
WNW	2	2	1	0	0	0	5
NW	5	0	0	0	0	0	5
NNW	1	1	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	19	28	7	2	1	0	57

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: MAR 1/5/74 - 30/4/75

Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	1	2	0	0	0	0	3
NE	0	0	0	0	0	0	0
ENE	1	0	0	0	0	0	1
E	3	0	0	0	0	0	3
ESE	2	1	0	0	0	0	3
SE	3	1	0	0	0	0	4
SSE	0	0	0	0	0	0	0
S	3	0	0	0	0	0	3
SSW	1	1	0	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	2	1	0	0	0	0	3
W	2	4	0	0	0	0	6
WNW	9	1	0	0	0	0	10
NW	3	0	0	0	0	0	3
NNW	2	0	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	32	11	0	0	0	0	43

Periods of Calms 0 Hours

Hours of Missing Data: 103

Total Observations for Mar: 641

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: APR 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	1	2	0	0	0	4
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	2	0	0	0	0	2
E	0	4	0	0	0	0	4
ESE	0	1	2	0	0	0	3
SE	1	2	3	0	0	0	6
SSE	0	0	1	0	0	0	1
S	0	0	2	0	0	0	2
SSW	0	0	3	4	0	0	7
SW	0	0	0	1	0	0	1
WSW	0	0	2	1	0	0	3
W	0	1	1	0	3	1	6
WNW	0	3	2	0	1	1	7
NW	0	1	8	2	0	3	14
NNW	1	2	2	1	0	0	6
Variable	0	0	0	0	0	0	0
Totals	3	17	28	9	4	5	66

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	1	1	0	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	0	1	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	0	1	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	1	0	0	3	4
WNW	0	0	0	0	0	0	0
NW	0	0	2	1	0	3	6
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	2	5	1	0	6	15

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: APR 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	2	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	4	0	0	0	0	4
ESE	0	2	0	0	0	0	2
SE	0	1	0	0	0	0	1
SSE	0	1	0	1	0	0	2
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	1	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	3	0	2	1	6
WNW	0	1	1	1	2	6	11
NW	0	0	0	3	1	3	7
NNW	0	0	3	1	0	0	4
Variable	0	0	0	0	0	0	0
Totals	0	10	8	8	5	10	41

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	9	9	4	1	0	24
NNE	0	4	5	0	0	0	9
NE	0	14	3	0	0	0	17
ENE	2	5	6	0	0	0	13
E	0	11	5	0	0	0	16
ESE	1	9	2	0	0	0	12
SE	2	12	0	0	0	0	14
SSE	2	7	2	1	0	0	12
S	1	9	5	2	0	0	17
SSW	2	4	9	11	1	0	27
SW	0	2	7	7	4	0	20
WSW	1	0	1	1	1	0	4
W	1	1	0	1	4	12	19
WNW	1	4	2	9	5	5	26
NW	1	10	19	23	13	6	72
NNW	2	6	13	2	1	2	26
Variable	0	0	0	0	0	0	0
Totals	17	107	88	61	30	25	328

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: APR 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	7	2	0	0	0	12
NNE	1	3	0	0	0	0	4
NE	1	6	0	0	0	0	7
ENE	0	3	2	0	0	0	5
E	3	8	3	0	0	0	14
ESE	1	12	2	0	0	0	15
SE	3	8	1	0	0	0	12
SSE	4	2	0	2	0	0	8
S	0	1	4	4	0	0	9
SSW	0	1	4	6	3	0	14
SW	1	1	3	1	0	0	6
WSW	2	0	2	0	1	0	5
W	2	1	1	0	0	0	4
WNW	2	1	2	2	1	1	9
NW	0	4	4	3	0	0	11
NNW	0	2	5	1	0	0	11
Variable	0	0	0	0	0	0	0
Totals	26	60	35	19	5	1	146

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	0	0	0	0	0	2
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	4	1	0	0	0	0	5
SE	1	1	0	0	0	0	2
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	1	0	0	0	0	1
SW	1	0	0	0	0	0	1
WSW	2	1	1	0	0	0	4
W	2	5	0	0	0	0	7
WNW	6	4	0	0	0	0	10
NW	4	4	2	0	0	0	10
NNW	4	2	0	0	0	0	6
Variable	0	0	0	0	0	0	0
Totals	28	20	3	0	0	0	51

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: APR 1/5/74 - 30/4/75

Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	2	0	0	0	0	0	2
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	1	1	0	0	0	0	2
SE	0	1	0	0	0	0	1
SSE	1	1	0	0	0	0	2
S	0	1	0	0	0	0	1
SSW	2	0	0	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	2	0	0	0	0	0	2
W	3	3	1	0	0	0	7
WNW	10	6	0	0	0	0	16
NW	12	4	0	0	0	0	16
NNW	4	0	1	0	0	0	5
Variable	0	0	0	0	0	0	0
Totals	39	17	2	0	0	0	58

Periods of Calms 1 Hours

Hours of Missing Data: 13

Total Observations for APR: 707

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: MAY 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	19	12	6	0	0	38
NNE	2	7	4	1	0	0	14
NE	1	9	6	0	0	0	16
ENE	5	5	7	2	0	0	19
E	7	12	3	0	0	0	22
ESE	2	8	11	0	0	0	21
SE	2	7	13	1	0	0	23
SSE	1	9	16	2	0	0	28
S	3	17	13	8	0	0	41
SSW	2	4	13	5	0	0	24
SW	0	18	13	0	0	0	31
WSW	2	3	4	1	0	0	10
W	1	4	5	2	1	0	13
WNW	1	3	7	2	0	0	13
NW	2	6	8	2	0	0	18
NNW	1	9	9	5	1	0	25
Variable	0	0	0	0	0	0	0
Totals	33	140	144	37	2	0	356

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	4	3	0	0	7
NNE	0	1	0	0	0	0	1
NE	0	2	3	0	0	0	5
ENE	0	1	1	0	0	0	2
E	0	0	1	0	0	0	1
ESE	0	0	2	0	0	0	2
SE	0	4	4	1	0	0	9
SSE	0	3	0	1	0	0	4
S	0	1	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	1	1	1	0	0	0	3
WSW	1	0	0	0	0	0	1
W	1	0	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	1	1	0	0	0	2
NNW	0	0	2	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	3	14	19	5	0	0	41

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: MAY 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	5	0	0	0	0	5
NNE	0	3	0	0	0	0	3
NE	2	0	0	0	0	0	2
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	2	4	0	0	0	6
SSE	1	3	0	0	0	0	4
S	0	0	0	0	0	0	0
SSW	1	0	2	0	0	0	3
SW	0	0	1	0	0	0	1
WSW	0	1	0	0	0	0	1
W	1	0	2	0	0	0	3
WNW	1	1	0	0	0	0	2
NW	0	1	1	0	0	0	2
NNW	0	1	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	6	17	10	0	0	0	33

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	5	8	3	0	0	0	16
NNE	6	6	5	0	0	0	17
NE	0	2	0	0	0	0	2
ENE	2	0	0	0	0	0	2
E	0	5	2	0	0	0	7
ESE	1	1	1	0	0	0	3
SE	0	11	3	0	0	0	14
SSE	5	5	0	0	0	0	10
S	5	7	7	1	0	0	20
SSW	3	7	15	0	0	0	25
SW	3	3	1	0	0	0	7
WSW	6	2	3	0	0	0	11
W	1	5	0	0	0	0	6
WNW	0	2	4	1	0	0	7
NW	6	8	1	1	0	0	16
NNW	2	6	1	0	0	0	9
Variable	0	0	0	0	0	0	0
Totals	45	78	46	3	0	0	172

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: MAY 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	3	1	0	0	0	5
NNE	1	0	0	0	0	0	1
NE	0	0	1	0	0	0	1
ENE	1	0	0	0	0	0	1
E	2	0	0	0	0	0	2
ESE	0	2	0	0	0	0	2
SE	4	0	0	0	0	0	4
SSE	3	8	0	0	0	0	11
S	3	6	1	0	0	0	10
SSW	0	3	1	0	0	0	4
SW	2	3	0	0	0	0	5
WSW	3	2	0	0	0	0	5
W	6	2	0	0	0	0	8
WNW	5	4	3	0	0	0	12
NW	3	2	1	1	0	0	7
NNW	2	2	1	0	0	0	5
Variable	0	0	0	0	0	0	0
Totals	36	37	9	1	0	0	83

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	1	1	0	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	2	0	0	0	0	0	2
SSE	2	0	0	0	0	0	2
S	1	2	1	0	0	0	4
SSW	2	1	0	0	0	0	3
SW	1	1	0	0	0	0	2
WSW	2	2	0	0	0	0	4
W	2	2	1	0	0	0	5
WNW	3	3	1	0	0	0	7
NW	1	3	1	0	0	0	5
NNW	2	1	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	20	16	4	0	0	0	40

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: MAY 1/5/74 - 30/4/75
Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	1	0	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	1	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	1	0	0	0	0	0	1
W	0	1	1	0	0	0	2
WNW	3	1	2	0	0	0	6
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	6	3	3	0	0	0	12

Periods of Calms 0 Hours

Hours of Missing Data: 7

Total Observations for MAY: 737

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JUN 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	6	17	37	8	1	0	69
NNE	2	16	10	0	0	0	28
NE	4	8	7	0	0	0	19
ENE	4	2	5	1	0	0	12
E	3	14	1	1	1	0	20
ESE	1	10	5	0	0	0	16
SE	5	11	11	0	0	0	27
SSE	1	12	6	0	0	0	19
S	4	9	17	0	0	0	30
SSW	3	6	20	0	0	0	29
SW	0	9	14	1	0	0	24
WSW	1	5	2	2	0	0	10
W	1	6	1	1	0	0	9
WNW	1	5	3	1	0	0	10
NW	0	13	0	0	0	0	13
NNW	1	5	9	1	0	0	16
Variable	0	0	0	0	0	0	0
Totals	37	148	148	16	2	0	351

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	4	2	3	0	0	9
NNE	0	1	1	0	0	0	2
NE	0	1	0	0	0	0	1
ENE	0	0	1	0	0	0	1
E	1	0	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	2	0	0	0	0	2
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	1	0	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	3	1	0	0	0	4
W	0	0	0	0	0	0	0
WNW	0	1	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	2	1	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	2	15	6	3	0	0	26

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JUN 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	4	3	1	0	0	8
NNE	0	1	3	0	0	0	4
NE	0	0	1	0	0	0	1
ENE	0	3	0	0	0	0	3
E	0	3	0	0	0	0	3
ESE	0	2	0	0	0	0	2
SE	1	1	0	0	0	0	2
SSE	0	1	0	0	0	0	1
S	0	3	0	0	0	0	3
SSW	0	2	0	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	1	0	1	0	0	2
WNW	0	0	0	0	0	0	0
NW	0	1	2	0	0	0	3
NNW	1	1	9	0	0	0	11
Variable	0	0	0	0	0	0	0
Totals	2	23	18	2	0	0	45

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	5	11	1	0	0	20
NNE	1	0	1	1	0	0	3
NE	4	3	0	0	0	0	7
ENE	2	3	1	0	0	0	7
E	2	4	3	0	0	0	10
ESE	0	5	1	0	0	0	6
SE	1	24	0	0	0	0	25
SSE	3	13	1	0	0	0	17
S	5	8	6	0	0	0	19
SSW	3	12	4	0	0	0	19
SW	5	4	0	0	0	0	9
WSW	4	1	0	0	0	0	5
W	7	4	1	0	0	0	12
WNW	3	2	0	1	0	0	6
NW	2	4	1	0	0	0	7
NNW	1	2	6	1	0	0	10
Variable	0	0	0	0	0	0	0
Totals	48	94	36	4	0	0	182

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JUN 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	0	2	1	0	0	0	3
SE	3	3	0	0	0	0	6
SSE	3	9	0	0	0	0	12
S	6	3	0	0	0	0	9
SSW	5	4	0	0	0	0	9
SW	4	3	0	0	0	0	7
WSW	6	4	1	0	0	0	11
W	5	3	0	0	0	0	8
WNW	6	0	0	0	0	0	6
NW	1	0	0	0	0	0	1
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	41	32	2	0	0	0	75

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	2	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	1	1	0	0	0	0	2
S	2	1	0	0	0	0	3
SSW	0	0	0	0	0	0	0
SW	3	1	0	0	0	0	4
WSW	2	2	0	0	0	0	4
W	6	2	0	0	0	0	8
WNW	4	0	0	0	0	0	4
NW	2	0	0	0	0	0	2
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	20	8	2	0	0	0	30

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JUN 1/5/74 - 30/4/75
Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	1	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	0	2	0	0	0	0	2

Periods of Calms 0 Hours

Hours of Missing Data: 8

Total Observations for JUN: 712

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JUL 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	7	5	27	2	0	0	41
NNE	5	6	7	1	0	0	19
NE	6	13	2	0	0	0	21
ENE	5	10	0	0	0	0	15
E	10	12	0	0	0	0	22
ESE	4	4	2	0	0	0	10
SE	3	4	1	0	0	0	8
SSE	5	8	3	0	0	0	16
S	0	16	10	0	0	0	26
SSW	3	17	23	1	0	0	44
SW	1	15	9	0	0	0	25
WSW	7	11	3	0	0	0	21
W	7	5	4	0	0	0	16
WNW	7	5	3	2	0	0	17
NW	10	19	2	0	0	0	31
NNW	7	10	8	1	0	0	26
Variable	0	0	0	0	0	0	0
Totals	87	160	104	7	0	0	358

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	1	1	0	0	0	0	2
SE	0	1	0	0	0	0	1
SSE	0	1	0	0	0	0	1
S	0	1	0	0	0	0	1
SSW	0	1	1	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	1	1	0	0	0	0	2
WNW	1	0	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	0	3	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	3	7	4	0	0	0	14

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JUL 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	1	0	0	0	1
ENE	0	1	0	0	0	0	1
E	0	2	0	0	0	0	2
ESE	0	2	1	0	0	0	3
SE	0	1	1	1	0	0	3
SSE	1	0	1	0	0	0	2
S	0	0	0	0	0	0	0
SSW	0	3	0	0	0	0	3
SW	1	4	1	0	0	0	6
WSW	1	1	0	0	0	0	2
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	2	1	0	0	0	0	3
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	5	15	5	1	0	0	26

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	4	0	0	0	0	7
NNE	2	0	0	0	0	0	2
NE	3	4	1	0	0	0	8
ENE	1	3	0	0	0	0	4
E	2	3	0	0	0	0	5
ESE	0	1	1	0	0	0	3
SE	1	6	6	0	0	0	13
SSE	3	12	0	0	0	0	15
S	5	8	0	0	0	0	13
SSW	3	10	0	0	0	0	13
SW	5	14	2	0	0	0	21
WSW	5	5	0	0	0	0	10
W	8	6	0	0	0	0	14
WNW	4	2	2	0	0	0	8
NW	3	14	9	0	0	0	26
NNW	2	6	4	0	0	0	12
Variable	0	0	0	0	0	0	0
Totals	51	98	25	0	0	0	173

Periods of Calms 2 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JUL 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	4	1	0	0	0	7
NNE	1	0	0	0	0	0	1
NE	0	1	0	0	0	0	1
ENE	2	2	0	0	0	0	4
E	4	0	0	0	0	0	4
ESE	1	0	0	0	0	0	1
SE	5	2	0	0	0	0	7
SSE	2	1	0	0	0	0	3
S	2	1	0	0	0	0	3
SSW	3	2	4	0	0	0	9
SW	3	1	3	0	0	0	7
WSW	3	3	0	0	0	0	6
W	15	3	0	0	0	0	18
WNW	15	3	0	0	0	0	18
NW	7	5	1	0	0	0	13
NNW	2	1	1	0	0	0	4
Variable	0	0	0	0	0	0	0
Totals	67	29	10	0	0	0	106

Periods of Calms 3 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	1	0	0	0	0	0	1
NE	1	0	0	0	0	0	1
ENE	1	0	0	0	0	0	1
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	1	1	0	0	0	0	2
SSE	1	1	0	0	0	0	2
S	1	0	1	0	0	0	2
SSW	1	0	0	0	0	0	1
SW	2	0	0	0	0	0	2
WSW	2	0	0	0	0	0	2
W	3	5	0	0	0	0	8
WNW	9	2	0	0	0	0	11
NW	5	1	0	0	0	0	6
NNW	0	0	0	0	0	0	2
Variable	0	0	0	0	0	0	2
Totals	28	11	1	0	0	0	40

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: JUL 1/5/74 - 30/4/75

Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	1	0	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	1	0	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	2	1	0	0	0	0	3
WNW	4	0	0	0	0	0	4
NW	3	0	0	0	0	0	3
NNW	2	0	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	13	1	0	0	0	0	14

Periods of Calms 0 Hours

Hours if Missing Data: 7

Total Observations for JUL: 737

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: AUG 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	12	10	0	0	0	24
NNE	3	8	10	2	0	0	23
NE	4	17	15	1	0	0	37
ENE	3	10	5	1	0	0	19
E	6	6	2	1	0	0	15
ESE	2	2	1	0	0	0	5
SE	0	7	3	0	0	0	10
SSE	1	4	7	0	0	0	12
S	0	13	15	0	0	0	28
SSW	1	11	15	1	0	0	28
SW	2	8	13	1	0	0	24
WSW	0	1	9	0	0	0	10
W	4	2	1	1	0	0	8
WNW	2	3	0	0	0	0	5
NW	4	7	7	0	0	0	18
NNW	4	10	5	0	0	0	19
Variable	0	0	0	0	0	0	2
Totals	38	121	118	8	0	0	285

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	1	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	1	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	0	0	1
SSE	1	2	0	0	0	0	3
S	1	3	5	0	0	0	9
SSW	1	1	0	0	0	0	2
SW	3	3	1	0	0	0	7
WSW	1	0	0	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	1	0	0	0	0	1
NW	1	2	1	0	0	0	4
NNW	0	1	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	8	14	9	0	0	0	31

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: AUG 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	3	1	0	0	0	4
NNE	0	2	1	0	0	0	3
NE	0	1	1	0	0	0	2
ENE	0	0	0	0	0	0	0
E	0	1	1	0	0	0	2
ESE	1	0	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	2	0	0	0	0	2
S	0	1	0	0	0	0	1
SSW	0	5	0	0	0	0	5
SW	0	3	0	0	0	0	3
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	1	0	0	0	0	1
NW	0	1	0	0	0	0	1
NNW	1	2	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	2	23	4	0	0	0	29

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	8	2	0	0	0	10
NNE	1	5	4	0	0	0	10
NE	4	3	2	0	0	0	9
ENE	1	3	0	0	0	0	4
E	3	6	0	0	0	0	9
ESE	0	7	1	1	0	0	9
SE	1	7	0	0	0	0	8
SSE	4	10	0	0	0	0	14
S	9	23	4	0	0	0	36
SSW	6	9	2	0	0	0	17
SW	7	6	2	0	0	0	15
WSW	5	5	0	0	0	0	10
W	2	2	0	0	0	0	4
WNW	2	4	0	0	0	0	6
NW	0	5	0	0	0	0	5
NNW	2	5	1	0	0	0	8
Variable	0	0	0	0	0	0	0
Totals	47	108	18	1	0	0	174

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: AUG 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	3	1	0	0	0	4
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	4	0	0	0	0	0	4
SSE	4	6	0	0	0	0	10
S	5	3	0	0	0	0	8
SSW	5	3	0	0	0	0	8
SW	0	0	0	0	0	0	0
WSW	3	0	0	0	0	0	3
W	8	2	0	0	0	0	10
WNW	1	2	0	0	0	0	3
NW	2	2	0	0	0	0	4
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	33	22	1	0	0	0	56

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	1	0	0	0	0	0	1
WSW	4	0	0	0	0	0	4
W	3	5	0	0	0	0	8
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	1	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	8	6	1	0	0	0	15

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: AUG 1/5/74 - 30/4/75
Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	1	1	0	0	0	0	2
NNW	1	0	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	2	3	0	0	0	0	5

Periods of Calms 0 Hours

Hours of Missing Data: 149

Total Observations for Aug: 595

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: SEP 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	2	7	24	4	0	39
NNE	5	5	11	2	0	0	23
NE	3	6	2	0	0	0	11
ENE	2	2	1	0	0	0	5
E	5	10	0	0	0	0	15
ESE	2	11	2	0	0	0	15
SE	1	10	3	0	0	0	14
SSE	2	13	9	0	0	0	24
S	0	22	12	3	0	0	37
SSW	1	12	17	7	0	0	37
SW	0	3	2	1	0	0	6
WSW	2	5	1	3	0	0	11
W	1	6	1	2	0	0	10
WNW	2	1	0	0	0	0	3
NW	1	0	3	0	1	0	5
NNW	3	1	3	10	0	0	17
Variable	0	0	0	0	0	0	0
Totals	32	109	74	52	5	0	272

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	4	1	0	0	6
NNE	0	3	1	1	0	0	5
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	1	0	0	0	0	1
SSW	1	1	0	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	1	0	0	0	1
WNW	1	1	0	0	0	0	2
NW	0	0	0	0	0	0	0
NNW	0	1	1	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	2	10	7	2	0	0	21

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: SEP 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	1	6	5	0	0	14
NNE	1	5	5	0	0	0	11
NE	0	0	0	0	0	0	0
ENE	0	0	1	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	1	1	0	0	0	2
SE	0	3	0	0	0	0	3
SSE	0	2	0	0	0	0	2
S	0	0	0	0	0	0	0
SSW	0	3	0	0	0	0	3
SW	1	0	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	1	0	1	0	0	0	2
WNW	0	0	0	0	0	0	0
NW	0	0	0	1	0	0	1
NNW	0	1	3	2	0	0	6
Variable	0	0	0	0	0	0	0
Totals	5	16	17	8	0	0	46

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	7	18	8	0	0	34
NNE	2	2	4	4	0	0	12
NE	2	0	2	2	0	0	6
ENE	4	2	2	1	0	0	9
E	3	3	0	0	0	0	6
ESE	3	4	3	0	0	0	10
SE	3	7	0	0	0	0	10
SSE	4	4	0	1	0	0	9
S	11	8	3	0	0	0	22
SSW	5	14	1	0	0	0	20
SW	9	5	0	0	0	0	14
WSW	5	3	0	0	0	0	8
W	5	1	0	0	0	0	6
WNW	2	5	1	2	0	0	10
NW	2	8	1	0	0	0	11
NNW	0	2	4	1	0	0	7
Variable	0	0	0	0	0	0	0
Totals	61	75	39	19	0	0	194

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: SEP 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	2	0	0	0	3
NNE	3	1	4	0	0	0	8
NE	1	1	0	0	0	0	2
ENE	0	1	0	0	0	0	1
E	2	0	0	0	0	0	2
ESE	5	2	0	0	0	0	7
SE	6	4	0	0	0	0	10
SSE	19	9	0	0	0	0	28
S	12	4	2	0	0	0	18
SSW	11	5	0	0	0	0	16
SW	8	1	0	0	0	0	9
WSW	7	1	0	0	0	0	8
W	9	1	0	1	0	0	11
WNW	5	1	0	1	0	0	7
NW	2	2	1	0	0	0	5
NNW	0	1	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	91	34	9	2	0	0	136

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	1	1	0	0	0	0	2
E	1	0	0	0	0	0	1
ESE	1	0	0	0	0	0	1
SE	2	0	0	0	0	0	2
SSE	6	1	0	0	0	0	7
S	6	1	0	0	0	0	7
SSW	1	1	0	0	0	0	2
SW	0	1	0	0	0	0	1
WSW	2	1	0	0	0	0	3
W	11	3	0	0	0	0	14
WNW	2	0	0	0	0	0	2
NW	1	0	0	0	0	0	1
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	34	9	0	0	0	0	43

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: SEP 1/5/74 - 30/4/75
Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	1	0	0	0	0	1
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	1	0	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	1	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	1	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	2	0	0	0	0	0	2
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	3	4	0	0	0	0	7

Periods of Calms 0 Hours

Hours of Missing Data: 1

Total Observations for SEP: 719

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: OCT 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	4	2	21	14	1	0	42
NNE	4	9	6	3	0	0	22
NE	1	1	1	0	0	0	3
ENE	4	3	0	0	0	0	7
E	4	5	0	0	0	0	9
ESE	1	5	1	0	0	0	7
SE	3	0	0	0	0	0	3
SSE	2	2	0	0	0	0	4
S	1	8	8	0	0	0	17
SSW	0	4	11	0	0	0	15
SW	0	1	7	0	0	0	8
WSW	0	1	0	0	0	0	1
W	2	1	0	0	0	0	3
WNW	1	3	3	3	0	0	10
NW	3	11	4	3	0	0	21
NNW	6	2	18	15	0	0	41
Variable	0	0	0	0	0	0	0
Totals	36	58	80	38	1	0	213

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	5	0	0	0	6
NNE	0	0	3	0	0	0	3
NE	0	0	2	0	0	0	2
ENE	0	2	1	0	0	0	3
E	0	0	0	0	0	0	0
ESE	1	0	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	1	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	2	3	12	0	0	0	17

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: OCT 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	2	1	0	0	0	5
NNE	0	1	3	0	0	0	4
NE	1	3	0	0	0	0	4
ENE	0	1	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	1	0	1	0	0	0	2
SE	2	0	0	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	2	0	0	0	0	2
SSW	0	1	0	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	2	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	6	10	7	0	0	0	23

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	14	15	1	0	0	31
NNE	0	8	4	0	0	0	12
NE	2	3	3	0	0	0	8
ENE	1	2	1	0	0	0	4
E	2	2	1	0	0	0	5
ESE	1	3	3	0	0	0	7
SE	1	1	1	0	0	0	3
SSE	0	0	0	0	0	0	0
S	1	3	0	0	0	0	4
SSW	1	7	3	0	0	0	11
SW	0	0	0	0	0	0	0
WSW	1	3	0	0	0	0	4
W	1	0	0	0	0	0	1
WNW	2	3	1	0	0	0	6
NW	1	5	2	0	0	0	8
NNW	2	10	13	0	0	0	25
Variable	0	0	0	0	0	0	0
Totals	17	64	47	1	0	0	129

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: OCT 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	1	0	1	0	0	5
NNE	1	1	0	0	0	0	2
NE	0	0	0	0	0	0	0
ENE	3	2	0	0	0	0	5
E	2	5	0	0	0	0	7
ESE	1	1	0	0	0	0	2
SE	9	7	0	0	0	0	16
SSE	9	1	0	0	0	0	10
S	9	6	1	0	0	0	16
SSW	3	3	1	0	0	0	7
SW	4	1	0	0	0	0	5
WSW	1	1	0	0	0	0	2
W	10	4	0	0	0	0	14
WNW	9	5	0	0	0	0	14
NW	2	1	0	0	0	0	3
NNW	0	3	1	0	0	0	4
Variable	0	0	0	0	0	0	0
Totals	66	42	3	1	0	0	112

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	4	1	0	0	0	0	5
NNE	0	0	0	0	0	0	0
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	4	0	0	0	0	0	4
SE	3	1	0	0	0	0	4
SSE	5	2	0	0	0	0	7
S	9	4	0	0	0	0	13
SSW	5	2	0	0	0	0	7
SW	2	0	0	0	0	0	2
WSW	2	0	0	0	0	0	2
W	11	13	1	0	0	0	25
WNW	13	7	0	0	0	0	20
NW	3	4	0	0	0	0	7
NNW	1	1	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	64	35	1	0	0	0	100

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: OCT 1/5/74 - 30/4/75

Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	12	0	0	0	0	0	12
NNE	2	0	0	0	0	0	2
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	2	1	0	0	0	0	3
SE	1	0	0	0	0	0	1
SSE	3	0	0	0	0	0	3
S	5	1	0	0	0	0	6
SSW	2	0	0	0	0	0	2
SW	2	0	0	0	0	0	2
WSW	2	0	0	0	0	0	2
W	9	2	0	0	0	0	11
WNW	25	3	0	0	0	0	28
NW	14	0	0	0	0	0	14
NNW	2	0	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	83	7	0	0	0	0	90

Periods of Calms 4 Hours

Hours of Missing Data: 56

Total Observations for OCT: 688

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: NOV 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	5	4	10	0	0	20
NNE	1	7	2	0	0	0	10
NE	0	2	1	0	0	0	3
ENE	2	4	3	0	0	0	9
E	1	2	0	0	0	0	3
ESE	0	3	5	0	0	0	8
SE	0	2	0	0	0	0	2
SSE	0	1	0	0	0	0	1
S	0	6	6	0	0	0	12
SSW	0	1	9	2	0	0	12
SW	0	5	7	0	0	0	12
WSW	1	0	6	4	0	0	11
W	0	1	6	3	0	0	10
WNW	0	2	3	1	0	0	6
NW	0	2	5	3	0	0	10
NNW	1	1	0	5	0	0	7
Variable	0	0	0	0	0	0	0
Totals	7	44	57	28	0	0	136

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	1	2	0	0	4
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	1	0	0	0	0	0	1
E	0	0	1	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	1	0	0	0	0	1
SSW	1	1	1	0	0	0	3
SW	0	0	0	0	0	0	0
WSW	0	0	0	3	0	0	3
W	0	0	1	1	0	0	2
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	1	0	2	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	3	3	6	6	0	0	18

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: NOV 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	3	0	0	0	3
NNE	0	0	3	0	0	0	3
NE	0	0	1	1	0	0	2
ENE	0	0	5	2	0	0	7
E	0	0	0	0	0	0	0
ESE	0	0	1	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	2	0	0	0	0	2
SSW	0	2	2	0	0	0	4
SW	0	1	2	0	0	0	3
WSW	0	2	0	2	0	0	4
W	0	2	0	0	0	0	2
WNW	0	0	0	0	0	0	0
NW	0	0	1	0	0	0	1
NNW	0	1	2	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	0	10	20	5	0	0	35

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	4	8	0	0	0	15
NNE	1	7	5	0	0	0	13
NE	1	8	1	0	0	0	10
ENE	1	1	0	0	0	0	2
E	0	0	0	0	0	0	0
ESE	0	1	3	0	0	0	4
SE	0	2	2	0	0	0	4
SSE	2	5	3	0	0	0	10
S	3	13	5	1	0	0	22
SSW	1	22	17	0	0	0	40
SW	4	7	11	0	0	0	22
WSW	1	3	6	3	0	0	13
W	0	3	4	4	2	0	13
WNW	0	7	4	2	0	0	13
NW	2	9	6	3	0	0	20
NNW	0	4	9	1	0	0	14
Variable	0	0	0	0	0	0	0
Totals	19	96	84	14	2	0	215

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level— Period of Record: NOV 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	2	0	0	0	0	4
NNE	0	2	0	0	0	0	2
NE	2	2	0	0	0	0	4
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	1	1	0	0	0	0	2
SE	0	2	0	0	0	0	2
SSE	6	7	3	0	0	0	16
S	3	9	1	0	0	0	13
SSW	6	7	5	0	0	0	18
SW	1	5	2	0	0	0	8
WSW	6	13	5	0	0	0	24
W	10	4	7	1	0	0	22
WNW	4	2	2	0	0	0	8
NW	4	9	3	0	0	0	16
NNW	2	3	1	0	0	0	6
Variable	0	0	0	0	0	0	0
Totals	47	68	29	1	0	0	145

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	0	0	0	0	0	2
NNE	1	0	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	1	0	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	2	0	0	0	0	0	2
SE	3	0	0	0	0	0	3
SSE	4	5	0	0	0	0	9
S	6	1	0	0	0	0	7
SSW	2	2	0	0	0	0	4
SW	3	2	0	0	0	0	5
WSW	5	1	0	0	0	0	6
W	12	1	0	0	0	0	13
WNW	8	6	0	0	0	0	14
NW	0	7	0	0	0	0	7
NNW	1	1	1	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	50	26	1	0	0	0	77

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: NOV 1/5/74 - 30/4/75

Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	18	0	0	0	0	0	18
NNE	1	0	0	0	0	0	1
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	3	0	0	0	0	0	3
SE	4	2	0	0	0	0	6
SSE	3	2	0	0	0	0	5
S	6	2	0	0	0	0	8
SSW	1	1	0	0	0	0	2
SW	1	0	0	0	0	0	1
WSW	3	0	0	0	0	0	3
W	8	2	0	0	0	0	10
WNW	11	6	0	0	0	0	17
NW	8	4	0	0	0	0	12
NNW	2	1	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	70	20	0	0	0	0	90

Periods of Calms 0 Hours

Hours of Missing Data: 4

Total Observations for NOV: 716

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: DEC 1/5/74 - 30/4/75

Stability Class: A—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	0	0	0	0	1
NNE	1	1	0	0	0	0	2
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	2	1	0	0	0	0	3
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	3	0	0	0	0	3
SW	0	0	0	0	0	0	0
WSW	0	1	0	0	0	0	1
W	1	1	1	0	0	0	3
WNW	1	0	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	5	10	1	0	0	0	16

Periods of Calms 0 Hours

Stability Class: B—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	0	1	1	0	0	0	2
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	1	0	0	0	0	1
SSW	0	1	1	0	0	0	2
SW	0	0	2	0	0	0	2
WSW	0	0	0	0	0	0	0
W	0	0	1	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	0	5	5	0	0	0	10

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: DEC 1/5/74 - 30/4/75

Stability Class: C—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	1	0	0	1
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	1	1	0	0	0	0	2
SSW	0	1	1	0	0	0	2
SW	0	0	1	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	1	0	0	0	0	0	1
NW	0	1	0	0	0	0	1
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	2	5	2	1	0	0	10

Periods of Calms 0 Hours

Stability Class: D—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	9	3	1	0	0	14
NNE	1	5	1	0	0	0	7
NE	1	4	0	5	1	0	11
ENE	0	1	0	0	0	1	2
E	2	7	2	0	1	3	15
ESE	1	4	1	0	0	0	6
SE	7	3	0	1	0	0	11
SSE	6	8	0	0	0	0	14
S	3	4	3	0	0	0	10
SSW	1	5	8	1	0	0	15
SW	1	7	10	0	0	0	18
WSW	1	3	16	2	1	0	23
W	0	6	6	4	0	0	16
WNW	1	3	3	2	0	0	9
NW	3	4	2	3	1	0	13
NNW	0	1	2	1	0	0	4
Variable	0	0	0	0	0	0	0
Totals	29	74	57	20	4	4	188

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: DEC 1/5/74 - 30/4/75

Stability Class: E—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	4	0	0	0	0	5
NNE	1	0	3	1	0	0	5
NE	0	3	4	1	0	0	8
ENE	1	5	0	0	0	0	6
E	1	2	0	0	0	0	3
ESE	0	2	0	1	1	0	4
SE	3	6	3	0	1	0	13
SSE	3	6	3	0	0	0	12
S	2	7	3	0	0	0	12
SSW	5	31	8	0	0	0	44
SW	9	16	13	3	0	0	41
WSW	3	8	4	1	0	0	16
W	2	8	2	1	0	0	13
WNW	5	4	4	2	0	0	15
NW	3	6	0	2	0	0	11
NNW	0	2	1	1	0	0	4
Variable	0	0	0	0	0	0	0
Totals	39	110	48	13	2	0	212

Periods of Calms 0 Hours

Stability Class: F—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	2	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	1	0	0	0	0	1
E	1	0	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	3	1	0	0	0	0	4
SSE	6	3	0	0	0	0	9
S	1	4	0	0	0	0	5
SSW	0	3	0	0	0	0	3
SW	2	2	2	0	0	0	6
WSW	2	1	0	0	0	0	3
W	9	10	0	0	0	0	19
WNW	11	6	0	0	0	0	17
NW	3	0	0	0	0	0	3
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	39	33	2	0	0	0	74

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 35-Foot Level—Period of Record: DEC 1/5/74 - 30/4/75

Stability Class: G—Elevation: 35 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	1	0	0	0	0	0	1
NE	1	0	0	0	0	0	1
ENE	2	0	0	0	0	0	2
E	1	0	0	0	0	0	1
ESE	1	0	0	0	0	0	1
SE	1	0	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	3	0	0	0	0	0	3
SSW	1	0	0	0	0	0	1
SW	0	1	0	0	0	0	1
WSW	0	2	0	0	0	0	2
W	6	2	0	0	0	0	8
WNW	11	1	0	0	0	0	12
NW	2	0	0	1	0	0	3
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	31	6	0	1	0	0	38

Periods of Calms 0 Hours

Hours of Missing Data: 195

Total Observations for DEC: 549

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	31	77	112	56	3	0	279
NNE	26	75	52	9	0	0	162
NE	25	66	31	0	0	0	122
ENE	34	43	31	2	0	0	110
E	36	36	7	4	0	0	83
ESE	40	53	11	0	0	0	104
SE	21	58	18	0	0	0	97
SSE	19	50	26	0	0	0	95
S	20	92	54	6	0	0	172
SSW	8	75	130	31	0	0	244
SW	12	51	78	29	0	0	170
WSW	6	31	30	7	1	0	75
W	14	28	26	12	3	0	83
WNW	15	26	12	3	1	2	59
NW	24	53	39	9	1	0	126
NNW	28	45	44	27	1	2	147
Variable	0	0	0	0	0	0	0
Totals	359	859	701	195	10	4	2128

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	4	14	5	0	0	25
NNE	0	11	9	2	0	0	21
NE	0	6	5	0	0	0	11
ENE	1	2	6	0	0	0	9
E	1	3	2	0	0	0	6
ESE	1	4	2	0	0	0	7
SE	2	9	4	0	0	0	15
SSE	2	4	1	0	0	0	7
S	4	9	9	0	0	0	22
SSW	1	7	7	0	0	0	15
SW	3	5	4	1	0	0	13
WSW	1	5	3	2	0	0	11
W	2	5	2	2	0	1	12
WNW	1	1	1	2	0	2	7
NW	3	2	3	3	1	0	12
NNW	1	8	6	2	1	1	19
Variable	0	0	0	0	0	0	0
Totals	26	84	78	19	2	4	213

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level— Period of Record: 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	14	32	3	0	0	52
NNE	1	12	12	2	0	0	27
NE	1	8	6	1	0	0	16
ENE	2	8	6	3	0	0	19
E	5	7	0	0	0	0	12
ESE	3	7	3	0	0	0	13
SE	4	8	5	0	0	0	17
SSE	3	10	2	0	0	0	15
S	0	9	3	0	0	0	12
SSW	0	10	12	2	0	0	24
SW	6	12	9	1	0	0	28
WSW	1	4	0	0	1	0	6
W	4	6	4	6	0	0	20
WNW	3	4	2	2	0	3	14
NW	4	4	11	4	4	4	31
NNW	6	8	8	1	1	2	26
Variable	0	0	0	0	0	0	0
Totals	46	131	115	25	6	9	332

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	26	79	123	18	1	0	247
NNE	21	70	53	8	0	0	152
NE	24	55	33	11	1	0	124
ENE	21	35	16	1	2	0	75
E	22	50	11	0	0	3	86
ESE	16	43	11	1	0	0	71
SE	17	62	31	1	0	0	111
SSE	18	61	11	0	0	0	90
S	23	105	60	8	0	0	196
SSW	24	65	109	39	4	0	241
SW	25	70	94	33	7	0	229
WSW	30	31	24	7	1	0	93
W	19	28	22	14	5	5	93
WNW	15	29	30	16	11	9	110
NW	23	62	63	52	12	3	215
NNW	20	56	62	24	5	0	167
Variable	0	0	0	0	0	0	0
Totals	344	901	753	233	49	20	2300

Periods of Calms 3 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	30	41	34	4	0	0	109
NNE	21	57	24	1	0	0	103
NE	21	46	19	2	0	0	88
ENE	13	26	9	0	0	0	48
E	19	44	14	2	1	0	80
ESE	12	32	9	2	1	0	56
SE	29	54	22	4	1	0	110
SSE	17	72	27	2	0	0	118
S	20	86	57	10	0	0	173
SSW	18	96	111	24	4	0	253
SW	27	84	69	20	2	0	202
WSW	22	30	38	3	1	0	94
W	23	29	45	12	5	1	115
WNW	27	34	23	12	6	2	104
NW	24	55	39	23	7	3	151
NNW	31	50	15	5	2	0	103
Variable	0	0	0	0	0	0	0
Totals	354	836	555	126	30	6	1907

Periods of Calms 1 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	22	28	2	0	0	0	52
NNE	7	12	2	0	0	0	21
NE	12	7	1	0	0	0	20
ENE	7	4	0	0	0	0	11
E	9	10	3	0	0	0	22
ESE	10	8	1	0	0	0	19
SE	14	14	7	0	0	0	35
SSE	12	21	3	0	0	0	36
S	12	36	29	0	0	0	77
SSW	5	25	36	0	0	0	66
SW	20	26	7	1	0	0	54
WSW	15	14	10	0	0	0	39
W	19	18	8	0	1	0	46
WNW	24	31	16	2	0	0	73
NW	17	45	7	0	0	0	69
NNW	9	41	9	1	0	0	60
Variable	0	0	0	0	0	0	0
Totals	214	340	141	4	1	0	700

Periods of Calms 6 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: 1/5/74 - 30/4/75

Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	8	17	5	0	0	0	30
NNE	6	10	2	0	0	0	18
NE	5	7	0	0	0	0	12
ENE	9	5	0	0	0	0	14
E	10	12	0	0	0	0	22
ESE	7	9	0	0	0	0	16
SE	14	10	3	0	0	0	27
SSE	17	14	0	0	0	0	31
S	10	22	17	0	0	0	49
SSW	10	8	13	1	0	0	32
SW	19	16	2	0	0	0	37
WSW	15	17	0	1	0	0	33
W	10	21	2	1	1	0	35
WNW	13	31	1	0	0	0	45
NW	19	19	3	0	0	0	41
NNW	11	18	3	0	0	0	32
Variable	0	0	0	0	0	0	0
Totals	183	236	51	3	1	0	474

Periods of Calms 6 Hours

Hours of Missing Data: 690

Total Observations for the Period are: 8070

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JAN 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	1	0	0	0	0	0	1
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	1	1	0	0	0	0	2
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	1	0	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	1	0	0	1
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	2	0	0	0	0	0	2
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	6	2	0	1	0	0	9

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	1	0	0	0	0	0	0
WNW	0	0	0	1	0	0	1
NW	0	0	0	0	0	0	1
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	0	0	1	0	0	2

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JAN 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	1	0	0	0	0	0	1
SE	1	0	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	1	0	0	0	0	0	1
WNW	1	0	0	0	0	0	1
NW	2	0	0	0	0	0	2
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	6	1	0	0	0	0	7

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	7	11	7	0	0	27
NNE	0	3	2	0	0	0	5
NE	0	2	5	0	0	0	7
ENE	1	5	0	0	0	0	6
E	3	1	2	0	0	0	6
ESE	1	0	0	0	0	0	1
SE	2	2	1	0	0	0	5
SSE	0	8	0	0	0	0	8
S	0	6	8	0	0	0	14
SSW	1	4	5	4	2	0	16
SW	1	1	2	3	2	0	9
WSW	1	3	0	1	0	0	5
W	1	0	3	0	3	3	10
WNW	1	1	1	1	0	0	4
NW	4	5	1	2	0	0	12
NNW	1	3	6	1	0	0	11
Variable	0	0	0	0	0	0	0
Totals	19	51	47	19	7	3	146

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JAN 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	5	4	12	3	0	0	24
NNE	3	8	3	0	0	0	14
NE	3	10	4	0	0	0	17
ENE	4	6	1	0	0	0	11
E	2	8	3	0	0	0	13
ESE	1	3	1	0	0	0	5
SE	4	7	4	1	0	0	16
SSE	0	10	8	2	0	0	20
S	4	16	8	1	0	0	29
SSW	1	11	26	6	0	0	44
SW	6	14	16	11	1	0	48
WSW	1	5	3	1	1	0	11
W	1	5	1	5	4	1	17
WNW	0	0	0	0	5	2	7
NW	1	3	0	0	1	0	5
NNW	4	3	3	0	0	0	10
Variable	0	0	0	0	0	0	0
Totals	40	113	93	30	12	3	291

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	1	0	0	0	0	3
NNE	1	0	0	0	0	0	1
NE	0	2	0	0	0	0	2
ENE	1	2	0	0	0	0	3
E	1	1	0	0	0	0	2
ESE	1	1	0	0	0	0	2
SE	0	1	1	0	0	0	2
SSE	0	3	0	0	0	0	3
S	2	6	1	0	0	0	9
SSW	3	5	4	0	0	0	12
SW	3	5	1	0	0	0	9
WSW	2	0	1	0	0	0	3
W	1	1	0	0	0	0	2
WNW	5	4	3	1	0	0	13
NW	3	3	0	0	0	0	6
NNW	1	1	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	26	36	11	1	0	0	74

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JAN 1/5/74 - 30/4/75

Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	4	0	0	0	0	4
NNE	0	2	1	0	0	0	3
NE	1	3	0	0	0	0	4
ENE	1	1	0	0	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	2	1	2	0	0	0	5
SSE	0	0	0	0	0	0	0
S	0	2	2	0	0	0	4
SSW	1	1	0	0	0	0	2
SW	2	0	1	0	0	0	3
WSW	1	3	0	0	0	0	4
W	3	0	0	0	0	0	3
WNW	5	0	0	0	0	0	5
NW	1	1	0	0	0	0	2
NNW	1	2	1	0	0	0	4
Variable	0	0	0	0	0	0	0
Totals	18	20	7	0	0	0	45

Periods of Calms 1 Hours

Hours of Missing Data: 169

Total Observations for JAN: 575

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: FEB 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	2	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	1	1	0	0	0	2
ENE	0	1	2	0	0	0	3
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	1	0	0	0	1
SSW	0	2	2	0	0	0	4
SW	0	0	0	0	0	0	0
WSW	0	1	0	0	0	0	1
W	1	0	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	7	6	0	0	0	14

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	0	1	0	0	0	3
NNE	0	0	1	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	0	2	0	0	0	2
SSW	0	0	2	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	1	0	0	0	0	0	1
NW	0	0	0	1	0	0	1
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	3	1	6	1	0	0	11

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: FEB 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	1	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	1	0	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	2	0	0	0	0	2
S	0	0	1	0	0	0	1
SSW	0	2	3	0	0	0	5
SW	0	0	0	0	0	0	0
WSW	1	0	0	0	0	0	1
W	0	1	1	1	0	0	3
WNW	0	0	0	0	0	0	0
NW	0	1	0	0	3	0	4
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	2	6	6	1	3	0	18

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	4	3	9	3	0	0	19
NNE	0	7	4	1	0	0	12
NE	6	10	0	0	0	0	16
ENE	1	0	0	0	0	0	1
E	4	0	0	0	0	0	4
ESE	3	3	0	0	0	0	6
SE	1	2	0	0	0	0	3
SSE	0	0	0	0	0	0	0
S	0	3	5	0	0	0	8
SSW	0	7	10	0	0	0	17
SW	1	3	8	3	3	0	18
WSW	0	1	0	1	0	0	2
W	1	2	3	3	0	0	9
WNW	0	2	4	1	0	0	7
NW	1	3	2	7	0	0	13
NNW	0	3	5	2	1	0	11
Variable	0	0	0	0	0	0	0
Totals	22	49	50	21	4	0	146

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: FEB 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	7	10	3	0	0	0	20
NNE	4	23	6	1	0	0	34
NE	6	20	3	0	0	0	29
ENE	2	8	2	0	0	0	12
E	3	5	0	0	0	0	8
ESE	1	3	2	0	0	0	6
SE	3	7	2	0	0	0	12
SSE	1	13	3	0	0	0	17
S	1	9	5	3	0	0	18
SSW	2	13	19	9	0	0	43
SW	1	6	20	4	1	0	32
WSW	3	0	4	2	0	0	9
W	1	1	2	1	0	0	5
WNW	2	2	11	0	0	0	15
NW	2	10	6	7	2	0	27
NNW	5	18	2	1	0	0	26
Variable	0	0	0	0	0	0	0
Totals	44	148	90	28	3	0	313

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	3	0	0	0	0	6
NNE	1	0	0	0	0	0	1
NE	2	0	0	0	0	0	2
ENE	1	0	0	0	0	0	1
E	2	0	0	0	0	0	2
ESE	1	0	0	0	0	0	1
SE	3	0	0	0	0	0	3
SSE	5	3	1	0	0	0	9
S	0	3	9	0	0	0	12
SSW	1	6	7	0	0	0	14
SW	2	2	0	0	0	0	4
WSW	0	0	1	0	0	0	1
W	0	2	0	0	0	0	2
WNW	3	4	1	0	0	0	8
NW	1	5	2	0	0	0	8
NNW	0	3	2	1	0	0	6
Variable	0	0	0	0	0	0	0
Totals	25	31	23	1	0	0	80

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: FEB 1/5/74 - 30/4/75
Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	1	0	0	0	0	0	1
E	2	2	0	0	0	0	4
ESE	2	2	0	0	0	0	4
SE	5	2	0	0	0	0	7
SSE	8	2	0	0	0	0	10
S	2	10	3	0	0	0	15
SSW	0	1	1	0	0	0	2
SW	1	1	0	0	0	0	2
WSW	1	0	0	0	0	0	1
W	0	3	0	0	0	0	3
WNW	1	2	0	0	0	0	3
NW	3	2	0	0	0	0	5
NNW	0	3	1	0	0	0	4
Variable	0	0	0	0	0	0	0
Totals	27	30	5	0	0	0	62

Periods of Calms 2 Hours

Hours of Missing Data: 25

Total Observations for FEB: 647

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: MAR 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	2	0	0	0	0	2
NNE	1	1	0	0	0	0	2
NE	0	0	0	0	0	0	0
ENE	2	0	0	0	0	0	2
E	0	0	1	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	0	0	1
SSE	0	1	0	0	0	0	1
S	0	2	0	0	0	0	2
SSW	0	3	1	0	0	0	4
SW	0	1	0	1	0	0	2
WSW	0	0	5	1	1	0	7
W	0	0	1	0	0	0	1
WNW	0	0	1	1	0	0	2
NW	2	3	0	0	0	0	5
NNW	1	2	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	6	16	9	3	1	0	35

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	1	0	0	1
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	2	0	0	0	2
W	0	0	0	0	0	0	0
WNW	0	0	0	1	0	0	1
NW	0	0	1	1	0	0	2
NNW	0	2	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	0	4	3	3	0	0	10

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: MAR 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	2	0	0	0	3
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	1	1	0	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	3	1	0	0	4
SW	0	1	1	0	0	0	2
WSW	0	0	0	0	1	0	1
W	0	0	1	0	0	0	1
WNW	0	0	1	1	0	0	2
NW	0	0	3	1	1	0	5
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	3	11	3	2	0	20

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	7	9	7	0	0	24
NNE	0	8	6	4	0	0	18
NE	2	12	8	4	0	0	26
ENE	3	3	3	1	0	0	10
E	1	10	0	0	0	0	11
ESE	4	3	0	0	0	0	7
SE	1	2	0	0	0	0	3
SSE	2	3	3	0	0	0	8
S	4	10	11	1	0	0	26
SSW	0	4	6	7	0	0	17
SW	0	5	17	8	0	0	30
WSW	0	3	2	0	0	0	5
W	1	4	0	1	1	0	7
WNW	1	2	5	4	2	0	14
NW	1	2	9	12	6	0	30
NNW	0	3	6	4	0	0	13
Variable	0	0	0	0	0	0	0
Totals	21	81	85	53	9	0	249

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: MAR 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	2	3	0	0	0	6
NNE	0	9	6	0	0	0	15
NE	1	3	4	1	0	0	9
ENE	0	4	0	0	0	0	4
E	4	10	6	2	0	0	22
ESE	1	9	2	1	0	0	13
SE	2	12	7	3	1	0	25
SSE	0	8	5	0	0	0	13
S	1	8	11	0	0	0	20
SSW	0	6	8	0	0	0	14
SW	0	9	12	1	0	0	22
WSW	1	0	5	0	0	0	6
W	2	6	11	0	1	0	20
WNW	1	1	0	3	0	0	5
NW	1	3	6	12	3	3	28
NNW	1	4	0	1	2	0	8
Variable	0	0	0	0	0	0	0
Totals	16	94	86	24	7	3	230

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	0	0	0	0	0	3
NNE	1	0	1	0	0	0	2
NE	0	2	0	0	0	0	2
ENE	2	0	0	0	0	0	2
E	1	3	2	0	0	0	6
ESE	2	2	1	0	0	0	5
SE	1	6	3	0	0	0	10
SSE	1	0	1	0	0	0	2
S	1	1	5	0	0	0	7
SSW	0	2	2	0	0	0	4
SW	1	0	0	0	0	0	1
WSW	0	2	0	0	0	0	2
W	0	2	2	0	1	0	5
WNW	0	2	1	1	0	0	4
NW	0	0	1	0	0	0	1
NNW	0	1	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	13	23	19	1	1	0	57

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: MAR 1/5/74 - 30/4/75

Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	2	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	2	0	0	0	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	1	1	0	0	0	0	2
SSE	0	3	0	0	0	0	3
S	2	2	0	0	0	0	4
SSW	1	4	1	0	0	0	6
SW	1	3	0	0	0	0	4
WSW	3	2	0	0	0	0	5
W	0	1	1	0	0	0	2
WNW	0	5	0	0	0	0	5
NW	3	2	0	0	0	0	5
NNW	1	2	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	14	27	2	0	0	0	43

Periods of Calms 0 Hours

Hours of Missing Data: 100

Total Observations for MAR: 644

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: APR 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	4	3	0	0	0	8
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	1	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	6	0	0	0	0	6
SE	1	4	1	0	0	0	6
SSE	0	2	0	0	0	0	2
S	0	0	1	0	0	0	1
SSW	0	0	5	4	0	0	9
SW	0	0	0	1	0	0	1
WSW	0	0	1	1	0	0	2
W	0	1	1	4	0	0	6
WNW	0	1	0	0	0	2	3
NW	0	6	6	0	0	0	12
NNW	0	3	3	0	1	2	9
Variable	0	0	0	0	0	0	0
Totals	2	27	22	10	1	4	66

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	1	0	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	1	1	0	0	0	0	2
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	1	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	1	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	1	0	0	1	2
WNW	0	0	0	0	0	2	2
NW	0	0	1	1	1	0	3
NNW	0	0	1	0	1	1	3
Variable	0	0	0	0	0	0	0
Totals	2	2	4	1	2	4	15

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: APR 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	1	2	0	0	4
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	2	2	0	0	0	0	4
ESE	0	2	0	0	0	0	2
SE	0	0	0	0	0	0	0
SSE	0	2	0	0	0	0	2
S	0	0	1	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	0	1	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	1	0	2	0	0	3
WNW	0	1	1	1	0	3	6
NW	0	0	3	3	0	4	10
NNW	0	1	2	1	1	2	7
Variable	0	0	0	0	0	0	0
Totals	2	11	9	9	1	9	41

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	10	17	1	1	0	31
NNE	0	11	7	0	0	0	18
NE	1	9	1	0	0	0	11
ENE	1	13	3	0	0	0	17
E	0	11	4	0	0	0	15
ESE	1	9	3	0	0	0	13
SE	4	8	1	0	0	0	13
SSE	1	6	1	0	0	0	8
S	1	13	4	3	0	0	21
SSW	1	3	9	15	2	0	30
SW	0	1	7	6	2	0	16
WSW	2	0	3	2	1	0	8
W	0	1	1	1	0	2	5
WNW	0	3	0	3	8	9	23
NW	0	11	22	23	6	3	65
NNW	2	10	14	5	4	0	35
Variable	0	0	0	0	0	0	0
Totals	16	119	97	59	24	14	329

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: APR 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	4	6	2	0	0	0	12
NNE	0	6	2	0	0	0	8
NE	2	7	0	0	0	0	9
ENE	1	3	2	0	0	0	6
E	3	13	3	0	0	0	19
ESE	1	5	2	0	0	0	8
SE	3	8	1	0	0	0	12
SSE	4	2	2	0	0	0	8
S	0	0	6	6	0	0	12
SSW	0	0	3	7	4	0	14
SW	0	1	1	0	0	0	2
WSW	0	1	4	0	0	0	5
W	2	1	1	0	0	0	4
WNW	2	1	0	1	1	0	5
NW	1	4	9	3	0	0	17
NNW	1	2	3	1	0	0	7
Variable	0	0	0	0	0	0	0
Totals	24	60	41	18	5	0	148

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	4	8	0	0	0	0	12
NNE	0	4	0	0	0	0	4
NE	3	0	0	0	0	0	3
ENE	0	0	0	0	0	0	0
E	1	5	0	0	0	0	6
ESE	0	0	0	0	0	0	0
SE	1	2	0	0	0	0	3
SSE	1	1	0	0	0	0	2
S	0	0	0	0	0	0	0
SSW	0	0	1	0	0	0	1
SW	3	0	0	0	0	0	3
WSW	1	0	1	0	0	0	2
W	2	1	0	0	0	0	3
WNW	1	4	3	0	0	0	8
NW	0	4	1	0	0	0	5
NNW	0	3	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	17	32	6	0	0	0	55

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: APR 1/5/74 - 30/4/75
Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	1	1	0	0	0	3
NNE	2	2	0	0	0	0	4
NE	1	3	0	0	0	0	4
ENE	0	1	0	0	0	0	1
E	3	1	0	0	0	0	4
ESE	1	0	0	0	0	0	1
SE	2	0	0	0	0	0	2
SSE	1	1	0	0	0	0	2
S	1	1	0	0	0	0	2
SSW	2	0	0	0	0	0	2
SW	3	0	0	0	0	0	3
WSW	2	2	0	0	0	0	4
W	3	2	0	0	1	0	6
WNW	1	8	1	0	0	0	10
NW	4	3	1	0	0	0	8
NNW	3	4	0	0	0	0	7
Variable	0	0	0	0	0	0	0
Totals	30	29	3	0	1	0	63

Periods of Calms 1 Hours

Hours of Missing Data: 2

Total Observations for APR: 718

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: MAY 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	9	13	5	0	0	27
NNE	3	20	8	0	0	0	31
NE	1	14	1	0	0	0	16
ENE	5	9	10	0	0	0	24
E	3	10	3	1	0	0	17
ESE	3	10	5	0	0	0	18
SE	4	18	5	0	0	0	27
SSE	3	13	16	0	0	0	32
S	2	14	8	5	0	0	29
SSW	1	7	18	6	0	0	32
SW	1	9	15	4	0	0	29
WSW	0	8	1	1	0	0	10
W	2	2	9	0	1	0	14
WNW	0	7	5	1	0	0	13
NW	0	2	13	1	0	0	16
NNW	2	10	5	2	0	0	19
Variable	0	0	0	0	0	0	0
Totals	30	162	135	26	1	0	354

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	3	0	0	0	4
NNE	0	2	4	0	0	0	6
NE	0	2	1	0	0	0	3
ENE	0	0	3	0	0	0	3
E	0	1	1	0	0	0	2
ESE	0	0	2	0	0	0	2
SE	0	5	4	0	0	0	9
SSE	0	1	1	0	0	0	2
S	0	1	1	0	0	0	2
SSW	0	0	0	0	0	0	0
SW	0	1	1	0	0	0	2
WSW	1	1	0	0	0	0	2
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	1	1	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	1	17	22	0	0	0	40

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: MAY 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	4	0	0	0	0	5
NNE	0	1	1	0	0	0	2
NE	1	2	0	0	0	0	3
ENE	1	0	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	3	0	0	0	0	3
SSE	1	5	1	0	0	0	7
S	0	0	0	0	0	0	0
SSW	0	0	1	0	0	0	1
SW	2	0	2	0	0	0	4
WSW	0	1	0	0	0	0	1
W	0	0	1	0	0	0	1
WNW	0	1	0	0	0	0	1
NW	1	0	0	0	0	0	1
NNW	0	2	1	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	7	19	7	0	0	0	33

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	14	1	0	0	0	16
NNE	3	9	5	0	0	0	17
NE	2	3	3	0	0	0	8
ENE	2	0	0	0	0	0	2
E	1	4	1	0	0	0	6
ESE	1	2	0	0	0	0	3
SE	4	7	1	0	0	0	12
SSE	4	3	2	0	0	0	9
S	2	2	6	0	0	0	10
SSW	1	9	12	3	0	0	25
SW	2	5	6	0	0	0	13
WSW	5	4	1	1	0	0	11
W	4	4	0	0	0	0	8
WNW	2	4	1	0	0	0	7
NW	2	4	5	0	0	0	11
NNW	1	5	1	0	0	0	7
Variable	0	0	0	0	0	0	0
Totals	37	79	45	4	0	0	165

Periods of Calms 2 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: MAY 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	3	0	0	0	4
NNE	1	1	2	0	0	0	4
NE	2	0	1	0	0	0	3
ENE	0	0	0	0	0	0	0
E	2	1	0	0	0	0	3
ESE	2	0	0	0	0	0	2
SE	1	0	0	0	0	0	1
SSE	2	0	0	0	0	0	2
S	3	7	5	0	0	0	15
SSW	0	5	0	0	0	0	5
SW	2	3	0	0	0	0	5
WSW	1	2	0	0	0	0	3
W	5	1	1	0	0	0	7
WNW	4	4	2	0	0	0	10
NW	3	1	1	0	0	0	5
NNW	0	3	1	1	0	0	5
Variable	0	0	0	0	0	0	0
Totals	29	28	16	1	0	0	74

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	1	0	0	0	0	2
NNE	0	2	0	0	0	0	2
NE	0	0	0	0	0	0	0
ENE	0	1	0	0	0	0	1
E	1	0	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	2	0	0	0	0	0	2
S	2	2	0	0	0	0	4
SSW	0	1	0	0	0	0	1
SW	1	1	0	0	0	0	2
WSW	2	0	0	0	0	0	2
W	5	6	2	0	0	0	13
WNW	0	2	0	0	0	0	2
NW	2	0	0	0	0	0	2
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	16	16	2	0	0	0	34

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: MAY 1/5/74 - 30/4/75

Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	4	0	0	0	0	4
WNW	3	1	0	0	0	0	4
NW	1	0	0	0	0	0	1
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	7	5	0	0	0	0	12

Periods of Calms 0 Hours

Hours of Missing Data: 30

Total Observations for MAY: 714

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JUN 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	5	21	30	4	0	0	60
NNE	4	24	7	0	0	0	35
NE	2	14	4	0	0	0	20
ENE	7	2	7	1	0	0	17
E	4	3	0	2	0	0	9
ESE	13	13	0	0	0	0	26
SE	6	15	5	0	0	0	26
SSE	3	8	6	0	0	0	17
S	4	7	12	0	0	0	23
SSW	3	11	20	0	0	0	34
SW	6	12	14	1	0	0	33
WSW	2	1	3	0	0	0	6
W	1	7	1	2	0	0	11
WNW	2	5	1	1	0	0	9
NW	2	12	1	0	0	0	15
NNW	0	4	6	0	0	0	10
Variable	0	0	0	0	0	0	0
Totals	64	159	117	11	0	0	351

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	2	5	0	0	0	8
NNE	0	3	0	0	0	0	3
NE	0	0	0	0	0	0	0
ENE	0	1	1	0	0	0	2
E	1	0	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	0	1	0	0	0	0	1
SSE	0	1	0	0	0	0	1
S	1	0	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	1	0	0	0	0	0	1
WSW	0	2	1	0	0	0	3
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	2	1	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	4	14	8	0	0	0	26

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JUN 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	3	8	0	0	0	12
NNE	0	2	2	0	0	0	4
NE	0	1	1	0	0	0	2
ENE	1	4	0	0	0	0	5
E	0	0	0	0	0	0	0
ESE	1	1	0	0	0	0	2
SE	2	1	0	0	0	0	3
SSE	0	1	0	0	0	0	1
S	0	2	0	0	0	0	2
SSW	0	2	0	0	0	0	2
SW	1	0	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	1	0	1	0	0	2
WNW	0	0	0	0	0	0	0
NW	0	2	1	0	0	0	3
NNW	2	1	3	0	0	0	6
Variable	0	0	0	0	0	0	0
Totals	8	21	15	1	0	0	45

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	7	16	0	0	0	26
NNE	2	0	3	0	0	0	5
NE	2	2	0	0	0	0	4
ENE	4	4	2	0	0	0	10
E	3	3	2	0	0	0	8
ESE	0	6	0	0	0	0	6
SE	1	15	11	0	0	0	27
SSE	2	10	3	0	0	0	15
S	0	10	6	0	0	0	16
SSW	7	3	12	0	0	0	22
SW	5	5	2	0	0	0	12
WSW	5	3	0	0	0	0	8
W	2	3	2	0	0	0	7
WNW	3	1	2	0	0	0	6
NW	4	4	0	0	0	0	8
NNW	1	1	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	44	77	61	0	0	0	182

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JUN 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	1	1	0	0	0	0	2
ENE	0	0	0	0	0	0	0
E	1	1	0	0	0	0	2
ESE	0	2	1	0	0	0	3
SE	4	3	0	0	0	0	7
SSE	0	5	2	0	0	0	7
S	4	5	3	0	0	0	12
SSW	3	1	1	0	0	0	5
SW	5	8	0	0	0	0	13
WSW	2	3	1	0	0	0	6
W	2	1	0	0	0	0	3
WNW	5	5	0	0	0	0	10
NW	1	1	0	0	0	0	2
NNW	2	0	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	30	37	8	0	0	0	75

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	2	0	0	0	0	3
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	2	0	0	0	0	2
S	0	1	0	0	0	0	1
SSW	0	1	0	0	0	0	1
SW	3	1	0	0	0	0	4
WSW	3	2	2	0	0	0	7
W	3	0	0	0	0	0	3
WNW	2	1	0	0	0	0	3
NW	3	0	0	0	0	0	3
NNW	0	2	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	15	13	2	0	0	0	30

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JUN 1/5/74 - 30/4/75

Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	1	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	0	2	0	0	0	0	2

Periods of Calms 0 Hours

Hours of Missing Data: 8

Total Observations for JUN: 712

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JUL 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	6	10	19	1	0	0	36
NNE	4	8	9	0	0	0	21
NE	10	10	1	0	0	0	21
ENE	9	8	0	0	0	0	17
E	13	6	1	0	0	0	20
ESE	7	5	1	0	0	0	13
SE	4	3	0	0	0	0	7
SSE	5	11	0	0	0	0	16
S	3	21	6	0	0	0	30
SSW	1	18	22	3	0	0	44
SW	0	11	10	1	0	0	22
WSW	0	14	5	0	0	0	19
W	3	13	5	0	0	0	21
WNW	6	3	0	0	0	0	9
NW	9	15	6	1	0	0	31
NNW	13	8	8	2	0	0	31
Variable	0	0	0	0	0	0	0
Totals	93	164	93	8	0	0	358

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	1	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	1	1	0	0	0	0	2
SSE	0	1	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	3	0	0	0	0	3
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	1	1	0	0	0	0	2
NNW	0	0	1	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	2	9	1	1	0	0	13

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JUL 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	1	0	0	0	0	1
E	1	1	0	0	0	0	2
ESE	0	3	1	0	0	0	4
SE	0	1	2	0	0	0	3
SSE	0	0	0	0	0	0	0
S	0	0	1	0	0	0	1
SSW	0	0	3	0	0	0	3
SW	2	5	0	0	0	0	7
WSW	0	1	0	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	8
NW	0	0	0	0	0	0	0
NNW	2	1	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	5	14	7	0	0	0	26

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	2	0	0	0	0	5
NNE	3	3	1	0	0	0	7
NE	4	1	0	0	0	0	5
ENE	1	2	1	0	0	0	4
E	2	3	1	0	0	0	6
ESE	1	4	0	0	0	0	5
SE	1	4	5	0	0	0	10
SSE	3	11	1	0	0	0	15
S	3	11	4	0	0	0	18
SSW	4	7	0	0	0	0	11
SW	4	12	6	0	0	0	22
WSW	5	5	0	0	0	0	10
W	4	1	0	0	0	0	5
WNW	4	4	1	0	0	0	9
NW	2	8	8	1	0	0	19
NNW	6	11	4	0	0	0	21
Variable	0	0	0	0	0	0	0
Totals	50	89	32	1	0	0	172

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JUL 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	1	2	0	0	0	6
NNE	5	0	2	0	0	0	7
NE	0	0	0	0	0	0	0
ENE	1	2	0	0	0	0	3
E	2	2	0	0	0	0	4
ESE	2	2	0	0	0	0	4
SE	2	3	0	0	0	0	5
SSE	3	3	0	0	0	0	6
S	1	3	0	0	0	0	4
SSW	5	7	0	0	0	0	12
SW	0	6	0	0	0	0	6
WSW	2	2	0	0	0	0	4
W	3	5	1	0	0	0	9
WNW	5	5	1	0	0	0	11
NW	9	11	1	0	0	0	21
NNW	5	1	0	0	0	0	6
Variable	0	0	0	0	0	0	0
Totals	48	53	7	0	0	0	108

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	1	0	0	0	0	0	1
NE	2	0	0	0	0	0	2
ENE	3	0	0	0	0	0	3
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	2	0	0	0	0	0	2
SSE	2	0	0	0	0	0	2
S	0	2	0	0	0	0	2
SSW	1	0	0	0	0	0	1
SW	2	2	0	0	0	0	4
WSW	1	2	0	0	0	0	3
W	4	1	0	0	0	0	5
WNW	2	0	2	0	0	0	4
NW	2	5	0	0	0	0	7
NNW	1	0	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	23	12	2	0	0	0	37

Periods of Calms 3 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: JUL 1/5/74 - 30/4/75
Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	1	0	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	1	0	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	2	1	0	0	0	0	3
WSW	0	1	0	0	0	0	1
W	1	0	0	0	0	0	1
WNW	1	1	0	0	0	0	2
NW	1	0	0	0	0	0	1
NNW	2	0	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	10	3	0	0	0	0	13

Periods of Calms 1 Hours

Hours of Missing Data: 12

Total Observations for JUL: 732

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: AUG 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	8	17	6	0	0	0	31
NNE	6	9	9	0	0	0	24
NE	5	16	13	0	0	0	34
ENE	7	10	7	1	0	0	25
E	9	5	2	0	0	0	17
ESE	5	4	1	0	0	0	10
SE	3	3	1	0	0	0	7
SSE	3	8	2	0	0	0	13
S	4	21	8	0	0	0	33
SSW	2	7	14	3	0	0	26
SW	3	13	16	1	0	0	33
WSW	2	2	8	0	0	0	12
W	4	1	2	1	0	0	8
WNW	2	1	0	0	0	0	3
NW	6	6	1	0	0	0	13
NNW	5	11	7	0	0	0	23
Variable	0	0	0	0	0	0	0
Totals	74	134	97	7	0	0	312

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	1	0	0	0	0	0	1
S	1	5	5	0	0	0	11
SSW	0	3	0	0	0	0	3
SW	1	3	2	0	0	0	6
WSW	0	1	0	0	0	0	1
W	1	0	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	1	1	1	0	0	0	3
NNW	1	2	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	6	18	8	0	0	0	32

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: AUG 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	2	0	0	0	0	2
NNE	0	4	0	0	0	0	4
NE	0	1	1	0	0	0	2
ENE	0	1	0	0	0	0	1
E	1	1	0	0	0	0	2
ESE	0	1	1	0	0	0	2
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	3	0	0	0	0	3
SSW	0	2	0	0	0	0	2
SW	1	3	1	0	0	0	5
WSW	0	1	0	0	0	0	1
W	0	1	0	0	0	0	2
WNW	0	1	0	0	0	0	1
NW	1	0	0	0	0	0	1
NNW	1	2	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	5	23	3	0	0	0	31

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	1	0	0	0	0	7
NNE	7	7	5	0	0	0	19
NE	4	3	1	0	0	0	8
ENE	4	5	0	0	0	0	9
E	3	4	0	0	0	0	7
ESE	2	5	2	0	0	0	9
SE	1	8	0	0	0	0	9
SSE	1	7	0	0	0	0	8
S	7	28	3	0	0	0	38
SSW	8	6	9	0	0	0	23
SW	8	9	7	1	0	0	25
WSW	6	3	0	0	0	0	9
W	2	3	2	0	0	0	7
WNW	2	3	0	0	0	0	5
NW	3	5	0	0	0	0	8
NNW	3	3	1	0	0	0	7
Variable	0	0	0	0	0	0	0
Totals	64	103	30	1	0	0	198

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: AUG 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	0	0	0	0	0	2
NNE	3	0	1	0	0	0	4
NE	0	2	0	0	0	0	2
ENE	0	1	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	3	0	0	0	0	0	3
SSE	3	8	0	0	0	0	11
S	4	6	0	0	0	0	10
SSW	1	5	4	0	0	0	10
SW	2	1	1	0	0	0	4
WSW	1	1	0	0	0	0	2
W	5	1	0	0	0	0	6
WNW	2	1	0	0	0	0	3
NW	3	2	0	0	0	0	5
NNW	3	0	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	32	28	6	0	0	0	66

Periods of Calms 1 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	1	0	0	0	0	1
SW	1	1	0	0	0	0	2
WSW	0	0	0	0	0	0	0
W	1	0	0	0	0	0	1
WNW	1	2	0	0	0	0	3
NW	3	2	0	0	0	0	5
NNW	1	2	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	8	9	0	0	0	0	17

Periods of Calms 1 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: AUG 1/5/74 - 30/4/75

Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	1	0	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	1
NW	0	1	0	0	0	0	1
NNW	1	1	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	3	2	0	0	0	0	5

Periods of Calms 0 Hours

Hours of Missing Data: 81

Total Observations for AUG: 663

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: SEP 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	7	2	17	28	0	0	54
NNE	0	8	8	1	0	0	17
NE	3	5	4	0	0	0	12
ENE	1	4	2	0	0	0	7
E	4	4	0	0	0	0	8
ESE	7	9	3	0	0	0	19
SE	0	9	1	0	0	0	10
SSE	3	4	0	0	0	0	7
S	6	16	12	1	0	0	35
SSW	1	20	23	8	0	0	52
SW	2	3	8	7	0	0	20
WSW	0	3	1	2	0	0	6
W	1	0	2	0	1	0	4
WNW	2	1	0	0	0	0	3
NW	1	1	0	0	0	0	2
NNW	2	1	0	2	0	0	5
Variable	0	0	0	0	0	0	0
Totals	40	90	81	49	1	0	261

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	3	0	0	0	3
NNE	0	3	4	0	0	0	7
NE	0	2	0	0	0	0	2
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	1	0	0	0	0	1
SSW	1	0	1	0	0	0	2
SW	1	0	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	1	1	0	0	0	2
NW	0	0	0	0	0	0	0
NNW	0	1	1	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	2	9	10	0	0	0	21

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: SEP 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	3	14	0	0	0	18
NNE	0	3	5	0	0	0	8
NE	0	3	2	0	0	0	5
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	1	0	0	0	1
SE	0	2	1	0	0	0	3
SSE	0	0	1	0	0	0	1
S	0	2	0	0	0	0	2
SSW	0	0	1	0	0	0	1
SW	0	2	0	0	0	0	2
WSW	0	0	0	0	0	0	0
W	2	0	1	0	0	0	3
WNW	0	0	0	0	0	0	0
NW	0	0	1	0	0	0	1
NNW	0	0	1	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	3	15	28	0	0	0	46

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	8	27	0	0	0	37
NNE	1	3	6	1	0	0	11
NE	1	2	2	3	0	0	8
ENE	1	1	5	0	0	0	7
E	4	6	1	0	0	0	11
ESE	0	3	2	0	0	0	5
SE	1	7	1	1	0	0	10
SSE	1	3	1	0	0	0	5
S	2	6	2	0	0	0	10
SSW	2	11	16	0	0	0	29
SW	3	11	8	0	0	0	22
WSW	4	1	2	0	0	0	7
W	3	4	2	0	0	0	9
WNW	0	2	0	2	0	0	4
NW	3	6	1	0	0	0	10
NNW	2	4	1	1	0	0	8
Variable	0	0	0	0	0	0	0
Totals	30	78	77	8	0	0	193

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: SEP 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	1	2	0	0	0	6
NNE	1	1	0	0	0	0	2
NE	2	0	4	1	0	0	7
ENE	0	0	1	0	0	0	1
E	1	0	0	0	0	0	1
ESE	3	2	0	0	0	0	5
SE	5	6	2	0	0	0	13
SSE	4	11	0	0	0	0	15
S	1	13	4	0	0	0	18
SSW	4	8	8	0	0	0	20
SW	1	13	4	0	0	0	18
WSW	4	1	0	0	0	0	5
W	1	2	0	0	0	0	3
WNW	4	3	0	2	0	0	9
NW	2	4	1	0	0	0	7
NNW	1	0	1	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	37	65	27	3	0	0	132

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	1	0	0	0	0	0	1
SE	2	2	0	0	0	0	4
SSE	1	6	0	0	0	0	7
S	2	4	1	0	0	0	7
SSW	0	3	4	0	0	0	7
SW	1	1	0	0	0	0	2
WSW	0	1	0	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	0	2	0	0	0	2
NW	2	5	0	0	0	0	7
NNW	1	0	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	11	23	7	0	0	0	41

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: SEP 1/5/74 - 30/4/75
Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	1	0	0	0	0	0	1
S	0	1	0	0	0	0	1
SSW	0	0	1	0	0	0	1
SW	0	1	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	4	1	0	0	0	6

Periods of Calms 0 Hours

Hours of Missing Data: 20

Total Observations for SEP: 700

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: OCT 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	4	18	10	0	0	35
NNE	5	2	10	8	0	0	25
NE	2	4	6	0	0	0	12
ENE	3	4	0	0	0	0	7
E	1	4	0	0	0	0	5
ESE	2	3	0	0	0	0	5
SE	2	2	1	0	0	0	5
SSE	1	3	1	0	0	0	5
S	0	8	3	0	0	0	11
SSW	0	3	17	0	0	0	20
SW	0	0	12	3	0	0	15
WSW	2	2	1	0	0	0	5
W	2	1	0	0	0	0	3
WNW	2	4	3	0	0	0	9
NW	1	7	5	5	1	0	19
NNW	2	6	13	15	0	0	36
Variable	0	0	0	0	0	0	0
Totals	28	57	90	41	1	0	217

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	2	0	0	0	2
NNE	0	0	0	2	0	0	2
NE	0	0	4	0	0	0	4
ENE	0	1	2	0	0	0	3
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	2	0	0	0	0	0	2
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	1	0	0	1
Variable	0	0	0	0	0	0	0
Totals	2	2	8	3	0	0	15

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: OCT 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	3	0	0	0	3
NNE	0	0	4	0	0	0	4
NE	0	1	1	0	0	0	2
ENE	0	2	1	0	0	0	3
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	1	0	1	0	0	0	2
SSE	2	0	0	0	0	0	2
S	0	0	0	0	0	0	0
SSW	0	2	0	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	2	0	0	0	0	0	2
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	5	6	10	0	0	0	21

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	8	20	0	0	0	30
NNE	1	7	11	0	0	0	19
NE	0	3	6	0	0	0	9
ENE	0	0	2	0	0	0	2
E	0	3	0	0	0	0	3
ESE	1	2	1	0	0	0	4
SE	0	1	5	0	0	0	6
SSE	1	1	0	0	0	0	2
S	1	0	1	0	0	0	2
SSW	0	2	1	1	0	0	4
SW	0	4	4	1	0	0	9
WSW	0	0	1	0	0	0	1
W	0	1	1	0	0	0	2
WNW	1	1	0	0	0	0	2
NW	3	5	1	0	0	0	9
NNW	1	5	6	3	0	0	15
Variable	0	0	0	0	0	0	0
Totals	11	43	60	5	0	0	119

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: OCT 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	3	1	1	0	0	6
NNE	2	0	1	0	0	0	3
NE	1	1	0	0	0	0	2
ENE	1	0	0	0	0	0	1
E	0	1	2	0	0	0	3
ESE	1	5	0	0	0	0	6
SE	2	5	4	0	0	0	11
SSE	0	4	1	0	0	0	5
S	0	5	0	0	0	0	5
SSW	1	9	8	0	0	0	18
SW	3	12	4	1	0	0	20
WSW	2	3	1	0	0	0	6
W	0	1	0	0	0	0	1
WNW	1	4	0	0	0	0	5
NW	0	5	1	0	0	0	6
NNW	0	12	1	0	0	0	13
Variable	0	0	0	0	0	0	0
Totals	15	70	24	2	0	0	111

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	6	1	0	0	0	9
NNE	1	5	1	0	0	0	7
NE	0	1	1	0	0	0	2
ENE	0	1	0	0	0	0	1
E	2	0	0	0	0	0	2
ESE	1	1	0	0	0	0	2
SE	1	1	0	0	0	0	2
SSE	0	3	1	0	0	0	4
S	0	5	6	0	0	0	11
SSW	0	4	10	0	0	0	14
SW	3	10	2	0	0	0	15
WSW	2	3	0	0	0	0	5
W	1	2	1	0	0	0	4
WNW	4	6	1	0	0	0	11
NW	0	9	1	0	0	0	10
NNW	1	16	1	0	0	0	18
Variable	0	0	0	0	0	0	0
Totals	18	73	26	0	0	0	117

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: OCT 1/5/74 - 30/4/75
Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	2	0	0	0	0	2
NNE	1	1	0	0	0	0	2
NE	0	1	0	0	0	0	1
ENE	2	3	0	0	0	0	5
E	1	6	0	0	0	0	7
ESE	2	5	0	0	0	0	7
SE	0	3	0	0	0	0	3
SSE	4	2	0	0	0	0	6
S	2	2	2	0	0	0	6
SSW	2	1	7	0	0	0	10
SW	8	4	1	0	0	0	13
WSW	5	3	0	0	0	0	8
W	2	1	0	0	0	0	3
WNW	1	7	0	0	0	0	8
NW	1	3	0	0	0	0	4
NNW	0	3	1	0	0	0	4
Variable	0	0	0	0	0	0	0
Totals	31	47	11	0	0	0	89

Periods of Calms 0 Hours

Hours of Missing Data: 55

Total Observations for OCT: 689

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: NOV 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	6	6	8	3	0	24
NNE	10	3	1	0	0	0	5
NE	0	2	1	0	0	0	3
ENE	0	5	2	0	0	0	7
E	0	3	0	0	0	0	3
ESE	0	2	1	0	0	0	3
SE	0	3	4	0	0	0	7
SSE	0	0	1	0	0	0	1
S	1	2	3	0	0	0	6
SSW	0	3	7	7	0	0	17
SW	0	2	3	10	0	0	15
WSW	0	0	5	1	0	0	6
W	0	1	5	5	1	0	12
WNW	0	3	2	0	1	0	6
NW	1	1	7	2	0	0	11
NNW	1	0	2	6	0	0	9
Variable	0	0	0	0	0	0	0
Totals	5	36	50	39	5	0	135

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	1	0	3	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	1	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	1	0	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	1	1	0	0	0	2
SW	0	0	0	1	0	0	1
WSW	0	1	0	2	0	0	3
W	0	0	1	2	0	0	3
WNW	0	0	0	0	0	0	0
NW	1	0	0	0	0	0	1
NNW	0	0	1	1	0	0	2
Variable	0	0	0	0	0	0	0
Totals	2	3	4	9	0	0	18

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: NOV 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	3	1	0	0	4
NNE	0	0	0	2	0	0	2
NE	0	0	1	1	0	0	2
ENE	0	0	5	2	0	0	7
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	1	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	1	1	1	0	0	3
SW	0	1	3	1	0	0	5
WSW	0	1	0	0	0	0	1
W	0	2	0	2	0	0	4
WNW	0	1	0	0	0	0	1
NW	0	0	3	0	0	0	3
NNW	0	1	1	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	0	7	18	10	0	0	35

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	5	11	0	0	0	17
NNE	0	7	3	1	0	0	11
NE	0	5	7	0	0	0	12
ENE	0	1	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	0	1	0	0	0	1
SE	1	1	6	0	0	0	8
SSE	0	1	0	0	0	0	1
S	0	7	9	3	0	0	19
SSW	0	6	21	9	0	0	36
SW	1	8	15	11	0	0	35
WSW	1	4	4	1	0	0	10
W	0	2	3	7	1	0	13
WNW	1	2	6	3	1	0	13
NW	0	7	9	3	0	0	19
NNW	1	5	13	2	0	0	21
Variable	0	0	0	0	0	0	0
Totals	6	61	108	40	2	0	217

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level— Period of Record: NOV 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	8	2	0	0	0	11
NNE	1	3	0	0	0	0	4
NE	0	2	2	0	0	0	4
ENE	2	0	0	0	0	0	2
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	2	0	0	0	0	2
SSE	0	2	1	0	0	0	3
S	0	4	9	0	0	0	13
SSW	1	5	13	2	0	0	21
SW	4	6	4	2	0	0	16
WSW	2	7	6	0	0	0	15
W	1	2	17	4	0	0	24
WNW	0	2	2	1	0	0	5
NW	0	4	8	0	0	0	12
NNW	4	2	4	1	0	0	11
Variable	0	0	0	0	0	0	0
Totals	16	50	68	10	0	0	144

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	3	1	0	0	0	4
NNE	0	0	0	0	0	0	0
NE	2	1	0	0	0	0	3
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	2	1	0	0	0	0	3
SE	2	2	0	0	0	0	4
SSE	0	1	0	0	0	0	1
S	2	5	4	0	0	0	11
SSW	0	1	6	0	0	0	7
SW	0	2	3	1	0	0	6
WSW	4	4	1	0	0	0	9
W	1	2	1	0	0	0	4
WNW	3	2	1	0	0	0	6
NW	0	6	2	0	0	0	8
NNW	1	3	6	0	0	0	10
Variable	0	0	0	0	0	0	0
Totals	18	33	25	1	0	0	77

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: NOV 1/5/74 - 30/4/75
Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	3	4	0	0	0	9
NNE	1	3	1	0	0	0	5
NE	0	0	0	0	0	0	0
ENE	2	0	0	0	0	0	2
E	1	0	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	1	1	1	0	0	0	3
SSE	2	4	0	0	0	0	6
S	0	3	10	0	0	0	13
SSW	2	1	3	1	0	0	7
SW	2	3	0	0	0	0	5
WSW	3	4	0	0	0	0	7
W	1	7	0	0	0	0	8
WNW	1	5	0	0	0	0	6
NW	4	7	1	0	0	0	12
NNW	1	3	0	0	0	0	4
Variable	0	0	0	0	0	0	0
Totals	23	45	20	1	0	0	89

Periods of Calms 1 Hours

Hours of Missing Data: 4

Total Observations for NOV: 716

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: DEC 1/5/74 - 30/4/75

Stability Class: A—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	1	0	0	0	0	0	1
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	3	0	0	0	0	0	3
SE	1	0	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	1	0	0	0	0	1
SSW	0	1	1	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	2	0	0	0	0	2
WNW	1	1	0	0	0	0	2
NW	0	0	0	0	0	0	0
NNW	2	0	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Totals	10	5	1	0	0	0	16

Periods of Calms 0 Hours

Stability Class: B—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	1	2	0	0	0	0	3
SSE	0	0	0	0	0	0	0
S	0	2	0	0	0	0	2
SSW	0	0	3	0	0	0	3
SW	0	0	1	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Totals	1	5	4	0	0	0	10

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: DEC 1/5/74 - 30/4/75

Stability Class: C—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	0	0	0	0	0	0	0
NNE	1	0	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	1	0	0	1
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	2	0	0	0	0	2
SSW	0	1	0	0	0	0	1
SW	0	0	1	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	1	0	0	0	0	1
NNW	1	0	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Totals	2	5	1	1	0	0	9

Periods of Calms 0 Hours

Stability Class: D—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	4	2	0	0	0	8
NNE	4	5	0	1	0	0	10
NE	2	3	0	4	1	0	10
ENE	3	1	0	0	2	0	6
E	1	5	0	0	0	3	9
ESE	2	6	2	1	0	0	11
SE	0	5	0	0	0	0	5
SSE	3	8	0	0	0	0	11
S	3	9	1	1	0	0	14
SSW	0	3	8	0	0	0	11
SW	0	6	12	0	0	0	18
WSW	1	4	11	1	0	0	17
W	1	3	5	2	0	0	11
WNW	0	4	10	2	0	0	16
NW	0	2	5	4	0	0	11
NNW	2	3	5	6	0	0	16
Variable	0	0	0	0	0	0	0
Totals	24	71	61	22	3	3	184

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: DEC 1/5/74 - 30/4/75

Stability Class: E—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	6	4	0	0	0	12
NNE	1	5	1	0	0	0	7
NE	3	0	1	0	0	0	4
ENE	2	2	3	0	0	0	7
E	1	2	0	0	1	0	4
ESE	0	1	1	1	1	0	4
SE	0	1	2	0	0	0	3
SSE	0	6	5	0	0	0	11
S	1	10	6	0	0	0	17
SSW	0	26	21	0	0	0	47
SW	3	5	7	1	0	0	16
WSW	3	5	14	0	0	0	22
W	0	3	11	2	0	0	16
WNW	1	6	7	5	0	0	19
NW	1	7	6	1	1	0	16
NNW	5	5	0	0	0	0	10
Variable	0	0	0	0	0	0	0
Totals	23	90	89	10	3	0	215

Periods of Calms 0 Hours

Stability Class: F—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	5	4	0	0	0	0	9
NNE	2	1	0	0	0	0	3
NE	3	1	0	0	0	0	4
ENE	0	0	0	0	0	0	0
E	0	0	1	0	0	0	1
ESE	2	1	0	0	0	0	3
SE	2	0	3	0	0	0	5
SSE	0	2	0	0	0	0	2
S	2	7	3	0	0	0	12
SSW	0	1	2	0	0	0	3
SW	0	1	1	0	0	0	2
WSW	0	0	4	0	0	0	4
W	1	1	2	0	0	0	4
WNW	3	4	2	0	0	0	9
NW	1	6	0	0	0	0	7
NNW	3	10	0	0	0	0	13
Variable	0	0	0	0	0	0	0
Totals	24	39	18	0	0	0	81

Periods of Calms 0 Hours

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-15 (continued)

MONTHLY AND ANNUAL JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED AND DIRECTION BY ATMOSPHERIC STABILITY CLASS

VEPCO North Anna JFD 150-Foot Level—Period of Record: DEC 1/5/74 - 30/4/75
Stability Class: G—Elevation: 150 Feet

Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	5	0	0	0	0	7
NNE	1	2	0	0	0	0	3
NE	3	0	0	0	0	0	3
ENE	1	0	0	0	0	0	1
E	2	2	0	0	0	0	4
ESE	0	0	0	0	0	0	0
SE	3	2	0	0	0	0	5
SSE	1	2	0	0	0	0	3
S	1	1	0	0	0	0	2
SSW	2	0	0	0	0	0	2
SW	0	2	0	0	0	0	2
WSW	0	2	0	1	0	0	3
W	0	2	1	1	0	0	4
WNW	0	1	0	0	0	0	1
NW	1	0	1	0	0	0	2
NNW	2	1	0	0	0	0	3
Variable	0	0	0	0	0	0	0
Totals	19	22	2	2	0	0	45

Periods of Calms 0 Hours

Hours of Missing Data: 184

Total Observations for DEC: 560

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-16

MAXIMUM ELEVATIONS WITHIN A 10-MILE RADIUS OF THE NORTH ANNA UNIT 1 CONTAINMENT (1-MILE INCREMENTS)

	High Points, ft									
Sector	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
N	260	346	370	380	380	410	420	450	450	460
NNE	300	351	360	390	390	370	400	405	390	412
NE	300	330	360	350	350	380	390	400	384	360
ENE	270	320	340	310	360	370	350	330	330	320
E	290	310	320	320	310	330	350	380	384	370
ESE	290	290	300	310	310	300	310	360	370	370
SE	290	290	290	270	290	330	330	320	340	340
SSE	300	300	290	330	330	320	360	360	350	330
S	310	320	330	330	340	360	360	350	340	340
SSW	320	330	320	350	380	400	390	420	390	400
SW	351	370	380	411	440	460	480	490	470	450
WSW	350	390	403	410	420	450	470	500	500	480
W	320	370	360	390	420	436	470	480	450	440
WNW	330	360	330	380	420	430	360	380	370	380
NW	310	350	320	360	330	370	370	370	380	380
NNW	270	330	350	350	380	400	430	440	420	484

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-17

PARAMETERS USED TO DESCRIBE THE PRESSURIZED WATER REACTOR WITH U-TUBE STEAM GENERATORS (VOLATILE CHEMISTRY)

Parameters	Value
Thermal power (MWt)	2.90E+03
Steam flow rate, lb/hr	1.22E+07
Weight of water in reactor coolant system, lb	4.34E+05
Weight of water in reactor coolant system, lb	4.34E+05
Weight of water in all steam generators, lb	5.02E+05
Reactor coolant letdown flow (purification), lb/hr	2.23E+04
Reactor coolant letdown flow (yearly average for boron control), lb/hr	3.40E+03
Steam generator blowdown flow (total), lb/hr	3.25E+04
Fraction of radioactivity in blowdown stream which is not returned to the secondary coolant system	
Halogens	9.01E-01
Cs, Rb	5.36E-01
Others	9.04E-01
Flow through the purification system cation demineralizer, lb/hr	2.23E+03
Ratio of condensate demineralizer flow rate to the total steam flow rate	6.59E-01
Ratio of the total amount of noble gases routed to gaseous radwaste from the purification system to the total amount of noble gases routed from the primary coolant system to the purification system (not including the boron recovery system)	0.0

Notes:

1. The reactor coolant concentrations given are for reactor coolant entering the letdown line.
2. The secondary coolant concentrations are based on a primary-to-secondary leakage of 100 lb/day.
3. The steam-generator steam concentrations given are for steam leaving the steam generator.
4. Values used in determining coolant activities are given on pp. B-59 to B-65 of draft Regulatory Guide 1.BB.
5. These coolant activities are calculated according to draft Regulatory Guide 1.BB (September 9, 1975) methods.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-18

SOURCE TERMS FOR PWR WITH U-TUBE STEAM GENERATORS

Isotope	Reactor Coolant (µCi/g)	Reactor Coolant (Ci)	Steam Generator Liquids (µCi/g)	Steam Generator Liquids (Ci)	Steam-Generator Steam (µCi/g)	Decay Constant (sec^{-1})
Noble Gases						
Kr-83m	2.2E-02	4.4E+00	0.0	0.0	7.6E-09	1.04E-04
Kr-85m	1.1E-01	2.2E+01	0.0	0.0	3.9E-08	4.30E-05
Kr-85	1.9E-02	3.7E+00	0.0	0.0	6.5E-09	2.05E-09
Kr-87	6.4E-02	1.3E+01	0.0	0.0	2.1E-08	1.52E-04
Kr-88	2.1E-01	4.2E+01	0.0	0.0	7.1E-08	6.88E-05
Kr-89	5.4E-03	1.1E+00	0.0	0.0	1.9E-09	3.66E-03
Xe-131m	3.8E-02	7.6E+00	0.0	0.0	1.3E-08	6.69E-07
Xe-133m	1.6E-01	3.1E+01	0.0	0.0	5.5E-08	3.60E-06
Xe-133	9.3E+00	1.8E+03	0.0	0.0	3.2E-06	1.52E-06
Xe-135m	1.4E-02	2.8E+00	0.0	0.0	4.8E-09	7.55E-04
Xe-135	3.5E-01	6.8E+01	0.0	0.0	1.2E-07	2.10E-05
Xe-137	9.7E-03	1.9E+00	0.0	0.0	3.3E-09	3.01E-03
Xe-138	4.8E-02	9.4E+00	0.0	0.0	1.6E-08	8.14E-04
Halogens						
Br-83	5.4E-03	1.1E+00	7.3E-08	1.7E-05	7.3E-10	8.02E-05
Br-84	2.8E-03	5.6E-01	1.2E-08	2.7E-06	1.2E-10	3.66E-04
Br-85	3.3E-04	6.4E-02	2.0E-10	4.5E-08	2.0E-12	4.03E-03
I-130	2.6E-03	5.0E-01	6.7E-08	1.5E-05	6.7E-10	1.55E-05

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-18 (continued)

SOURCE TERMS FOR PWR WITH U-TUBE STEAM GENERATORS

Isotope	Reactor Coolant (μCi/g)	Reactor Coolant (Ci)	Steam Generator Liquids (μCi/g)	Steam Generator Liquids (Ci)	Steam-Generator Steam (μCi/g)	Decay Constant (sec^{-1})
Halogens (continued)						
I-131	3.7E-01	7.2E+01	1.1E-05	2.5E-03	1.1E-07	9.98E-07
I-132	1.1E-01	2.2E+01	2.0E-06	4.5E-04	2.0E-08	8.43E-05
I-133	4.8E-01	9.4E+01	1.4E-05	3.2E-03	1.4E-07	9.26E-06
I-134	5.2E-02	1.0E+01	3.5E-07	8.1E-05	3.5E-09	2.20E-04
I-135	2.2E-01	4.4E+01	4.8E-06	1.1E-03	4.8E-08	2.92E-05
					Cs, Rb	
Rb-86	1.1E-04	2.1E-02	1.9E-08	4.4E-06	1.9E-11	4.30E-07
Rb-88	2.2E-01	4.3E+01	6.4E-07	1.5E-04	6.4E-10	6.53E-04
Cs-134	3.1E-02	6.2E+00	5.2E-06	1.2E-03	5.2E-09	1.07E-08
Cs-136	1.6E-02	3.2E+00	2.8E-06	6.4E-04	2.8E-09	6.17E-07
Cs-137	2.3E-02	4.5E+00	4.3E-06	9.8E-04	4.3E-09	7.30E-10
Water Activation Products						
N-16	4.0E+01	7.9E+03	9.0E-07	2.0E-04	9.0E-07	9.75E-02
Tritium						
H-3	1.0E+00	2.0E+02	1.0E-03	2.3E-01	1.0E-03	1.79E-09
Other Nuclides						
Cr-51	2.6E-03	5.1E-01	2.8E-07	6.5E-05	2.8E-10	2.88E-07
Mn-54	4.2E-04	8.4E-02	6.4E-08	1.5E-05	6.4E-11	2.56E-08

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-18 (continued)

SOURCE TERMS FOR PWR WITH U-TUBE STEAM GENERATORS

Isotope	Reactor Coolant		Steam Generator Liquids		Steam-Generator Steam	Decay Constant
	(μCi/g)	(Ci)	(μCi/g)	(Ci)	(μCi/g)	(sec^{-1})
Other Nuclides (continued)						
Fe-55	2.2E-03	4.3E-01	2.6E-07	5.8E-05	2.6E-10	8.14E-09
Fe-59	1.4E-03	2.7E-01	1.9E-07	4.3E-05	1.9E-10	1.78E-07
Co-58	2.2E-02	4.3E+00	2.5E-06	5.8E-04	2.5E-09	1.12E-07
Co-60	2.7E-03	5.4E-01	2.9E-07	6.5E-05	2.9E-10	4.18E-09
Sr-89	4.8E-04	9.4E-02	6.3E-08	1.4E-05	6.3E-12	1.59E-07
Sr-90	1.4E-05	2.7E-03	1.3E-09	2.9E-07	1.3E-12	7.58E-10
Sr-91	7.8E-04	1.5E-01	9.6E-09	2.2E-06	9.6E-12	2.03E-05
Y-90	2.2E-05	4.4E-03	1.1E-09	2.6E-07	1.1E-12	3.01E-06
Y-91m	4.2E-04	8.2E-02	3.3E-09	7.6E-07	3.3E-12	2.32E-04
Y-91	2.7E-03	5.4E-01	2.9E-07	6.5E-05	2.9E-10	1.37E-07
Y-93	1.6E-04	3.1E-02	3.9E-09	9.0E-07	3.9E-12	1.89E-05
Zr-95	8.2E-05	1.6E-02	1.3E-08	2.9E-06	1.3E-11	1.23E-07
Nb-95	6.8E-05	1.3E-02	1.3E-08	2.9E-06	1.3E-11	2.29E-07
Mo-99	5.9E-01	1.2E+02	2.0E-05	4.5E-03	2.0E-08	2.92E-06
Tc-99m	4.4E-01	8.7E+01	1.0E-05	2.3E-03	1.0E-08	3.20E-05
Ru-103	6.1E-05	1.2E-02	6.3E-09	1.4E-06	6.3E-12	2.03E-07
Ru-106	1.4E-05	2.7E-03	1.3E-09	2.9E-07	1.3E-12	2.17E-08
Rh-103m	4.9E-05	9.8E-03	2.3E-09	5.1E-07	2.3E-12	2.06E-04
Rh-106	1.1E-05	2.1E-03	3.9E-10	8.9E-08	3.9E-10	2.32E-02

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Table 11.C-18 (continued)

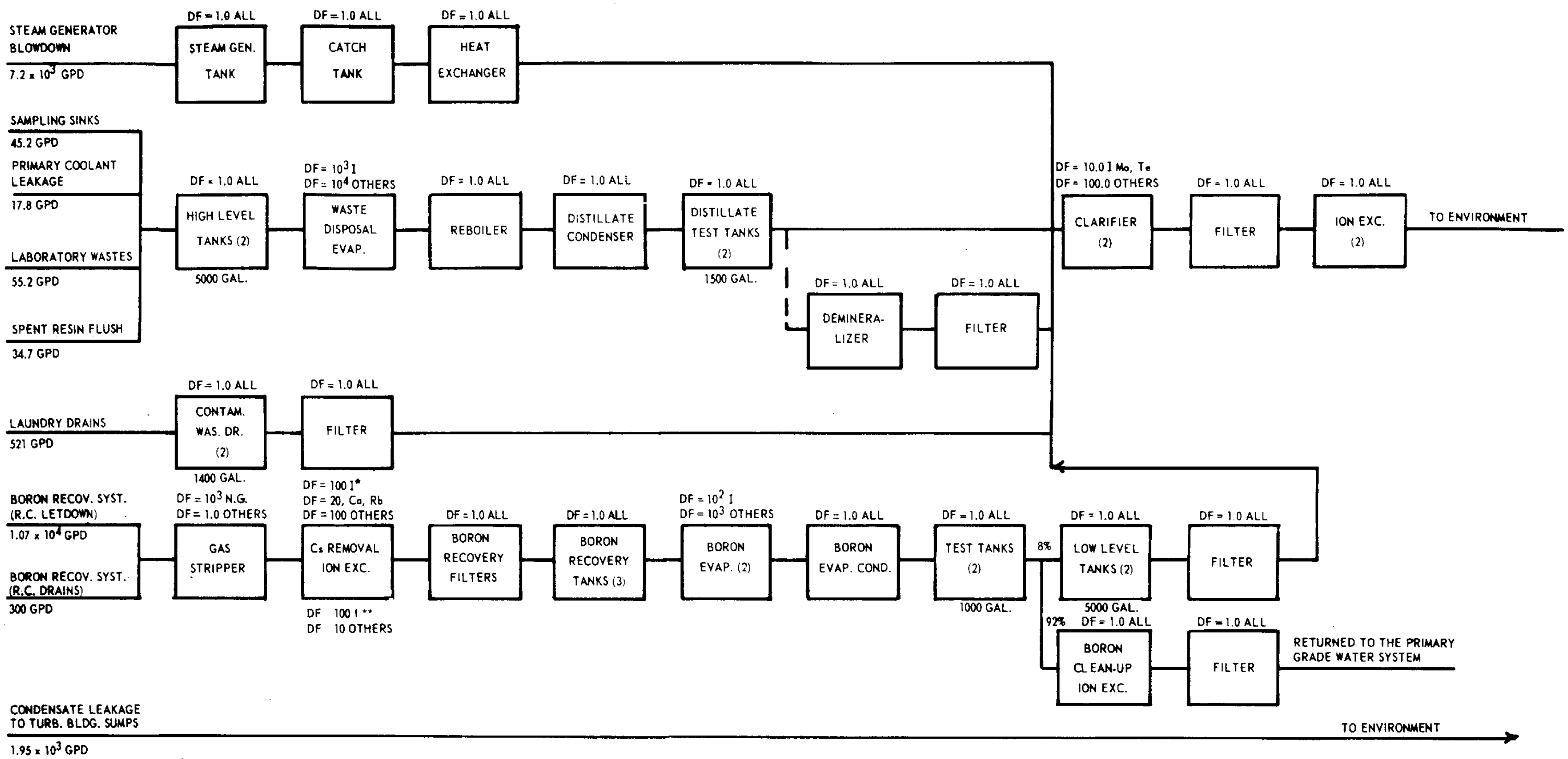
SOURCE TERMS FOR PWR WITH U-TUBE STEAM GENERATORS

Isotope	Reactor Coolant (μCi/g)	Reactor Coolant (Ci)	Steam Generator Liquids (μCi/g)	Steam Generator Liquids (Ci)	Steam-Generator Steam (μCi/g)	Decay Constant (sec^{-1})
Other Nuclides (continued)						
Te-125m	4.0E-05	7.8E-03	1.9E-09	4.3E-07	1.9E-12	1.38E-07
Te-127m	3.8E-04	7.5E-02	3.2E-08	7.3E-06	3.2E-11	7.36E-08
Te-127	1.0E-03	2.0E-01	5.8E-08	1.3E-05	5.8E-11	2.05E-05
Te-129m	1.9E-03	3.8E-01	1.9E-10	4.3E-05	1.9E-10	2.40E-07
Te-129	1.8E-03	3.5E-01	7.0E-08	1.6E-05	7.0E-11	1.65E-04
Te-131m	3.2E-03	6.3E-01	2.5E-07	5.8E-05	2.5E-10	6.42E-06
Te-131	1.2E-03	2.4E-01	2.1E-08	4.8E-06	2.1E-11	4.62E-04
Te-132	3.6E-02	7.0E+00	2.9E-06	6.6E-04	2.9E-09	2.47E-06
Ba-137	1.7E-02	3.4E+00	8.8E-07	2.0E-04	8.8E-10	4.53E-03
Ba-140	3.0E-04	5.9E-02	3.1E-08	7.1E-06	3.1E-11	6.27E-07
La-140	1.9E-04	3.8E-02	1.9E-08	4.2E-06	1.9E-11	4.79E-06
Ce-141	9.5E-05	1.9E-02	1.3E-08	2.9E-06	1.3E-11	2.47E-07
Ce-143	5.1E-05	1.0E-02	2.6E-09	5.9E-07	2.6E-12	5.83E-06
Ce-144	4.5E-05	8.9E-03	6.4E-09	1.5E-06	6.4E-12	2.82E-08
Pr-143	6.8E-05	1.3E-02	6.2-09	1.4E-06	6.2E-12	5.91E-07
Pr-144	3.6E-05	7.1E-03	2.0E-09	4.7E-07	2.0E-12	6.69E-04
Np-239	1.6E-03	3.1E-01	1.7E-07	3.8E-05	1.7E-10	3.41E-06

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 11C-1

FLOW CHART FOR LIQUID WASTE SYSTEM



* DF'S FOR R. C. LETDOWN INCLUDE Cs REMOVAL ION EXCHANGER PLUS MIXED BED DEMINERALIZER

** DF'S FOR R. C. DRAINS

NOTE: ALL FLOWS PER UNIT

N11C0001