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CHAPTER 10

RADIOACTIVE EFFLUENT TREATMENT AND MONITORING

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CHAPTER 10

RADIOACTIVE EFFLUENT TREATMENT AND MONITORING

10.1 AIRBORNE RELEASES

10.1.1 System Description

A simplified gaseous radwaste and gaseous effluent flow diagram is provided in Figure 10-1.

Each airborne release point is classified as stack, vent, or ground level in accordance with the definitions in Section 4.1.4 and the results in Table A-1 of Appendix A. The principal release points for potentially radioactive airborne effluents and their classifications are as follows:

- The ventilation chimney (a stack release point).
- The reactor building ventilation stack (a vent release point).

10.1.1.1 Condenser Offgas Treatment System

The condenser offgas treatment system is designed and installed to reduce radioactive gaseous effluents by collecting non-condensable off-gases from the condenser and providing for holdup to reduce the total radioactivity by radiodecay prior to release to the environment. The daughter products are retained by charcoal and HEPA filters. The system is described in Section 11.3.2.1.1 of the Quad Cities UFSAR.

10.1.1.2 Ventilation Exhaust Treatment System

Ventilation exhaust treatment systems are designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in selected effluent streams by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters prior to release to the environment. Such a system is not considered to have any effect on noble gas effluents. The ventilation exhaust treatment systems are shown in Figure 10-1.

Engineered safety features atmospheric cleanup systems are not considered to be ventilation exhaust treatment system components.

10.1.2 Radiation Monitors

10.1.2.1 Plant Chimney Monitor

Monitors 1(2)-1730A/B continuously monitor the final effluent from the chimney.

The monitor system has isokinetic sampling, gaseous grab sampling, iodine and particulate sampling, and tritium sampling capability.

The chimney effluent is also monitored by a separate particulate, iodine, and noble gas (SPING-4) system and a Victoreen system. The SPING/Victoreen system has high range capabilities to deal with accident conditions including postaccident sampling capability. The Victoreen sampling system automatically begins taking samples after a high signal has been received on the SPING-4 low range noble gas monitor. Output from the SPING/Victoreen system is obtainable in the control room.

No automatic isolation or control functions are performed by these monitors. Pertinent information on these monitors is provided in the Quad Cities UFSAR Section 11.5.2.3.

10.1.2.2 Reactor Building Vent Stack Effluent Monitor

The combined reactor building ventilation is also monitored by a SPING-4. This monitor has high range capabilities to deal with accident conditions. The SPING-4 noble gas detectors have ranges that envelope the range for the reactor building vent effluent trip point.

The vent stack monitor has isokinetic sampling and iodine and particulate sampling capability.

No automatic isolation or control functions are performed by this monitor.

Pertinent information on this monitor is provided in the Quad Cities UFSAR Section 11.5.2.4.

10.1.2.3 Reactor Building Ventilation Monitors

Monitors 1(2)-1735A/B continuously monitor the effluent from the Unit 1(2) reactor building. On high high alarm, the monitors automatically initiate closure of valves A01(2)A-5741, A01(2)B-5741, A01(2)A-5742, and A01(2)B-5742 thus isolating the Unit 1(2) reactor building, and initiate startup of the Unit 1(2) standby gas treatment system, and isolates control room HVAC.

In addition to the above monitors, there is continuous iodine and particulate sampling of the reactor building exhaust.

Pertinent information on these monitors is provided in Quad Cities UFSAR Section 11.5.2.4.

10.1.2.4 Condenser Air Ejector Monitors

Monitors 1(2)-1733A/B continuously monitor gross gamma activity downstream of the steam jet air ejector and prior to release to the main chimney.

On high high alarm the monitors automatically activate an interval timer which in turn initiates closure of air operated valve A01(2)-5406, thus terminating the release.

In addition, monitors 1(2)-1741 continuously monitor the final offgas effluent prior to entering the chimney, and monitors 1(2)-1738 continuously monitor gross gamma activity downstream of the steam jet air ejector. No control device is initiated by these monitors.

Pertinent information on these monitors is found in Quad Cities UFSAR Sections 11.5.2.1 and 11.5.2.2.

10.1.3 Alarm and Trip Setpoints

10.1.3.1 Setpoint Calculations

10.1.3.1.1 Reactor Building Vent Stack Monitors

The setpoint for the reactor building vent stack monitor is conservatively set at 2 mr/hr above background. The reactor building ventilation stack release rate, Q_{tv}, at 2 mr/hr is calculated to be 14,400 µCi/sec. Q_{tv} is then substituted into Equations 10-1 and 10-2 to determine Q_{ts}.

10.1.3.1.2 Condenser Air Ejector Monitors

The high-high trip setpoint is established at ≤ 100 µCi/Sec per MWt (≙2.5*E5*µ*Ci*/sec) and the high alarm is established at ≤ 50µCi/sec per MWt (≙1.25*E5*µ*Ci*/sec).

10.1.3.1.3 Plant Chimney Radiation Monitor

The setpoints for the plant chimney radiation monitor are conservatively set at 10,000 µCi/sec and 20,000 µCi/sec (high and high-high alarms respectively).

At this level the combined release from chimney and vent is approximately 10% of the RETS limit. This is determined by solving Equations 10-1 and 10-2 below.

10.1.3.2 Release Limits

Alarm and trip setpoints of gaseous effluent monitors are established to ensure that the release rate limits of RETS are not exceeded. The release limit Q_{ts} is found by solving Equations 10-1 and 10-2.

$$(1.11)\ \sum\{\ f_i[Q_{ts}\overline{S_i} + Q_{tv}\overline{V_i}]\} < 500\text{mrem/yr} \qquad (10\text{-}1)$$

$$\sum\{\overline{L_i}f_i[(X/Q)_s\ Q_{ts}\ \exp(-\lambda_i R/3600u_s) \qquad (10\text{-}2)$$

$$+ (X/Q)_v Q_{tv}\exp(-\lambda_i R/3600u_v)]$$

$$+ (1.11)(f_i)[Q_{ts}S_i + Q_{tv}V_i]\}$$

$$< 3000\ \text{mrem/yr}$$

The summations are over noble gas radionuclides i.

f_i Fractional Radionuclide Composition

The release rate of noble gas radionuclide i divided by the total release rate of all noble gas radionuclides.

Q_{ts} Total Allowed Release Rate, Stack Release [µCi/sec]

The total Allowed release rate of all noble gas radionuclides released as stack releases.

Q_{tv} Total Allowed Release Rate, Vent Release [µCi/sec]

The total allowed release rate of all noble gas radionuclides released as vent releases.

The remaining parameters in Equation 10-1 have the same definitions as in Equation A-8 of Appendix A. The remaining parameters in Equation 10-2 have the same definition as in Equation A-9 of Appendix A.

Equation 10-1 is based on Equation A-8 of Appendix A and the RETS restriction on whole body dose rate (500 mrem/yr) due to noble gases released in gaseous effluents (see Section A.1.3.1 of Appendix A). Equation 10-2 is based on Equation A-9 of Appendix A and the RETS restriction on skin dose rate (3000 mrem/yr) due to noble gases released in gaseous effluents (see Section A.1.3.2 of Appendix A).

The value of Equation 10-1 (2.3×10^6 µCi/sec) is used as the limiting noble gas release rate.

Calibration methods and surveillance frequency for the monitors will be conducted as specified in the RETS.

10.1.3.3 Release Mixture

In the determination of alarm and trip set points the radioactivity mixture in the exhaust air is assumed to be the same as the analysis of a representative sample of noble gases collected at the recombiner during the calendar quarter in which the monitor is recalibrated.

10.1.3.4 Conversion Factors

The conversion factors used to establish gaseous effluent monitor setpoints are obtained as follows.

- Reactor building vent effluent monitor.

  The monitor setpoint is established at 2 mr/hr above background. For the purpose of setpont determination it is assumed that the background is 1 mr/hr. There is sufficient conservatism in the setpoint calculation to accommodate routine variations in the background. However, the isotopic analysis in Section 10.1.3.3 is used to confirm that the setpoint is conservative.

- Condenser air ejector monitor.

  The isotopic analysis in Section 10.1.3.3 and the flow and monitor reading at the time of the analysis are used to establish the conversion factor.

- Plant chimney monitor.

  Calibration of the plant chimney monitor consists of recirculating an amount of off-gas (see 10.1.3.3) through the noble gas monitors and a Marinelli beaker. After readings have stabilized, the Marinelli beaker is removed and gamma isotopic analysis performed. The efficiency is determined from a plot of average gamma energy of the off-gas sample and net monitor readings.

10.1.3.5 HVAC Flow Rates

The HVAC exhaust flow rates may be obtained from the process computers, indication in the control room, or fan combinations. Setpoints were calculated using the following values:

Chimney Air Flow	350,000 cfm
Combined Reactor Vent* (1 fan)	48,000 cfm
Combined Reactor Vent* (2 fans)	96,000 cfm

* per unit

10.1.4 Allocation of Effluents from Common Release Points

Radioactive gaseous effluents released from the main chimney are comprised of contributions from both units. Under normal operating conditions, it is difficult to allocate the radioactivity between units due to fuel performance, in-plant leakage, power history, and other variables. Consequently, allocation is normally made evenly between the units. During extended unit shutdowns or periods of known differences, the apportionment is adjusted accordingly. The allocation of effluents is estimated on a monthly basis.

10.1.5 Dose Projections

Because the gaseous releases are continuous, the doses are routinely calculated in accordance with the RETS.

10.2 LIQUID RELEASES

10.2.1 System Description

Simplified liquid radwaste and liquid effluent flow diagrams are provided in Figures 10-2 and 10-3.

The liquid radwaste treatment system is designed and installed to reduce radioactive liquid effluents by collecting the liquids, providing for retention or holdup, and providing for treatment by demineralizer for the purpose of reducing the total radioactivity prior to release to the environment. The system is described in Section 11.2 of the Quad Cities UFSAR.

10.2.1.1 River Discharge Tank

There is one river discharge tank (65,000 gallons capacity) which receives water for discharge to the Mississippi River. This is the only release path in use.

10.2.2 Radiation Monitors

10.2.2.1 Liquid Radwaste Effluent Monitor

Monitor 1/2-1799-01 is used to monitor all releases from the river discharge tank. On high alarm the release is terminated manually.

Pertinent information on the monitor and associated control devices is provided in Quad Cities UFSAR Sections 11.5.2 and 11.5.3.

10.2.2.2 Service Water Effluent Monitors

Monitors 1(2)-1799-01 continuously monitor the service water effluent. No control device is initiated by these monitors.

Pertinent information on these monitors is provided in Quad Cities UFSAR 11.5.3.

10.2.3 Alarm and Trip Setpoints

10.2.3.1 Setpoint Calculations

Alarm and trip setpoints of liquid effluent monitors at the principal release points are established to ensure that the limits of 10 CFR 20 are not exceeded in the unrestricted area.

Currently these setpoints are based on the most conservative releases during the previous 18 months. If it is determined that this is no longer conservative, the setpoints are reevaluated.

10.2.3.1.1 Liquid Radwaste Effluent Monitor

The monitor setpoint is found by solving equation 10-3 for the total isotopic activity.

$$P \leq (K) \times \left(\sum C_i^T / \sum C_i^T / DWC_i\right) \times \left((0.5\ F_{AVG}^d + F_{max}^T) / F_{max}^T\right) + B \qquad (10\text{-}3)$$

P	Release Setpoint	[cpm]
C_i^T	Concentration of radionuclide i in the release tank.	[µCi/mℓ]
F_{max}^T	Maximum Release Tank Discharge Flow Rate	[gpm]
	The flow rate from the radwaste discharge tank.	
K	Calibration constant	[cpm/µCi/mℓ]
DWC_i	Derived Water Concentration of radionuclide i	[µCi/mℓ]
	From Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402.	
F_{AVG}^d	Average dilution flow of initial dilution stream	[gpm]
B	Background Count Rate	[cpm]

10.2.3.1.2 Service Water Effluent Monitors

The monitor setpoint is found by solving equation 10-4.

$$P \leq (K) \times \left(\sum C_i / \sum C_i / DWC_i\right) \times \left((F_{AVG}^d + F_{max}^T) / F_{max}^T\right) + B \qquad (10\text{-}4)$$

C_i = concentration of radionuclide i in service water

If there is no detectable activity then $\Sigma C_i / \Sigma C_i / DWC_i$ is assumed to be 1×10^{-6} µCi/mℓ.

F^I_{max} = Maximum discharge rate of service water for one unit. [gpm]

All other terms are as defined in equation 10-3.

10.2.3.2 Discharge Flow Rates

10.2.3.2.1 Release Tank Discharge Flow Rate

Prior to each batch release, a grab sample is obtained.

The results of the analysis of the sample determine the discharge rate of each batch as follows:

$$F^I_{max} = 0.1 \left(0.5 \, F^d / \sum (C_i / DWC_i) \right) \qquad (10\text{-}5)$$

The summation is over radionuclides i.

0.1 Reduction factor for conservatism.

F^I_{max} Maximum Permitted Discharge Flow Rate [gpm]

The maximum permitted flow rate from the radwaste discharge tank.

F^d Dilution Flow [gpm]

C_i Concentration of Radionuclide i in the Release Tank [µCi/mℓ]

The concentration of radioactivity in the radwaste discharge tank based on measurements of a sample drawn from the tank.

DWC_i = Derived Water Concentration of radionuclide i [uCi/mℓ]

From Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402.

10.2.3.3 Release Limits

Release limits are determined from 10 CFR 20. Calculated maximum permissible discharge rates are divided by 10 and dilution flows are divided by 2 to ensure that releases are well below applicable derived water concentrations (DWC). (The factor of 2 used in the dilution flows accounts for discharging the RDT tank to the south diffuser pipe).

10.2.3.4 Release Mixture

For the liquid radwaste effluent monitor the release mixture used for the setpoint determination is the radionuclide mix identified in the grab sample isotopic analysis plus four additional radionuclides. The additional radionuclides are H-3, Fe-55, Sr-89, and Sr-90. The quantities to be added are determined using scaling factors derived from station release data for the previous six months.

10.2.3.5 Conversion Factors

The readout for the liquid radwaste effluent monitor is in CPM. The calibration constant is based on the detector sensitivity to Cs-137.

10.2.3.6 Liquid Dilution Flow Rates

The dilution flow is determined using Equation 10-6 below.

$$F^{d} = (N^{cw} \times F^{cw} + N^{sw} \times F^{sw} - F^{ICE}) \quad (10\text{-}6)$$

F^{d} = Dilution flow [gpm]
N^{cw} = Number of circulating water pumps on.
F^{cw} = 157000 gpm
Flow with one circulating water pump on.
N^{sw} = Number of service water pumps on
F^{sw} = 13800 gpm
Flow with one service water pump on
F^{ICE} = Deicing flow

10.2.4 Allocation of Effluents from Common Release Points

Radioactive liquid effluent released from the release tank is comprised of contributions from both units.

Allocation of waste is achieved by comparing the pump timer totals for each unit's floor drain and equipment drain pumps to the amount of waste sent to the river discharge tank from the floor drain and waste collector storage tanks. Liquid effluents from laundry and chemical waste are allocated evenly between units. During extended unit shutdown or periods of significant plant input differences, the apportionment is adjusted accordingly. The allocation of the effluents is made on a monthly basis.

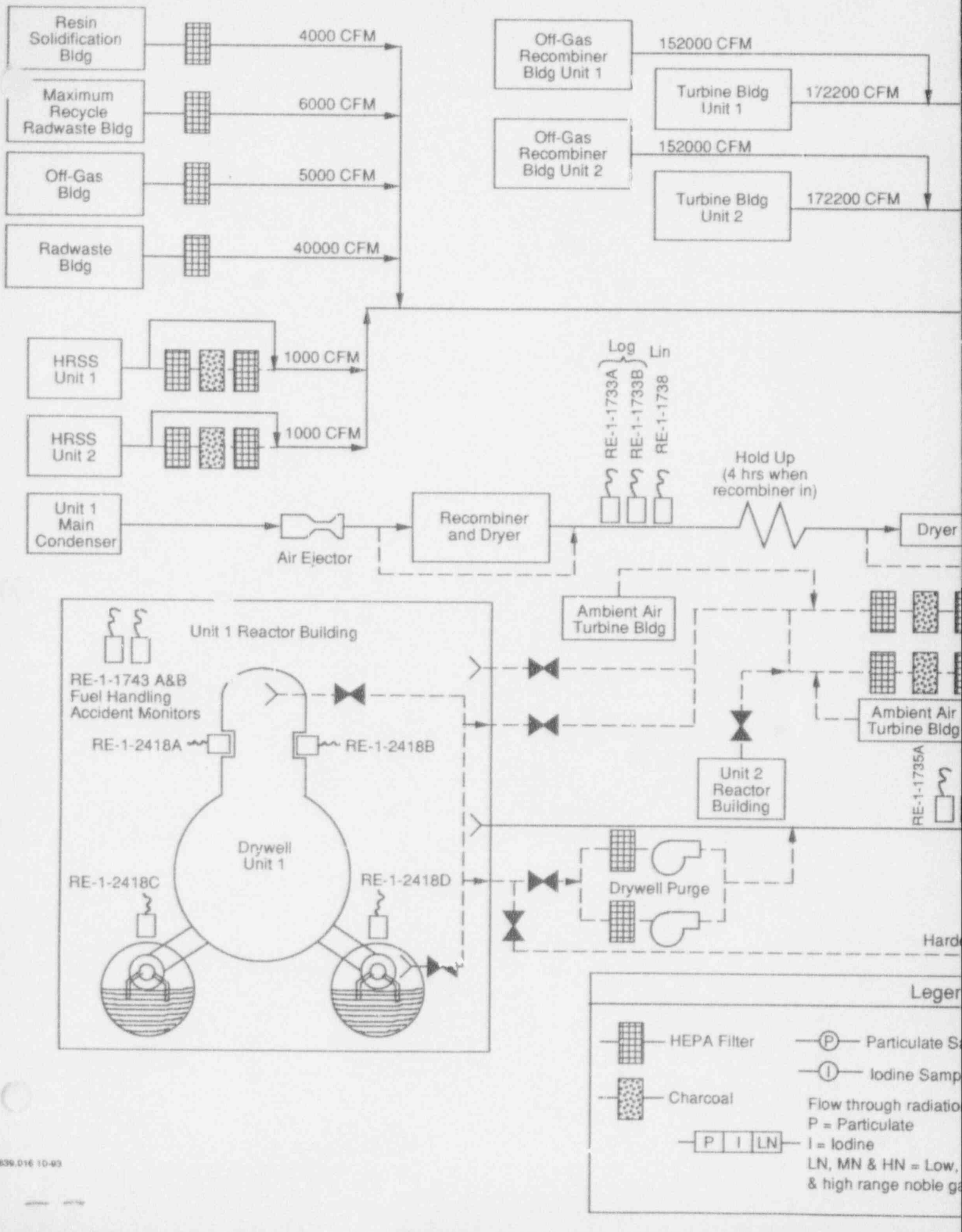
10.2.5 Projected Concentrations for Releases

If total DWC is greater than 25, the projected dose due to liquid effluent releases is calculated. Otherwise, the releases from the previous month are used to estimate the projected dose for the coming month using the methodology in Section A.2 of Appendix A. (See Section A.2.1 of Appendix A).

10.3 SOLIDIFICATION OF WASTE/PROCESS CONTROL PROGRAM

The process control program (PCP) contains the sampling, analysis, and formulation determination by which solidification of radioactive wastes from liquid systems is ensured.

Figure 10-4 is a simplified diagram of solid radwaste processing.



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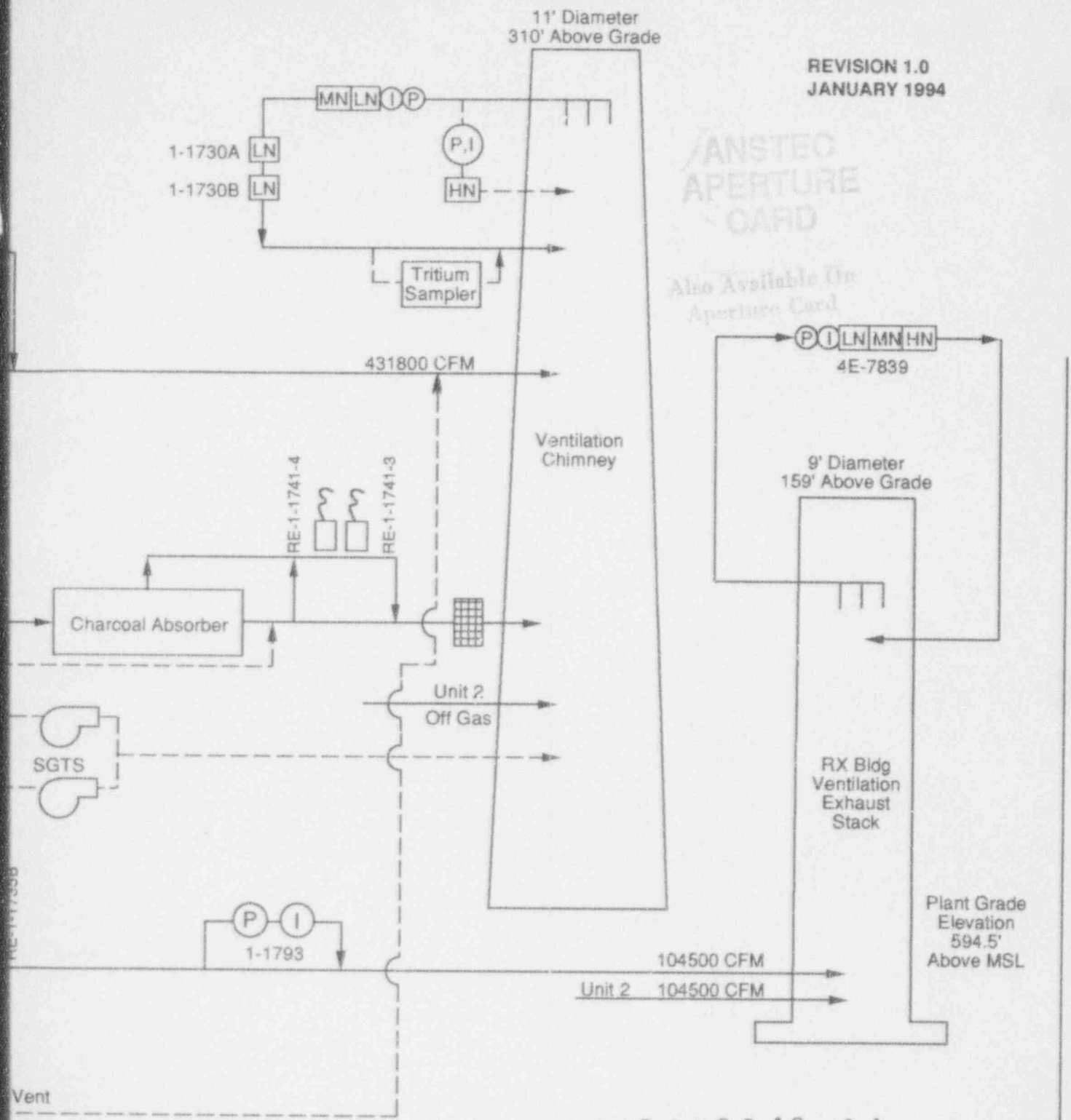

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nd Notes

- Radiation Detector
- Normally continuous flow path during power generation
- Occasional Flow Path
- FE — Flow Element
- Note: All flow rates are design flow rates, not actual

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FIGURE 10-1

SIMPLIFIED GASEOUS RADWASTE AND GASEOUS EFFLUENT FLOW DIAGRAM

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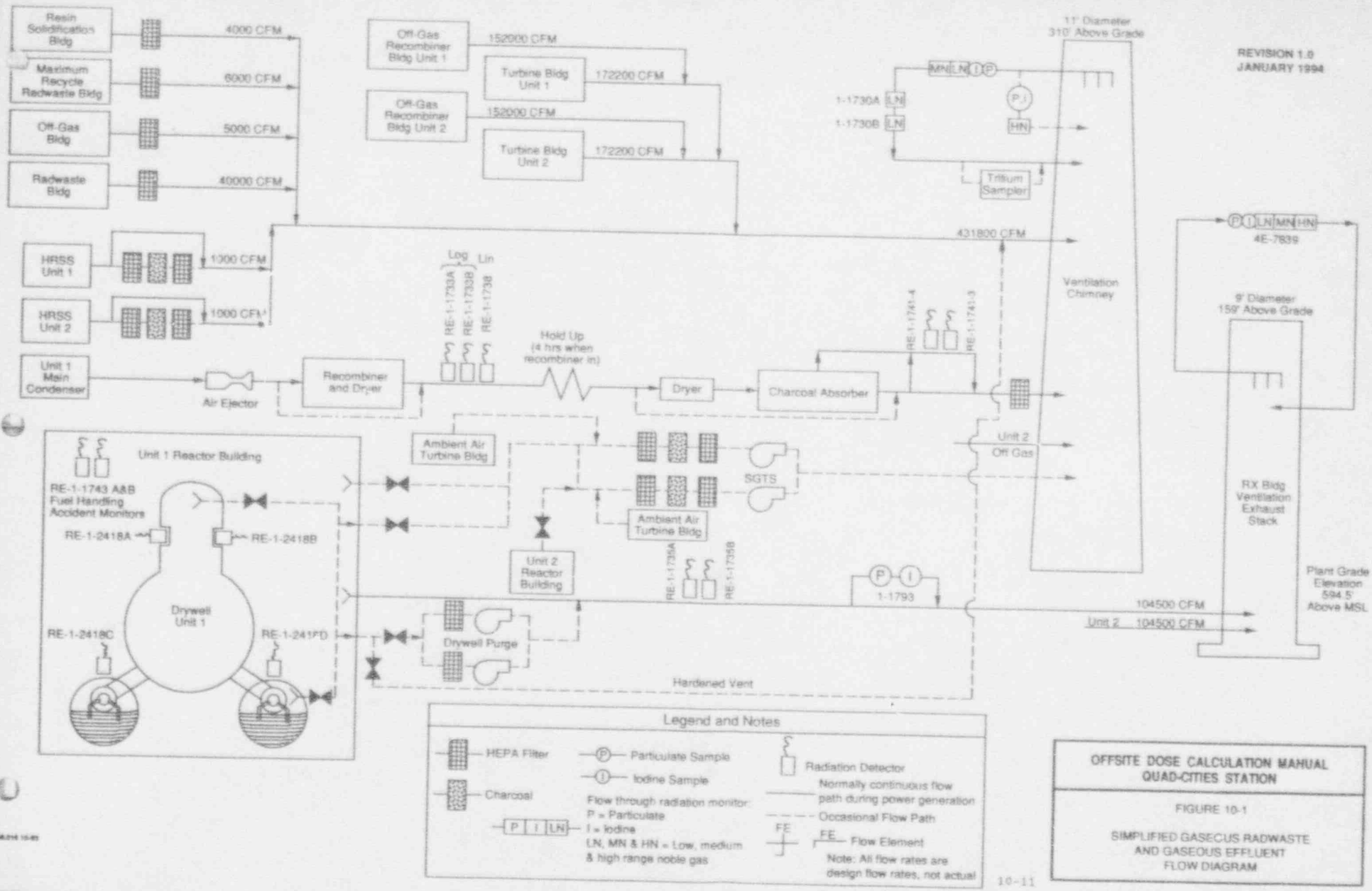

Legend and Notes

- HEPA Filter
- Charcoal
- P I LN — Flow through radiation monitor: P = Particulate, I = Iodine, LN, MN & HN = Low, medium & high range noble gas
- (P) Particulate Sample
- (I) Iodine Sample
- Radiation Detector
- Normally continuous flow path during power generation
- Occasional Flow Path
- FE — Flow Element
- Note: All flow rates are design flow rates, not actual

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FIGURE 10-1

SIMPLIFIED GASEOUS RADWASTE AND GASEOUS EFFLUENT FLOW DIAGRAM

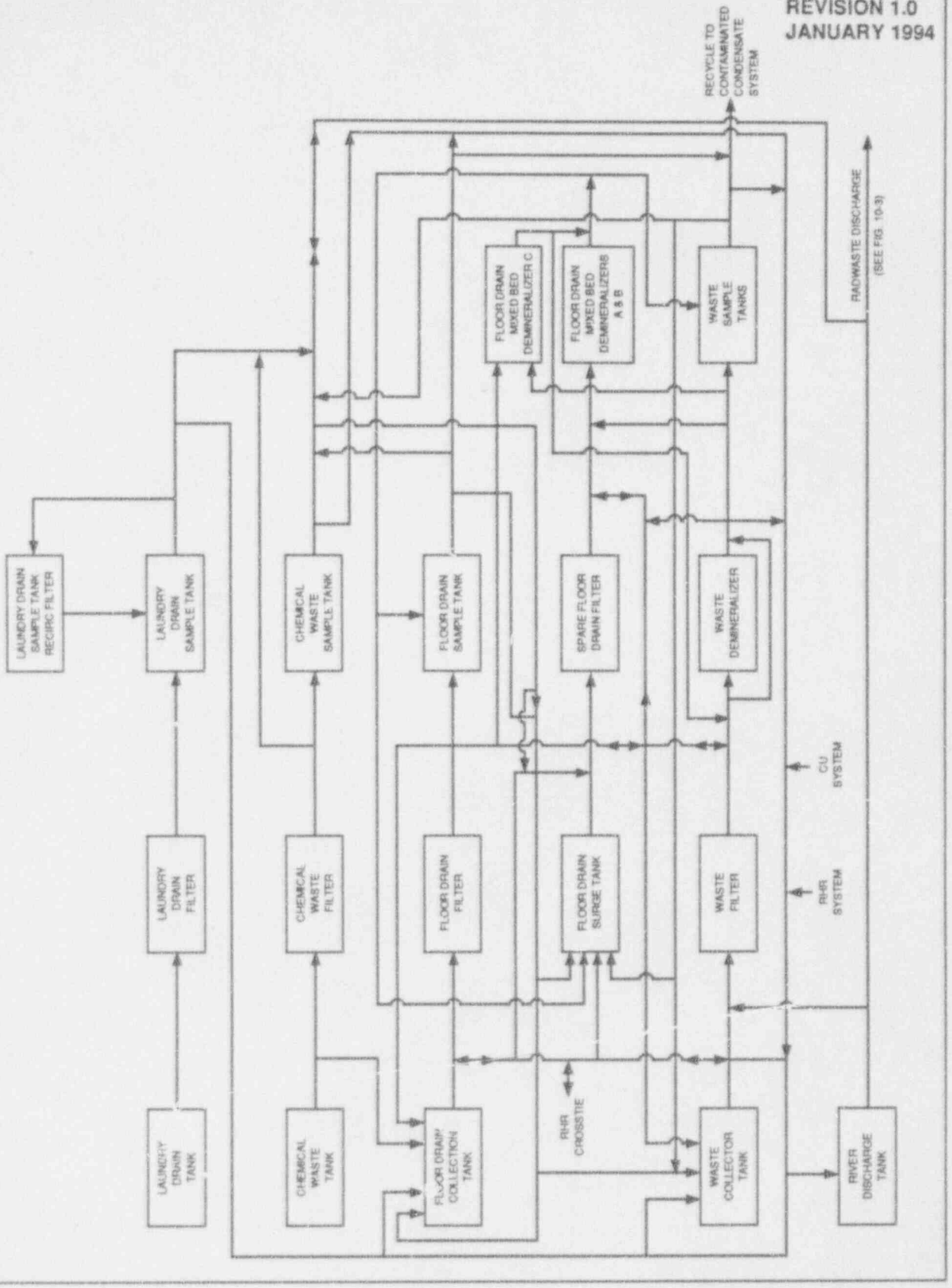

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FIGURE 10-2

SIMPLIFIED LIQUID RADWASTE PROCESSING DIAGRAM

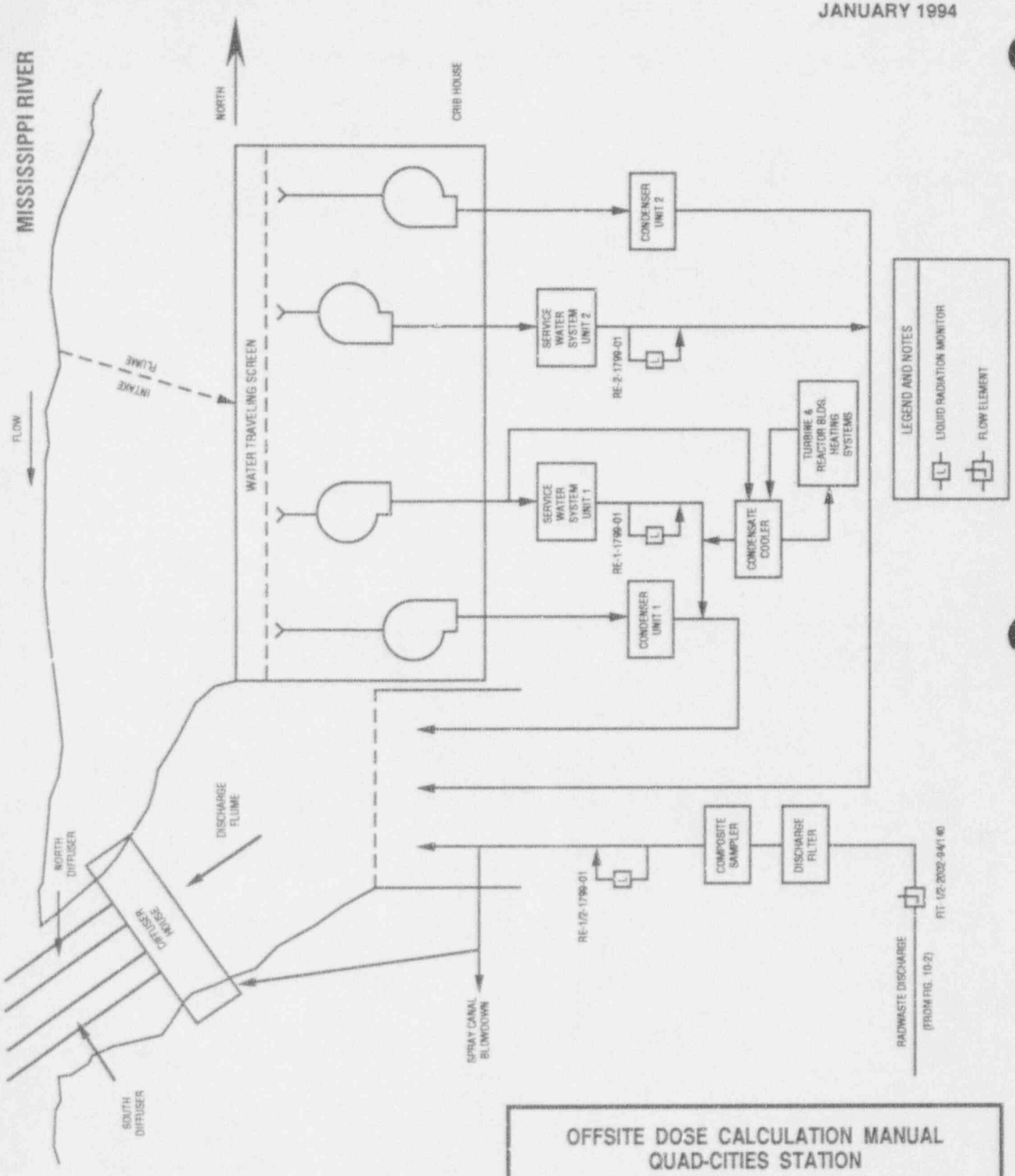

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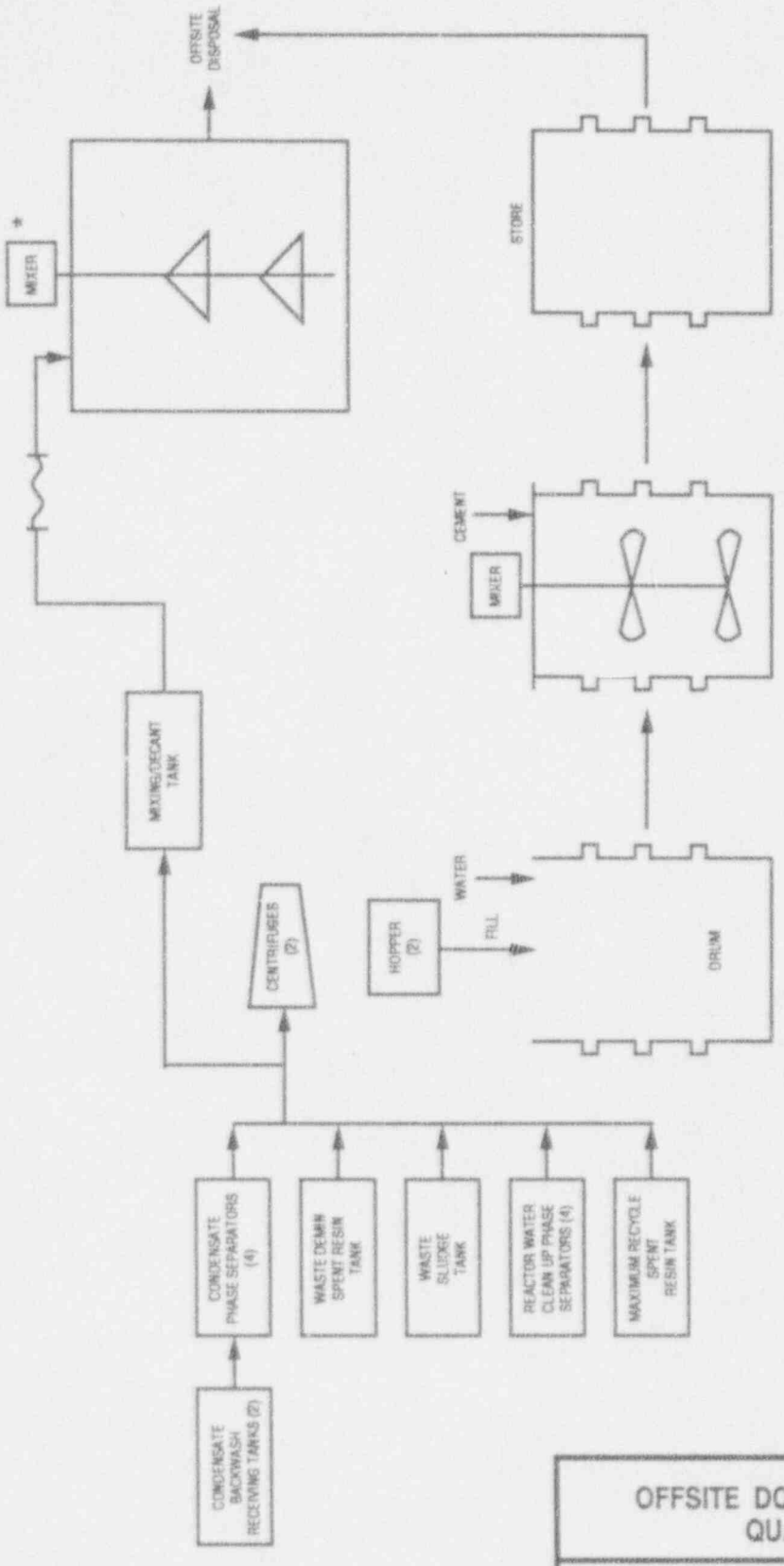
FIGURE 10-3

SIMPLIFIED LIQUID EFFLUENT
FLOW DIAGRAM



* MIXER USED ONLY WITH CEMENT SOLIDIFICATION. NOT USED WHEN DEWATER USING HIGH INTEGRITY CONTAINERS.

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FIGURE 10-4

SIMPLIFIED SOLID RADWASTE PROCESSING DIAGRAM

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CHAPTER 11

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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RADIOLOGICAL ENVIRONMENTAL MONITORING PRCGRAM

The parameters of the radiological environmental monitoring program to be performed in the environs around Quad Cities Station are presented in Table 11-1.

Figure 11-1 shows the 16 fixed air sampling sites and TLD locations; also shown are the outer ring (approximately 5 miles distant) TLD locations. Figure 11-2 shows the inner ring TLD locations. The TLDs are code numbered as follows:

XYY-N

X = 1 means inner ring,

X = 2 means outer ring, and

YY-N is an identification code.

Figure 11-3 shows the milk, fish, water, and sediment sample locations.

The reporting levels for radioactivity concentrations in environmental samples are given in Table 11-2. The practical lower limits of detection for this program are given in Table 11-3.

Table 11-1
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations[a]	Sampling or Collection Frequency	Type and Frequency of Analysis
1. Airborne	a. Onsite and Near Field[b] Q-01 Onsite No. 1 0.5 mi N (0.8 km A) Q-02 Onsite No. 2 0.5 mi ENE (0.8 km D) Q-03 Onsite No. 3 0.6 mi S (1.0 km J) Q-04 Nitrin 1.5 mi NE (2.4 km C) Q-05 Saddle Club Dairy Farm 1.8 mi S (2.9 km J) Q-06 Fairbanks 1.8 mi NNW (2.9 km R)	Continuous sampler operation with particulate filter collection weekly and radioiodine canister collection biweekly[c]	Particulate Sampler: Gross beta analysis following filter change[d] Radioiodine Canister: I-131 analysis biweekly Sampling Train: Test and maintenance weekly
	b. Far Field[b] Q-07 Clinton 9.0 mi NE (14.5 km C) Q-08 Sikkema Farm 7.0 mi ENE (11.3 km D) Q-09 Erie 13.0 mi ESE (20.9 km F)	Continuous sampler operation with particulate filter exchange weekly and radioiodine canister exchange biweekly[c]	Particulate Sampler: Gross beta when analyses are made[d,e]

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations[a]	Sampling or Collection Frequency	Type and Frequency of Analysis
	Q-10 Hillsdale 10.0 mi SE (16.1 km G) Q-11 Port Byron 8.0 mi S (12.9 km J) Q-12 Bettendorf 13.0 mi SW (20.9 km L) Q-13 Princeton 4.8 mi SW (7.7 km L) Q-14 Utica Ridge Road 11.0 mi W (17.7 km N) Q-15 DeWitt 13.0 mi WNW (20.9 km P) Q-16 Low Moor 6.0 mi NNW (9.7 km R)		Radioiodine Canister: I-131 when analyses are made[e] Sampling Train: Test and maintenance weekly
2. Direct Radiation	a. At Air Sampler Sites[b] Same location as fixed air sampling locations in Item 1.	Quarterly	Gamma dose quarterly
	b. Inner Ring[c]	Quarterly	Gamma dose quarterly
	Q-101-1, 0.7 mi N 1.1 km A Q-101-2, 0.7 mi N 1.1 km A Q-102-1, 1.7 mi NNE 2.7 km B Q-102-2, 1.7 mi NNE 2.7 km B Q-103-1, 1.2 mi ENE 1.9 km C Q-103-2, 1.2 mi ENE 1.9 km C Q-104-1, 1.1 mi ENE 1.8 km D Q-104-2, 1.0 mi ENE 1.6 km D Q-104-3, 0.6 mi ENE 1.0 km D Q-105-1, 0.8 mi E 1.3 km E Q-105-2, 0.8 mi E 1.3 km E		

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations[a]	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation (Cont'd)	Q-106-1, 0.7 mi ESE 1.1 km F Q-106-2, 0.7 mi ESE 1.1 km F Q-107-1, 0.7 mi SE 1.1 km G Q-107-2, 0.7 mi SE 1.2 km G Q-107-3, 0.8 mi SE 1.3 km G Q-108-1, 0.9 mi SSE 1.4 km H Q-108-2, 0.9 mi SSE 1.4 km H Q-109-1, 0.9 mi S 1.4 km J Q-109-2, 0.9 mi S 1.4 km J Q-111-1, 2.6 mi SW 4.2 km L Q-111-2, 2.6 mi SW 4.2 km L Q-112-1, 2.4 mi WSW 3.9 km M Q-112-2, 2.4 mi WSW 3.9 km M Q-113-1, 2.5 mi W 4.0 km N Q-113-2, 2.5 mi W 4.0 km N Q-114-1, 2.6 mi WNW 4.2 km P Q-114-2, 2.6 mi WNW 4.2 km P Q-115-1, 2.3 mi NW 3.7 km Q Q-115-2, 2.3 mi NW 3.7 km Q Q-116-1, 2.2 mi NNW 3.5 km R Q-116-2, 2.2 mi NNW 3.5 km R		
	c. Outer Ring[b]	Quarterly	Gamma dose quarterly
	Q-201-1, 4.0 mi N 6.4 km A Q-201-2, 4.0 mi N 6.4 km A Q-202-1, 4.4 mi NNE 7.1 km B Q-202-2, 4.4 mi NNE 7.1 km B Q-203-1, 5.5 mi NE 8.8 km C Q-203-2, 5.5 mi NE 8.8 km C		

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations*	Sampling or Collection Frequency	Type and Frequency of Analysis
2. Direct Radiation (Cont'd)	Q-204-1, 4.5 mi ENE 7.2 km D		
	Q-204-2, 4.5 mi ENE 7.2 km D		
	Q-205-1, 4.5 mi E 7.2 km E		
	Q-205-2, 4.5 mi E 7.2 km E		
	Q-205-4, 4.5 mi E 7.2 km E		
	Q-206-1, 4.8 mi ESE 7.7 km F		
	Q-206-2, 4.8 mi ESE 7.7 km F		
	Q-207-1, 4.8 mi SE 7.7 km G		
	Q-207-2, 4.8 mi SE 7.7 km H		
	Q-207-4, 4.8 mi SE 7.7 km G		
	Q-208-1, 4.4 mi SSE 7.1 km H		
	Q-208-2, 4.4 mi SSE 7.1 km H		
	Q-209-1, 4.8 mi S 7.7 km J		
	Q-209-2, 4.8 mi S 7.7 km K		
	Q-209-4, 4.8 mi S 7.7 km J		
	Q-210-1, 4.4 mi SSW 7.1 km K		
	Q-210-2, 4.4 mi SSW 7.1 km L		
	Q-210-4, 4.4 mi SSW 7.1 km K		
	Q-211-1, 5.0 mi SW 8.0 km L		
	Q-211-2, 5.0 mi SW 8.0 km L		
	Q-212-1, 4.8 mi WSW 7.7 km M		
	Q-212-2, 4.8 mi WSW 7.7 km M		
	Q-213-1, 4.7 mi W 7.6 km N		
	Q-213-2, 4.7 mi W 7.6 km N		
	Q-214-1, 4.8 mi NW 7.7 km P		
	Q-214-2, 4.8 mi NW 7.7 km P		
	Q-215-1, 4.8 mi NW 7.7 km Q		
	Q-215-2, 4.8 mi NW 7.7 km Q		
	Q-216-1, 4.5 mi NNW 7.2 km R		
	Q-216-2, 4.5 mi NNW 7.2 km R		

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations[a]	Sampling or Collection Frequency	Type and Frequency of Analysis
3. Waterborne[a,h]			
a. Public Water	Q-19 East Moline Water Works, 16.0 mi SSW (25.8 km K) Q-20 Davenport Water Works, 18.0 mi SSW (29.0 km L)	Weekly collection composited monthly	Gamma isotopic analysis monthly
b. Cooling Water	Q-21 Intake Canal, 0.1 mi W (0.2 km N) Q-22 Discharge Canal, 0.1 mi SW (0.2 km L)	Weekly	Gross beta analysis weekly
c. Shoreline Sediments[2]	Q-27 Albany, Upstream on Mississippi River, 5.5 mi NE (8.8 km C) Q-28 Cordova, Downstream on Mississippi River, 3.3 mi SSW (5.3 km K)	Annually	Gamma isotopic analysis annually
4. Ingestion[h]			
a. Milk[1]	Q-18 Musal Dairy, 6.0 mi WSW (8.9 km M) Q-26 Bill Stanley Dairy, 3.0 mi ENE (4.8 km F) Q-31 Gerald Peterson Dairy, 5.0 mi ESE (8.0 km F)	Weekly: May to October Monthly: November to April	I-131 analysis on each sample
b. Fish[3]	Q-24 Pool #14 of Miss. River	Semiannually	Gamma isotopic on edible portions of each sample.
5. Land Use Census			
a. Milch Animals	1. Site boundary to 2 miles	Annually during grazing season	Enumeration by a door-to-door or equivalent counting technique.

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations*	Sampling or Collection Frequency	Type and Frequency of Analysis
5. Land Use Census (Cont'd)	2. 2 to 5 miles	Annually during grazing season	Enumeration by using referenced information from county agricultural agencies or other reliable sources.
	3. At dairies listed in Item 4.a.	Annually during grazing season	Inquire as to feeding practices: a. Pasture only. b. Feed and chop only. c. Pasture and feed; If both, ask farmer to estimate fraction of food from pasture: <25%, 25-50%, 50-75%, or >75%.

Table 11-1 (Cont'd)
Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations[a]	Sampling or Collection Frequency	Type and Frequency of Analysis
b. Nearest Resident	In all 16 sectors up to 5 miles.	Annually	

[a] See Table D-16 of Appendix D for definitions of sector codes used with kilometer distances.

[b] See Figure 11-1.

[c] Biweekly means every two weeks.

[d] A gamma isotopic analysis shall be performed wherever the gross beta concentration in a sample exceeds by five times (5x) the average concentration of the preceding calendar quarter for the sample location.

[e] Far field samples are analyzed when near field results are inconsistent with previous measurements and radioactivity is confirmed as having its origin in airborne effluents released from the station or at the discretion of the Emergency Preparedness Director.

[f] See Figure 11-2.

[g] Upstream shoreline sediment monitoring location is not required, serves as control only.

[h] See Figure 11-3.

[i] Milk samples are required from two monitoring locations only. Three dairies are listed to ensure the minimum criteria.

[j] The fish monitoring location is not identified exactly on the map, the point, Q-24, represents the area of the station discharge, Pool #14.

TABLE 11-2

REPORTING LEVELS FOR RADIOACTIVITY
CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/Kg, wet)	Milk (pCi/l)	Food Products (pCi/Kg, wet)
H-3	2×10^4(a)				
Mn-54	1×10^3		3×10^4		
Fe-59	4×10^2		1×10^4		
Co-58	1×10^3		3×10^4		
Co-60	3×10^2		1×10^4		
Zn-65	3×10^2		2×10^4		
Zr-Nb-95	4×10^2(b)				
I-131	2	0.9		3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	1×10^3	70	2×10^3
Ba-La-140	2×10^2(b)			3×10^2	

a) For drinking water samples. This is 40 CFR Part 141 value.

b) Total for parent and daughter.

TABLE 11-3

PRACTICAL LOWER LIMITS OF DETECTION (LLD)
FOR STANDARD ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Sample Media	Analysis	LLD[A,B] (4.66 Σ)	Units
Airborne "Particulate"	Gross Beta +	0.01	pCi/m^3
	Gamma Isotopic	0.01	pCi/m^3
Airborne I-131	Iodine 131	0.10	pCi/m^3
Milk/Public Water	I-131	5°	pCi/l
	Cs-134	10	pCi/l
	Cs-137	10 Δ	pCi/l
	Tritium	200	pCi/l
	Gross Beta +	5	pCi/l
	Gamma Isotopic	20	
pCi/l/nuclide			
Sediment	Gross Beta +	2	pCi/g
dry			
	Gamma Isotopic	0.2	pCi/g
dry			
Fish Tissue	I-131 Thyroid	0.1	pCi/g
wet			
	Cs-134, 137	0.1	pCi/g
wet			
	Gross Beta +	1.0	pCi/g
wet			
	Gamma Isotopic	0.2	pCi/g
wet			

° 0.5 pCi/l on milk samples collected during the pasture season.

+ Referenced to Cs-137

Δ 5.0 pCi/l on milk samples

Table 11-3 (Cont'd)

PRACTICAL LOWER LIMITS OF DETECTION (LLD)

FOR STANDARD ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

General Notes:

1. Other radionuclides which are measurable and identifiable by gamma ray spectrometry, together with the nuclides indicated in Table 11-3, shall also be identified and reported when an actual analysis is performed on a sample. Nuclides which are below the LLD for the analyses shall not be reported as being present at the LLD level for that nuclide.

2. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a real signal. For a particular measurement system (which may include radiochemical separation).

$$LLD = \frac{4.66 \cdot (S_b)}{(A) \cdot (E) \cdot (V) \cdot (2.22) \cdot (Y) \cdot (\exp(-\lambda\Delta t)) \cdot (t)}$$

LLD — The *a priori* lower limit of detection for a blank sample or background analysis as defined above (as pCi per unit mass or volume).

S_b — The square root of the background count or of a blank sample count; it is the estimated standard error of a background count or a blank sample count as appropriate (in units of counts).

E — The counting efficiency (as counts per disintegration).

A — The number of gamma rays emitted per distintegration for gamma ray radionuclide analysis (A = 1.0 for gross alpha and tritium measurements).

V — The sample size (in units of mass or volume).

2.22 — The number of disintegrations per minute per picocurie.

Y — The fractional radiochemical yield when applicable (otherwise Y = 1.0).

Table 11-3 (Cont'd)

**PRACTICAL LOWER LIMITS OF DETECTION (LLD)
FOR STANDARD ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM**

λ The radioactive decay constant for the particular radionuclide (in units of reciprocal minutes).

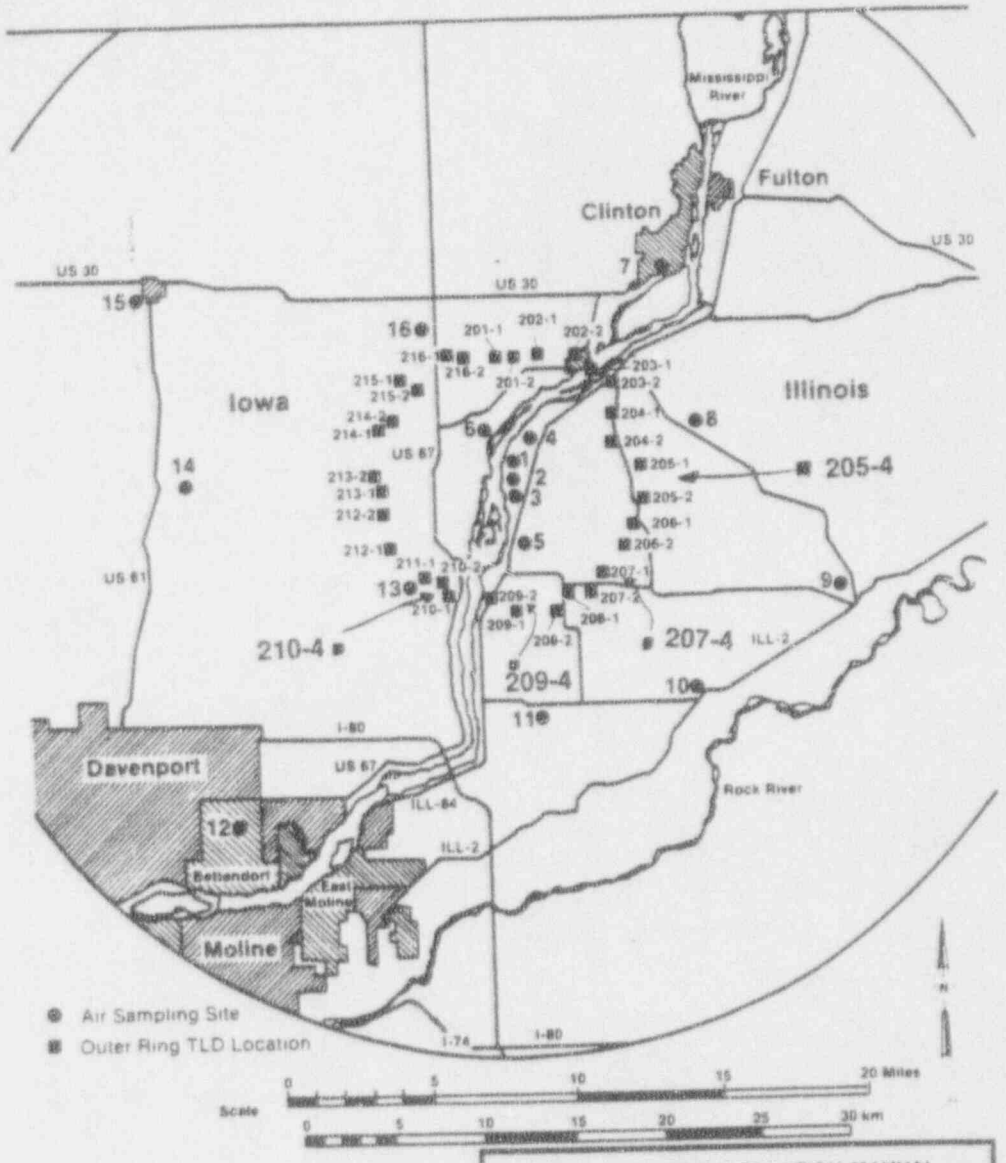
Δt The elapsed time between the midpoint of sample collection and the start time of counting ($\Delta t = 0.0$ for environmental samples and for gross alpha measurements).

t The duration of the count (in units of minutes).

The value of S_b used in the calculation of the LLD for a detection system shall be based on an actual observed background count or a blank sample count (as appropriate) rather than on an unverified theoretically predicted value. Typical values of E, V, Y, t, and Δt shall be used in the calculation.

For gamma ray radionuclide analyses the background counts are determined from the total counts in the channels which are within plus or minus one FWHM (Full Width at Half Maximum) of the gamma ray photopeak energy normally used for the quantitative analysis for that radionuclide. Typical values of the FWHM shall be used in the calculation.

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

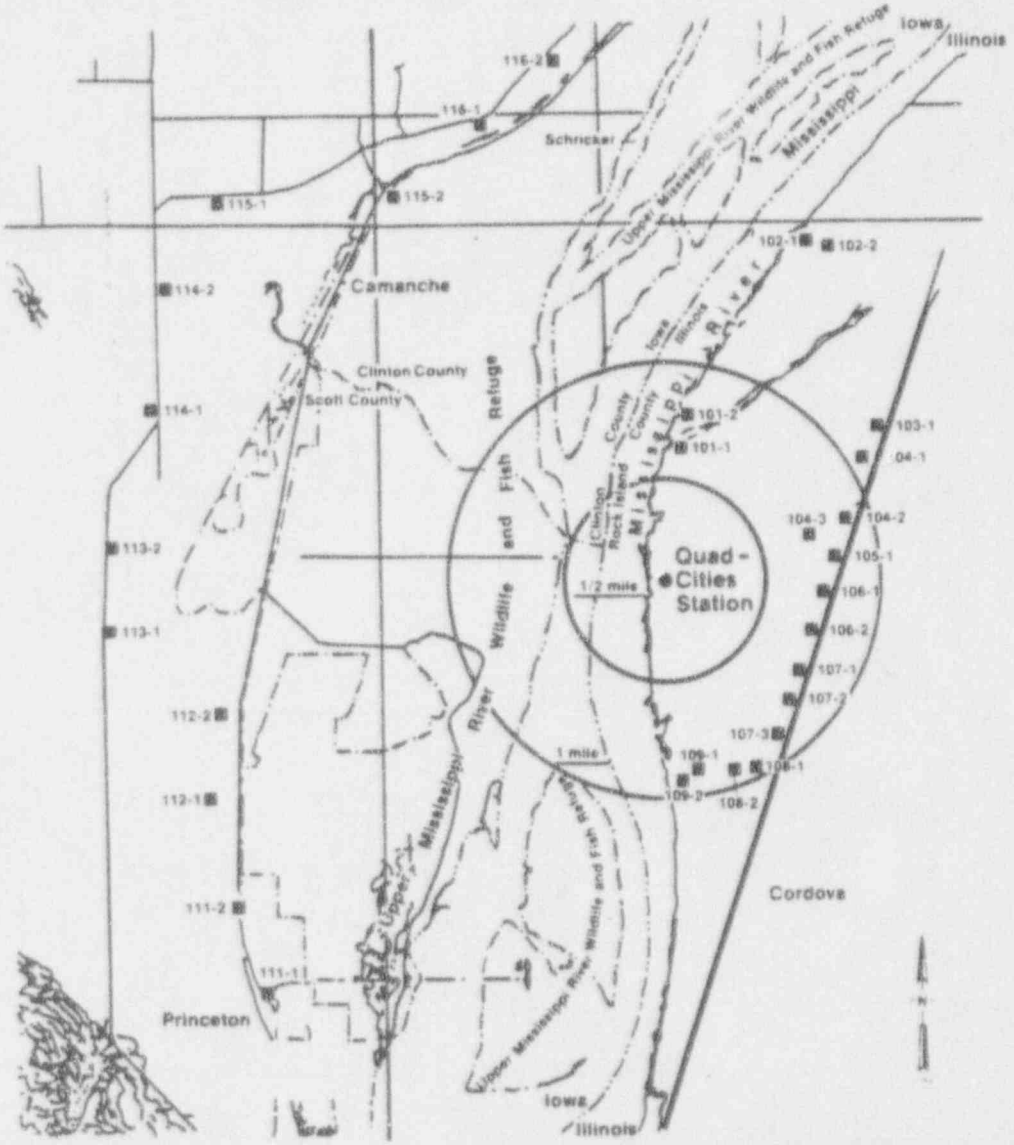


OFFSITE DOSE CALCULATION MANUAL
QUAD-CITIES STATION

FIGURE 11-1

FIXED AIR SAMPLING SITES AND
OUTER RING TLD LOCATIONS

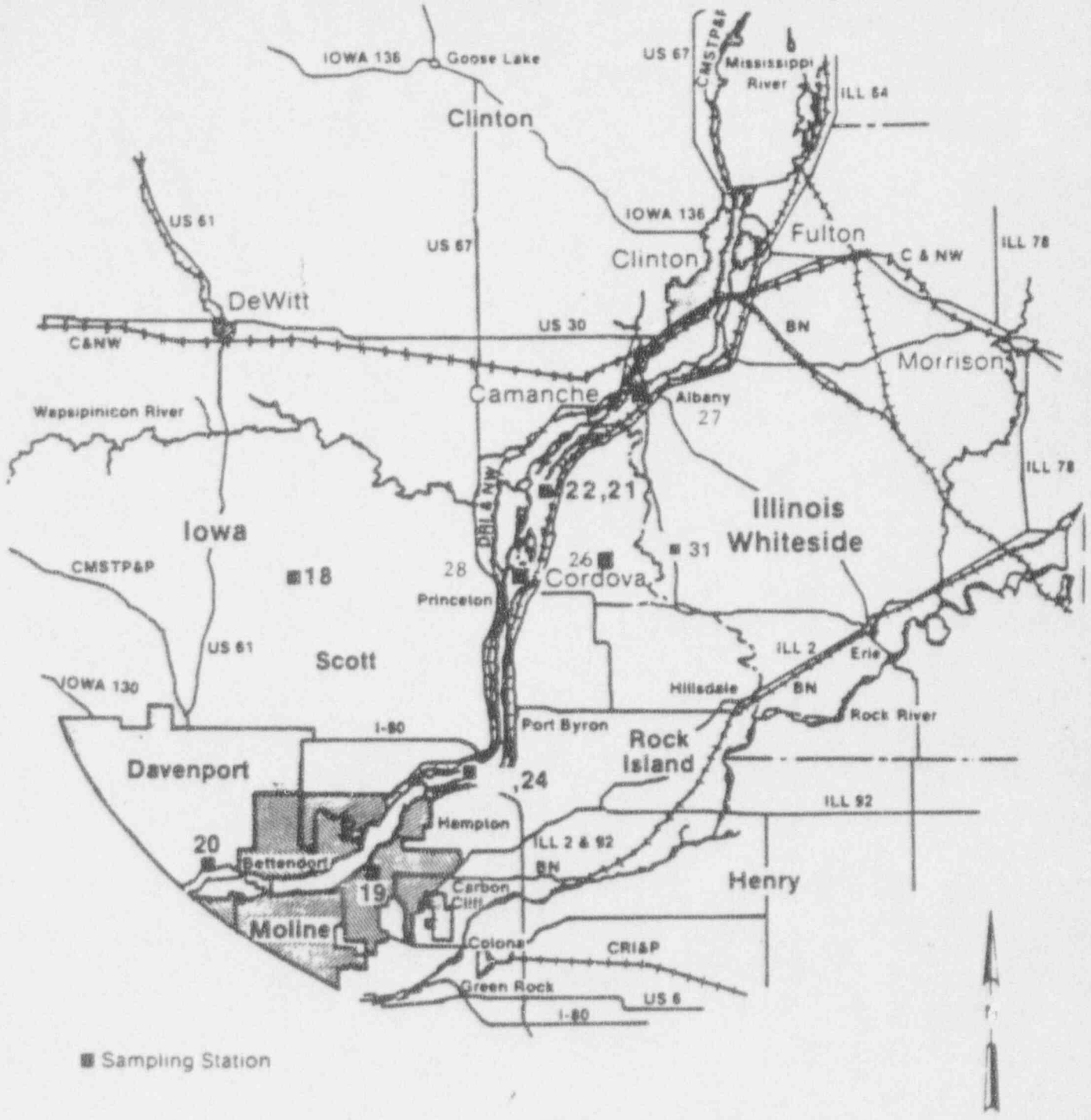
6415-1
10-85—372



OFFSITE DOSE CALCULATION MANUAL QUAD-CITIES STATION
FIGURE 11-2 INNER RING TLD LOCATIONS

6415-3
10-85-372

QUAD CITIES



OFFSITE DOSE CALCULATION MANUAL
QUAD-CITIES STATION

FIGURE 11-3

MILK, FISH, WATER, AND SEDIMENT SAMPLE LOCATIONS

15-2
-85-372

This page reserved for GENERIC QUAD CITIES ANNEX INDEX

CHAPTER 12.0

All pages in Chapter 12.0 are designated REVISION 1.0

SPECIAL NOTE

Until removal of the Radiological Effluent Technical Specifications has been approved by the Nuclear Regulatory Commission, the requirements of the Technical Specifications shall take precedence over this chapter, should any differences occur.

PAGE	REVISION
12 - i	1.0
12 - ii	1.0
12 - iii	1.0
12 - iv	1.0
12 - 1	1.0
12 - 2	1.0
12 - 3	1.0
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CHAPTER 12

RADIOACTIVE EFFLUENT TECHNICAL STANDARDS
(RETS)
TABLE OF CONTENTS

CHAPTER 12

RADIOACTIVE EFFLUENT TECHNICAL STANDARDS (RETS) LIST OF TABLES

* At present, there is no Table 12.3-2 in this chapter.

12.1 Definitions

12.1.1 Channel Calibration - A Channel Calibration shall be the adjustment, as necessary, of the Channel output such that it responds with the necessary range and accuracy to known values of the parameter which the Channel monitors. The Channel Calibration shall encompass the entire Channel including the sensor and alarm and/or trip functions, and shall include the Channel Functional Test. The Channel Calibration may be perfomed by any series of sequential, overlapping or total Channel steps such that the entire Channel is calibrated.

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

12.1.3 Channel Function Test - A Channel Functional Test shall be:

a. Analog Channels - the injection of a simulated signal into the Channel as close to the sensor as practicable to verify Operability including alarm and/or trip functions and Channel failure trips.

b. Bistable Channels - the injection of a simulated signal into the sensor to verify Operability including alarm and/or trip functions.

The Channel Functional Test may be performed by any series of sequential, overlapping or total Channel steps such that the entire Channel is tested.

12.1.4 Dose Equivalent I-131 - Dose Equivalent I-131 is that concentration of I-131 (microcurie/ gram) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in Table III of TID-14844, "Calculation of Distance Factors For Power and Test Reactor Sites."

12.1.5 Hot Standby - Hot standby means operation with the reactor critical, system pressure less than 1060 psig, the main steam isolation valves closed, and thermal power not exceeding 15%.

12.1.6 Immediate - Immediate means that the required action will be initiated as soon as practicable considering the safe operation of the unit and the importance of the required action.

12.1.7 Member(s) of the Public - Members of the Public means an individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

12.1.8 Modes Switch Interlock - A reactor mode switch selects the proper interlocking for the operating or shutdown condition of the plant. Following are the reactor mode switch positions and interlocks provided:

1. Shutdown - In this position, a reactor scram is initiated, power to the control rod drives is removed, and the reactor protection trip systems have been deenergized for 10 seconds prior to permissive for manual reset.

2. Refuel - In this position, interlocks are established so that one control rod only may be withdrawn when flux amplifiers are set at the proper sensitivity level and the refueling crane is not over the reactor. Also the trips from the turbine control valves, turbine stop valves, main steam isolation valves, and condenser vacuum are bypassed. If the refueling crane is over the reactor, all rods must be fully inserted and none can be withdrawn.

3. Startup/Hot Standby - In this position, the reactor protection scram trips, initiated by condenser low vacuum and main steamline isolation valve closure, are bypassed, the low pressure main steamline isolation valve closure trip is bypassed, and the reactor protection system is energized, with IRM and APRM neutron monitoring system trips and control rod withdrawal interlocks in service.

4. Run - In this position, the reactor system pressure is at or above 825 psig and the reactor protection system is energized with the APRM protection and RBM interlocks in service (excluding the 15% high flux scram).

12.1.9 Offsite Dose Calculation Manual (ODCM) - The Offsite Dose Calculation Manual shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Radiological Environmental Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by Sections 12-5 and (2) descriptions of the information that should be included in the Radioactive Effluent Release Reports and in the Annual Radiological Environmental Operating Reports required by Sections 12.6.2.1 and 12.6.2.2.

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

12.1.11 Operating - Operating means that a system, subsystem, train, component or device is performing its intended functions in its required manner.

12.1.12 Operating Cycle - Operating Cycle is the interval between the end of one Refueling Outage for a particular unit and the end of the next subsequent Refueling Outage for the same unit.

12.1.13 Process Control Program (PCP) - The Process Control Program shall contain the current formulas, sampling, analyses, test, and determinations to be made to ensure that processing and packaging of solid radioactive wastes based on demonstrated processing of actual or simulated wet solid wastes will be accomplished in such a way as to assure compliance with 10CFR Parts 20, 61, and 71, State regulations, burial ground requirements, and other requirements governing the disposal of solid radioactive waste.

12.1.14 Protective Instrumentation Definitions - Protective instrumentation definitions are as follows:

a. Channel - A Channel is an arrangement of a sensor and associated components used to evaluate plant variables and produce discrete outputs used in logic. A Channel terminates and loses its identity where individual Channel outputs are combined in a logic.

b. Trip System - A Trip System means an arrangement of instrument Channel trip signals and auxiliary equipment required to initiate action to accomplish a protective trip function. A Trip System may require one or more instrument Channel trip signals related to one or more plant parameters in order to initiate Trip System action. Initiation of Protective Action may require the tripping of a single Trip System or the coincident tripping of two Trip Systems.

c. Protective Action - An action initiated by the protection system when a limit is reached. A Protective Action can be at the Channel or system level.

d. Protective Function - A system protective action which results form the Protective Action of the Channels monitoring a particular plant condition.

12.1.15 Rated Thermal Power - Rated Thermal Power means a steady- state power level of 2511 thermal megawatts.

12.1.16 Reactor Power Operation - Reactor Power Operation is any operation with the mode switch in the Startup/Hot Standby or Run position with the reactor critical and above 1% Rated Thermal Power.

12.1.17 Reactor Vessel Pressure - Reactor Vessel Pressures listed in the Technical Specifications, unless otherwise indicated, are those measured by the reactor vessel steam space detector.

12.1.18 Refueling Outage - Refueling Outage is the period of time between the shutdown of the unit prior to a refueling and startup of the plant subsequent to that refueling. For the purpose of designating frequency of testing and surveillance, a Refueling Outage shall mean a regularly scheduled Refueling Outage; however, where such outages occur within 8 months of the completion of the previous Refueling Outage, the required surveillance testing need not be performed until the next regularly scheduled outage.

12.1.19 Source Check - Source Check is the qualitative assessment of instrument response when the sensor is exposed to a radioactive source.

12.1.20 Definitions Related to Estimating Dose to the Public Using the Appendix I Computer Program:

a. Actual - Refers to using known release data to project the dose to the public for the previous month. This data is stored in the database and used to demonstrate compliance with the reporting requirements of Chapter 12.

b. Projected - Refers to using known release data from the previous month or estimated release data to forecast a future dose to the public. This data is NOT incorporated into the database.

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12.2 INSTRUMENTATION

12.2.1.A Radioactive Liquid Effluent Instrumentation Operability

Applicability: Applies to radioactive effluents from the plant.

The effluent monitoring instrumentation shown in Table 12.2.1 shall be operable with alarm setpoints set to ensure that the limits of Section 12.3 are not exceeded. The alarm setpoints shall be determined in accordance with Section 10.2.

1. With a radioactive liquid effluent monitoring instrument alarm/trip setpoint less conservative than required, without delay suspend the release of radioactive liquid effluents monitored by the affected instrument, or declare the instrument inoperable, or change the setpoint so it is acceptably conservative.

2. With one or more radioactive liquid effluent monitoring instruments inoperable, take the action shown in Table 12.2-1. Exert best efforts to return the instrument to operable status within 30 days and, if unsuccessful, explain in the next Semi-Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

12.2.1.B Radioactive Liquid Effluent Instrumentation Surveillance

Applicability: Applies to the periodic measurements of radioactive effluents.

Each radioactive liquid effluent monitoring instrument shown in Table 12.2-2 shall be demonstrated operable by performance of the given source check, instrument check, calibration, and functional test operations at the frequencies shown in Table 12.2-2.

12.2.1.A Radioactive Liquid Effluent Instrumentation Operability	12.2.1.B Radioactive Liquid Effluent Instrumentation Surveillance
3. In the event a limiting condition for operation and associated action requirements cannot be satisfied because of circumstances in excess of those addressed in the specifications, provide a 30-day written report to the NRC and no changes are required in the operational condition of the plant, and this does not prevent the plant from entry into an operational mode.	

12.2.2.A Radioactive Gaseous Effluent Instrumentation Operability

The effluent monitoring instrumentation shown in Table 12.2-3 shall be operable with alarm/trip setpoints set to ensure that the limits of Section 12.4 are not exceeded. The alarm/trip setpoints shall be determined in accordance with the Section 10.1.

1. With a radioactive gaseous effluent monitoring instrument alarm/trip set point less conservative than required, without delay suspend the release of radioactive gaseous effluents monitored by the affected instrument, or declare the instrument inoperable, or change the setpoint so it is acceptably conservative.

2. With one or more radioactive gaseous effluent monitoring instruments inoperable, take the action shown in Table 12.2-3. Exert best efforts to return the instrument to operable status within 30 days and, if unsuccessful, explain in the next Semi-Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner. This is in lieu of an LER.

3. In the event a limiting condition for operation and associated action requirements cannot be satisfied because of circumstances in excess of those addressed in the specifications, provide a 30-day written report to the NRC and no changes are required in the operational condition of the plant, and this does not prevent the plant from entry into an operational mode.

12.2.2.B Radioactive Gaseous Effluent Instrumentation Surveillance

Each radioactive gaseous radiation monitoring instrument in Table 12.2-4 shall be demonstrated operable by performance of the given source check, instrument check, calibration, and functional test operations at the frequency shown in Table 12.2-4.

TABLE 12.2-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Minimum No. of Operable Channels	Total No. of Channels	Parameter	Action[1]
1	1	Service Water Effluent Gross Activity Monitor	A
1	1	Liquid Radwaste Effluent Flow Rate Monitor	C
1	1	Liquid Radwaste Effluent Gross Activity Monitor	B

Notes

Action A: With less than the minimum number of operable channels, releases via this pathway may continue, provided that at least once per 12 hours grab samples are collected and analyzed for beta or gamma activity at an LLD of less than or equal to 10^{-7} uCi/ml.

Action B: With less than the minimum number of operable channels, effluent releases via this pathway may continue, provided that prior to initiating a release, at least 2 independent samples are analyzed in accordance with Section 12.3.A.1, and at least 2 members of the facility staff independently verify the release calculation and discharge valving. Otherwise, suspend release of radioactive effluents via this pathway.

Action C: With less than the minimum number of operable channels, releases via this pathway may continue, provided the flow rate is estimated at least once per 4 hours during actual releases. Pump curves may be utilized to estimate flow.

TABLE 12.2-2

RADIOACTIVE LIQUID EFFLUENT MONITORING
INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Instrument	Instrument Check(1)	Calibration(1)(3)	Functional Test(1)(2)	Source Check(1)
Liquid Radwaste Effluent Gross Activity Monitor	D	R	Q (7)	(6)
Service Water Effluent Gross Activity Monitor	D	R	Q (7)	R
Liquid Radwaste Effluent Flow Rate Monitor	(4)	R	NA	NA

Notes

(1) D = once per 24 hours
M = once per 31 days
Q = once per 92 days
R = once per 18 months
S = once per 6 months

(2) The Instrument Functional Test shall also demonstrate that control room alarm annunciation occurs, if any of the following conditions exist, where applicable.

a. Instrument indicates levels above the alarm setpoints.
b. Circuit failure.
c. Instrument indicates a downscale failure.
d. Instrument controls not set in OPERATE mode.

(3) Calibration shall include performance of a functional test.

(4) Instrument Check to verify flow during periods of release.

(5) Calibration shall include performance of a source check.

(6) Source check shall consist of observing instrument response during a discharge.

(7) Functional test may be performed by using trip check and test circuitry associated with the monitor chassis.

TABLE 12.2-3

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Minimum No. of Operable Channels[1]	Total No. of Channels	Parameter	Action [2]
1	2	SJAE Radiation Monitors	D
1	2	Main Chimney Noble Gas Activity Monitor	A
1	1	Main Chimney Iodine Sampler	C
1	1	Main Chimney Particulate Sampler	C
1	1	Reactor Bldg. Vent Sampler Flow Rate Monitor	B
1	1	Reactor Bldg. Vent Iodine Sampler	C
1	1	Reactor Bldg. Vent Particulate Sampler	C
1	1	Main Chimney Sampler Flow Rate Monitor	B
1	1	Main Chimney Flow Rate Monitor	B
1	2	Reactor Bldg. Vent Noble Gas Monitor	E
1	1	Main Chimney High Range Noble Gas Monitor	F

Notes

(1) For SJAE monitors, applicable during SJAE operation. For other instrumentation, applicable at all times.

(2) Action A: With the number of operable channels less than the minimum requirement, effluent releases via this pathway may continue, provided grab samples are taken at least once per 8 hour shift and these samples are analyzed within 24 hours.

TABLE 12.2-3 (Con't)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Action B: With the number of operable channels less than the minimum required, effluent releases via this pathway may continue provided that the flow rate is estimated at least once per 4 hours.

Action C: With less than the minimum channels operable, effluent releases via this pathway may continue provided samples are continuously collected with auxiliary sampling equipment, as required in Table 12.4-1.

Action D: With less than the minimum channels operable, gases from the main condenser off gas system may be released to the environment for up to 72 hours provided at least one chimney monitor is operable; otherwise, be in hot stand-by in 12 hours.

Action E: With less than the minimum channels operable, immediately suspend release of radioactive effluents via this pathway.

Action F: With less than the minimum channels operable, initiate the preplanned alternate method of monitoring the appropriate parameter(s) within 72 hours, and:

(1) either restore the inoperable channel(s) to operable status within 7 days of the event, or

(2) prepare and submit a Special Report to the Commission within 30 days following the event outlining the action taken, the cause of the inoperability and the plans and schedule for restoring the system to operable status.

TABLE 12.2-4

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Instrument	Mode(2)	Instrument Check(1)	Calibration(1)(4)	Functional Test(1)(3)	Source Check(1)
Main Chimney Noble Gas Activity Monitor	B	D	R	Q	M
Main Chimney Sampler Flow Rate Monitor	B	D	R	Q[6]	NA
Reactor Bldg. Vent Sampler Flow Rate Monitor	B	D	R	Q[6]	NA
Main Chimney Flow Rate Monitor	B	D	R	Q	NA
Reactor Bldg Vent Activity Monitor	B	D	R	Q	Q
SJAE	A	D	R	Q	R
Main Chimney Iodine and Particulate Sampler	B	D[5]	NA	NA	NA
Reactor Bldg. Vent Iodine and Particulate Sampler	B	D[5]	NA	NA	NA
Main Chimney High Range Noble Gas Monitor	B	D[5]	R	Q	M

Notes

(1) D = once per 24 hours
M = once per 31 days
Q = once per 92 days
R = once per 18 months

(2) A = during SJAE operation
B = at all times

(3) The Instrument Functional Test shall also demonstrate that control room alarm annunciation occurs, if any of the following conditions exist, where applicable:

a. Instrument indicates levels above the alarm setpoint
b. Circuit failure
c. Instrument indicates a downscale failure
d. Instrument controls not set in OPERATE mode

TABLE 12.2-4 (cont'd)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

(4) Calibration shall include performance of a functional test.

(5) Instrument check to verify operability of the instrument; that the instrument is in place and functioning properly.

(6) Functional test shall be performed on local switches providing low flow alarm.

12.2.C LIQUID AND GASEOUS EFFLUENTS INSTRUMENTATION BASES

1. The radioactive liquid and gaseous effluent instrumentation is provided to monitor the release of radioactive materials in liquid and gaseous effluents during releases. The alarm setpoints for the instruments are provided to ensure that the alarms will occur prior to exceeding the limits of RETS and 10 CFR 20.

12.3.A Liquid Effluents Limits and Reporting

1. The concentration of radioactive material released form the site to unrestricted areas (at or beyond the site boundary, see Quad Cities Station ODCM Annex, Appendix F, Figure F-1) shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table 11, Column 2 with the Table 12.3-1 values representing the MPC's for noble gases.

   With the concentration of radioactive material released from the site to unrestricted areas exceeding the above limits, without delay decrease the release rate of radioactive materials and/or increase the dilution flow rate to restore the concentration to within the above limits.

2. The dose or dose commitment above background to a member of the public from radioactive materials in liquid effluents released to unrestricted areas (at or beyond the site boundary) from the site shall be limited to the following:

   a. During any calendar quarter:

      (1) Less than or equal to 3 mrem to the whole body.

      (2) Less than or equal to 10 mrem to any organ.

12.3.B Liquid Effluents Surveillance

1. The concentration of radioactive material in unrestricted areas shall be determined to be within the prescribed limits by obtaining the representative samples in accordance with the sampling and analysis program specified in Table 12.3-3. The sample analysis results will be used with the calculational methods in the ODCM to determine that the concentrations are within the limits of Specification 12.3.A.1.

2. a. The dose contributions from measured quantities of radioactive material shall be determined by calculation at least once per 31 days and a cumulative summation of these total body and organ doses shall be maintained for each calendar quarter.

12.3.A Liquid Effluents Limits and Reporting	12.3.B Liquid Effluents Surveillance
3 b. During any calendar year: (1) Less than or equal to 6 mrem to the whole body. (2) Less than or equal to 20 mrem to any organ. c. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions taken and the proposed actions to be taken to ensure that future releases are in compliance with 12.3.A.2.a & b. This is in lieu of a Licensee Event Report. d. With the calculated dose from the release of radioactive materials in liquid effluents exceeding the limits of Specification 12.3.A.2.a. or 12.3.A.2.b., prepare and submit a Special Report to the Commission within 30 days and limit the subsequent releases such that the dose or dose commitment to a member of the public from	b. Doses computed at the nearest community water system will consider only the drinking water pathway and shall be projected using the methods prescribed in the ODCM at least once per 92 days.

12.3.A Liquid Effluents Limits and Reporting	12.3.B Liquid Effluents Surveillance
all uranium fuel cycle sources is limited to less than or equal to 25 mrem to the total body or any organ (except thyroid, which is limited to less than or equal to 75 mrem) over 12 consecutive months. This Special Report shall include an analysis which demonstrates that radiation exposures to all members of the public from all uranium fuel cycle sources (including all effluent pathways and direct radiation) are less than the 40 CFR Part 190 Standard. Otherwise obtain a variance from the Commission to permit releases which exceed the 40 CFR Part 190 Standard. The radiation exposure analysis contained in the Special Report shall use methods prescribed in the ODCM. This report is in lieu of a Licensee Event Report.	
3 e. With the projected annual whole body or any internal organ dose computed at the nearest downstream community water system is equal to or exceeds 2 mrem from all radioactive materials released in liquid effluents from the Station, prepare and submit a Special Report within 30 days to the operator of the community water syster.	

12.3.A Liquid Effluents Limits and Reporting

The report is prepared to assist the operator in meeting the requirements of 40 CFR 141: EPA Primary Drinking Water Standards. A copy of this report will be sent to the NRC. This is in lieu of a Licensee Event Report.

3. At all times during processing prior to discharge to the environs, process and control equipment provided to reduce the amount or concentration of radioactive materials shall be operated when the projected dose due to liquid effluent releases to unrestricted areas (see Figure 12.5-1), when averaged over 31 days, exceeds 0.13 mrem to the total body or 0.42 mrem to any organ.

4. If liquid waste has to be or is being discharged without treatment as required above, prepare and submit to the Commission within 30 days, a report which includes the following information:

   a. Identification of the defective equipment.

   b. Cause of the defective equipment.

   c. Action(s) taken to restore the equipment to an operating status.

   d. Length of time the above requirements were not satisfied.

12.3.B Liquid Effluents Surveillance

3. Liquid Waste Treatment

   a. Doses due to liquid releases to unrestricted areas (at or beyond the site boundary) shall be projected at least once per 31 days in accordance with ODCM.

12.3.A Liquid Effluents Limits and Reporting

5. In the event a limited and/or associated action requirements identified in Sections 12.3.A and 12.3.B cannot be satisfied because of circumstances in excess of those addressed in this Section, no changes are required in the operational condition of the plant, and this does not prevent the plant from entry into an operational mode.

TABLE 12.3-1

ALLOWABLE CONCENTRATION OF DISSOLVED OR ENTRAINED NOBLE GASES RELEASED FROM THE SITE TO UNRESTRICTED AREAS IN LIQUID WASTE

NUCLIDE	AC(uCi/ml)*
Kr-85m	2×10^{-4}
Kr-85	5×10^{-4}
Kr-87	4×10^{-5}
Kr-88	9×10^{-5}
Ar-41	7×10^{-5}
Xe-131m	7×10^{-4}
Xe-133m	5×10^{-4}
Xe-133	6×10^{-4}
Xe-135m	2×10^{-4}
Xe-135	2×10^{-4}

* Computed from Equation 20 of ICRP Publication 2 (1959), adjusted for infinite cloud submersion in water, and R = 0.01 rem/week, density = 1.0 g/cc abd Pw/Pt = 1.0.

TABLE 12.3-3
RADIOACTIVE LIQUID WASTE SAMPLING
AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD) (uci/ml)
A. Batch Waster Release Tanks	Prior to Each Batch	Prior to Each Batch	Principal Gamma Emitters[a]	$5x10^{-7}$
			I-131	$1x10^{-6}$
	Prior to Each Batch	M Composite[b]	Gross Alpha	$1x10^{-7}$
			H-3	$1x10^{-5}$
	Prior to Each Batch	Q Composite[b]	Fe-55	$1x10^{-6}$
			Sr-89, Sr-90	$5x10^{-8}$
	Prior to One Batch/M	M	Dissolved & Entrained Gases[f] (Gamma Emitters)	$1x10^{-5}$
B. Plant Continuous Releases	M[c] (Grab Sample)	M[c]	I-131	$1x10^{-6}$
			Principle Gamma Emitters[a]	$5x10^{-7}$
			Dissolved and Entrained Gases[f] (Gamma Emitters)	$1x10^{-5}$
			H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	Q[c] (Grab Sample)	Q[c]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

TABLE 12-3-3 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING
AND ANALYSIS PROGRAM

TABLE NOTATION

a. The LLD is defined in Notation A of Table 11-3.

b. A composite sample is one in which the quantity of liquid samples is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

c. If the alarm setpoint of the service water effluent monitor as determined in the ODCM is exceeded, the frequency of analysis shall be increased to daily until the condition no longer exists.

d. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated then thoroughly mixed to assure representative sampling. A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume or system that has an input flow during the release.

e. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-60, Zn-65, Co-58, Mo-99, Cs-134, Cs137, Ce-141, and Ce-144. Other peaks which are measurable and identifiable by gamma ray spectrometry together with the above nuclides, shall be also identified and reported when the actual analysis is performed on a sample. Nuclides which are below the LLD for the analyses shall not be reported as being present at the LLD level for that nuclide.

f. The dissolved and entrained gases (gamma emitters) for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138. Other dissolved and entrained gases (gamma emitters) which are measurable and identifiable by gamma-ray spectrometry, together with the above nuclides, shall also be identified and reported when an actual analysis is performed on a sample. Nuclides which are below the LLD for the analyses shall not be reported as being present at the LLD level for that nuclide.

12.3.C LIQUID EFFLUENTS BASES

1. Concentration

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site to unrestricted areas will be less than the concentration levels specified in Appendix B, Table 2, Column 2 to 10CFR20.1001 - 20.2402. The concentration limit for noble gases was converted to an equivalent concentration in water using the International Commission on Radiological Protection (ICRP) Publication 2.

2. Dose

This specification is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.A of Appendix I. The statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable". The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents will be consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I", April 1977. NUREG-0113 provides methods for dose calculations consistent with Reg Guide 1.109 and 1.113.

12.3.C LIQUID EFFLUENTS BASES (CONT.)

3. Liquid Waste Treatment

The operability of the liquid radwaste treatment system ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and design objective Section 11.D of Appendix I to 10 CFR Part 50.

12.4 Gaseous Effluents

12.4.A. Gaseous Effluents Limits and Reporting

1. The dose rate in unrestricted areas (at or beyond the site boundary, see Quad Cities Station ODCM Annex, Appendix F, Figure F-1) due to radioactive materials released in gaseous effluents from the site shall be limited to the following:

   a. For Noble Gases:

      (1) Less than 500 mrem/ year to the whole body.

      (2) Less than 3000 mrem/ year to the skin.

   b. For iodine-131, for iodine 133, and for all radionuclides in particulate form with half-lives greater than 8 days less than 1500 mrem/year.

12.4.B Gaseous Effluents Surveillance

1. The dose rates due to radioactive materials released in gaseous effluents from the site shall be determined to be within the prescribed limits by obtaining representative samples in accordance with the sampling and analysis program specified in Table 12.4-1. The dose rates are calculated using methods prescribed in the Off-Site Dose Calculation Manual (ODCM).

12.4.A. Gaseous Effluents Limits and Reporting	12.4.B Gaseous Effluents Surveillance
c. If the dose rates exceed the above limits, without delay decrease the release rates to bring the dose rates within the limits, and to provide prompt notification to the Commission (12.6.2.1)	
2. The air dose in unrestricted areas (at or beyond the site boundary) due to Noble Gases released in gaseous effluents from the unit shall be limited to the following:	2. The air dose due to releases of radioactive noble gases in gaseous effluents shall be determined to be within the prescribed limits by obtaining representative samples in accordance with the sampling and analysis program specified in sections A and B of Table 12.4-1. The allocation of effluents between units having shared effluent control systems and the air doses are determined using methods prescribed in the ODCM at least once every 31 days.
a. For gamma radiation:	
(1) Less than or equal to 5 mrad during any calendar quarter.	
(2) Less than or equal to 10 mrad during any calendar year.	
b. For Beta radiation:	
(1) Less than or equal to 10 mrad during any calendar quarter.	
(2) Less than or equal to 20 mrad during any calendar year.	

12.4.A.	Gaseous Effluents Limits and Reporting	12.4.B	Gaseous Effluents Surveillance

2 c. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to ensure that future releases are in compliance with 12.4.A.2.a & b. This is in lieu of a Licensee Event Report.

d. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding the limits of Specification 12.4.A.2.a. or 12.4.A.2.b., prepare and submit a Special Report to the Commission within 30 days and limit the subsequent releases such that the doses or dose committment to a member of the public from all uranium fuel cycle sources is limited to less than or equal to 25 mrem to the total body or any organ (except thyroid, which is limited to less than or equal to 75 mrem) over 12 consecutive months. This Special Report shall include an analysis which demonstrates that radiation exposure to all members of the public from all uranium fuel cycle sources (including all effluent pathways and direct

12.4.A. Gaseous Effluents Limits and Reporting	12.4.B Gaseous Effluents Surveillance
radiation) are less than the 40 CFR Part 90 Standard. Otherwise, obtain a variance from the Commission to permit releases which exceed the 40 CFR Part 190 Standard. The radiation exposure analysis contained in the Special Report shall use the methods prescribed in the ODCM. This report is in lieu of a Licensee Event Report.	
3. The dose to a member of the public in unrestricted areas (at or beyond the site boundary) from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from the unit shall be limited to the following:	3. The dose to a member of the public due to releases of iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days shall be determined to be within the prescribed limits by obtaining representative samples in accordance with the sampling and analysis program specified in Table 12.4-1. For radionuclides not determined in each batch or weekly composite, the dose contribution to the current calendar quarter cumulative summation may be estimated by assuming an average monthly concentration based on the previous monthly or quarterly composite analyses. However, for reporting purposes, the calculated dose contributions shall be based on the actual composite analyses when possible. The allocation of effluents between units having shared effluent control systems and the doses are determined using the methods prescribed in the ODCM at least once every 31 days.

12.4.A.	Gaseous Effluents Limits and Reporting	12.4.B	Gaseous Effluents Surveillance

3 a. Less than or equal to 7.5 mrem to any organ during any calendar quarter.

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

c. With the calculated dose from the release of iodine131, iodine-133, tritium, and all radionuclides in particulate form with halflives greater than 8 days in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions taken and the proposed actions to be taken to ensure that future releases are in compliance with 12.4.A.3.a & 12.4.A.3.b. This is in lieu of a Licensee Event Report.

d. With the calculated dose from the release of iodine131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents exceeding the limits of Section 12.4.A.3a. or 12.4.A.3b., prepare and submit a Special Report to the Commission within 30 days and limit subsequent releases such that the dose or dose commitment to a member of the public from

12.4 A. Gaseous Effluents Limits and Reporting	12.4.B Gaseous Effluents Surveillance
all uranium fuel cycle sources is limited to less than or equal to 25 mrem to the total body or organ (except the thyroid, which is limited to less than or equal to 75 mrem) over 12 consecutive months. This Special Report shall include an analysis which demonstrates that radiation exposures to all members of the public from all uranium fuel cycle sources (including all effluent pathways and direct radiation) are less than the 40 CFR Part 190 Standard. Otherwise, obtain a variance from the Commission to permit releases which exceed the 40 CFR Part 190 Standard. The radiation exposure analysis contained in the Special Report shall use the methods prescribed in the ODCM. This report is in lieu of a Licensee Event Report.	
4. Off-gas System	4. Off-gas System
a. At all times during processing for discharge to the environs, process and control equipment provided to reduce the amount or concentration of radioative materials shall be operated.	Doses due to treated gases released to unrestricted areas at or beyond the site boundary shall be projected at least once per 31 days in accordance with the ODCM.
b. The above specification shall not apply for the Off-Gas Charcoal Adsorber Beds below 30 percent of rated thermal power.	

12.4.A. Gaseous Effluents Limits and Reporting

5.	The release rate of the sum of the activities from the noble gases measured at the main condenser air ejector shall be limited to less than or equal to 100 microcuries/sec per MWt (after 30 minutes decay) at all times. With the release rate of the sum of the activities from noble gases at the main condenser air ejector exceeding 100 microcuries/sec per MWt (after 30 minutes decay), restore, the release rate to within its limits within 72 hours, or be in at least HOT STANDBY within the next 12 hours.	5.	The radioactivity rate of noble gases at (near) the outlet of the main condenser air ejector shall be continuously monitored in accordance with Specification 12.2.2.A. The release rate of the sum of the activities from nolble gases from the main condenser air ejector shall be determined to be within the limits of Specification 12.4.A.5 at the following frequencies by performing an isotope analysis of a representative sample of gases taken at the recombiner outlet, or at the air ejector outlet if the recombiner is bypassed.
		a.	At least once per 31 days.
		b.	Within 4 hours following an increase, as indicated by the main condenser air ejector noble gas activity monitor, of greater than 50%, after factoring out increases due to changes in thermal power level and off-gas flow, in the nominal steady-state fission gas release from the primary coolant.
6.	In the event a limit and/or associated action requirement identified in Sections 12.4.A and 12.4.B cannot be satisfied because of circumstances in excess of those addressed in this Section, no changes are required in the operational condition of the plant, and this does not prevent the plant from entry into an operational mode.		

TABLE 12.4-1

RADIOACTIVE GASEOUS WASTE SAMPLING
AND ANALYSIS PROGRAM

GASEOUS RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD) (uCi/ml)
A. Main Chimney Reactor Bldg. Vent Stack	M Grab Sample	M[b]	Principal Gamma Emitters[a]	$1x10^{-4}$
		M	Tritium	$1x10^{-6}$
B. All Release Types as Listed in A Above	Continuous (d)	W[c] Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous (d)	W[c] Particulate Sample	Principal Gamma Emitters[a] (I-131, others)	$1x10^{-11}$
	Continuous (d)	Q Composite Particulate Sample	SR-89	$1x10^{-11}$
			SR-90	$1x10^{-11}$
	Continuous (d)	M Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
C. Main Chimney	Continuous (d)	Noble Gas Monitor	Noble Gases	$1x10^{-6}$
D. Reactor Bldg. Vent Stack	Continuous (d)	Noble Gas Monitor	Noble Gases	$1x10^{-4}$

TABLE 12.4-1 (Continued)
TABLE NOTATION

a. The lower limit of detection (LLD) is defined in table notation A. of Table 12.5-3.

b. Sampling and analyses shall also be performed following shutdown, startup, or a thermal power change exceeding 20 percent of rated thermal power in 1 hour unless (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 5, and (2) the noble gas activity monitor shows that effluent activity has not increased by more than a factor of 3.

c. Samples shall be changed at least once per 7 days and the analyses completed within 48 hours after removal from the sampler. Sampling shall also be performed within 24 hours following each shutdown, startup, or thermal power level change exceeding 20% of rated thermal power in one hour. This requirement does not apply if (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 5, and (2) the noble gas activity monitor shows that effluent activity has not increased by more than a factor of 3. When samples collected for 24 hours are analyzed, the corresponding LLD's may be increased by a factor of 10.

d. The ratio of sample flow rate to the sampled stream flow rate shall be known.

e. The principal gamma emitters for which the LLD specification applies exclusively are the following nuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions, and Mn-54, Fe-59, Co-60, Zn-65, Co-58, Mo-99, Cs-134, Cs-137, Ce141, and Ce-144 for particulate emissions. Other peaks which are measurable and identifiable by gamma ray spectrometry, together with the above nuclides, shall be also identified and reported when an actual analysis is performed on a sample. Nuclides which are below the LLD for the analyses shall not be reported as being present at the LLD level for that nuclide.

12.4.C. GASEOUS EFFLUENTS BASES

1. Gaseous Effluents Dose

This specification is provided to ensure that the dose at the unrestricted area boundary from gaseous effluents from the units on the site will be within the annual dose limits of 10CFR20. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of an individual in an unrestricted area to annual average concentrations exceeding the limits specified in Appendix B, Table 2 of 10CFR20. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual at or beyond the unrestricted area boundary to less than or equal to 500 mrem/year to the total body or to not less than or equal to 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background via the inhalation pathway to not less than or equal to 1500 mrem/year. For purposes of calculating doses resulting from airborne releases the main chimney is considered to be an elevated release point and the reactor vent stack is considered to be a mixed mode release point.

2. Dose, Noble Gases

This specification is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.B of Appendix I. The statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I is to be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculations established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents will be consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors", Revision 1, July 1977. The ODCM equations provide for determining the air doses at the unrestricted boundary based upon the historical average atmospheric conditions. NUREG-0133 provides methods for dose calculations consistent with Regulatory Guides 1.109 and 1.111.

12.4.C GASEOUS EFFLUENTS BASES (CONT.)

3. Dose, Radioiodines, Radioactive Material in Particulate Form and Radionuclides other than Noble Gases

This specification is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Conditions for Operation are the guides set forth in Section II.C of Appendix I. The statements provide the required operating flexibility and at the same time implement the guides set forth in Section Iv.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonable achievable." The ODCM calculational methods specified in the surveillance requirements implements the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methods approved by NRC for calculating the doses due to the actual release rates of the subject materials are required to be consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the histcrical average atmospheric conditions. The release rate specifications for radioiodines, radioactive material in particulate form and radionuclides other than noble gases are dependent on the existing radionuclide pathways to man, in the unrestricted area. The pathways which were examined in the development of these specifications were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man and 3) deposition onto grassy areas where milk animals graze with consumption of the milk by man.

12.5 ENVIRONMENTAL MONITORING

12.5.A Environmental Monitoring Program

1. The environmental monitoring program given in Table 12.5-1 shall be conducted except as specified below.

2. With the radiological environmental monitoring program not being conducted as specified in Table 12.5-1, prepare and submit to the Commission, in the Annual Radiological Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, contractor omission which is corrected as soon as discovered, malfunction of sampling equipment, or if a person who participates in the program goes out of business. If the equipment malfunctions, corrective actions shall be completed as soon as practical. If a person supplying samples goes out of business, a replacement will be found as soon as possible. All deviations from the sampling schedule shall be described in the annual report.

12.5.B. Environmental Monitoring Surveillance

1. The radiological environmental monitoring samples shall be collected pursuant to Table 12.5-1 fror the locations specified in the ODCM, and shall be analyzed pursuant to the requirements of Table 12.5-3.

2. The results of analyses performed on radiological environmental monitoring samples shall be summarized in the Annual Radiological Environmental Operating Report.

12.5.A Environmental Monitoring Program

3. With the level of radioactivity in an environmental sampling medium at one or more of the

locations specified in the ODCM exceeding the limits of Table 12.5-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days from the end of the affected calendar quarter, a Special Report which includes an evaluation of any release conditions, environmental factors or other aspects which caused the limits of Table 12.5-2 to be exceeded. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

12.5 B. Environmental Monitoring Surveillance

3. The land use census shall be conducted at least once per twelve months between the dates of June 1 and October 1 by a door-to-door survey, aerial survey, road survey, or by consulting local agriculture authorities.

12.5.A Environmental Monitoring Program

4. With milk samples unavailable from one or more of the sample locations required by Table 12.5-1, identify locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The locations from which samples were unavailable may then be deleted from the monitoring program. In lieu of a Licensee Event Report, identify the cause of the inavailability of samples and identify the new location(s) for obtaining replacement samples in the Annual Radiological Environmental Operating report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

5. A census of nearest residences of animals producing milk for human consumption shall be conducted annually (during the grazing season for animals) to determine their location and number with respect to the site. The nearest residence in each of the 16 meteorological sectors shall also be determined within a distance of five miles. The census shall be conducted under the following conditions:

   a. Within a 2-mile radius from the plant site, enumeration of animals and nearest residences by a door-to-door or equivalent counting technique.

12.5.B. Environmental Monitoring Surveillance

4. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report.

5. The results of the analyses performed as part of the required crosscheck program shall be included in the Annual Radiological Environmental Operating Report. The analyses shall be done in accordance with Section 5.3.1 and Chapter 11.

12.5.A Environmental Monitoring Program

   b. Within a 5-mile radius, enumeration of animals by using referenced information from county agricultural agents or other reliable sources.

   c. With a land use census identifying location(s) of animals which

12.5.B. Environmental Monitoring Surveillance

yield(s)an ODCM calculated dose or dose commitment greater than the values currently being calculated in Specification 12.4.A.3, the new location(s) shall be added to the radiological environmental monitoring program with 30 days, if possible.

The sampling location, having the lowest calculated dose or dose commitment (via the same exposure pathway) may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted.

7. Radiological analyses shall be performed on samples representative of those in Table 12.5-1, supplied as a part of the Interlaboratory Comparison Program which has been approved by the NRC.

8. With analyses not being performed as required, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report.

9. In the event a limit and/or associated actions requirements identified in Sections 12.5.A and 12.5.B cannot be satisified because of circumstances in exess of those addressed in these Sections, no changes are required in the operational condition of the plant, and

this does not prevent the plant from entry into an operational mode.

TABLE 12.5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Minimum Number of Samples and Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
a. Particulates	16 locations	Continuous operation of sampler for a week	Gross beta and gamma Isotopic as specified in ODCM.
b. Radioiodine	16 locations	Continuous operation of sampler for two weeks	I-131 as specified in ODCM.
2. DIRECT RADIATION	Forty Locations (Minimum of two TLDs per packet)	Quarterly	
3. WATERBORNE			
a. Public Water	2 Locations	Monthly composite of weekly collected samples	Gamma Isotopic analysis of each composite sample
b. Sediment	1 downstream location in receiving body of water	Annually	Gamma Isotopic analysis of each sample
c. Plant Cooling Water	Intake, Discharge	Weekly composite	Gross Beta analysis of each sample
4. INGESTION			
a. Milk	2 locations	At least once weekly when animals are on pasture; at least once per month at other times.	I-131 analysis of each sample
b. Fish	1 location in receiving body of water	Semi-annually	Gamma Isotopic analysis on edible portions

*Sample locations are described in the ODCM

TABLE 12.5-2

REPORTING LEVELS FOR RADIOACTIVITY
CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Analysis	Water	Airborne Particulate or Gases (pCi/m³)	Fish (pCi/Kg, wet)	Milk (PCi/l)	Food Products (PCi/Kg, wet)
	Reporting Levels				
H-3	2×10^4(a)				
Mn-54	1×10^3		3×10^4		
Fe-59	4×10^2		1×10^4		
Co-58	1×10^3		3×10^4		
Co-60	3×10^2		1×10^4		
Zn-65	3×10^2		2×10^4		
Zr-Nb-95	4×10^2				
I-131	2	0.9		3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	1×10^3	70	2×10^3
Ba-La-140	2×10^2			3×10^2	

a) for drinking water samples. This is 40 CFR Part 141 value.

TABLE 12.5-3

PRACTICAL LOWER LIMITS OF DETECTION (LLD)
FOR STANDARD ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Sample Media	Analysis	LLD[A,B] (4.66 σ_b)	Units
Airborne "Particulate"	Gross Beta +	0.01	pCi/m^3
	Gamma Isotopic	0.01	pCi/m^3
Airborne I-131	Iodine 131	0.10	pCi/m^3
Milk/Public Water	I-131	5°	pCi/l
	Cs-134	10	pCi/l
	Cs-137	10 ▲	pCi/l
	Tritium	200	pCi/l
	Gross Beta +	5	pCi/l
	Gamma Isotopic	20	pCi/l/nuclide
Sediment	Gross Beta +	2	pCi/g dry
	Gamma Isotopic	0.2	pCi/g dry
Fish Tissue	I-131 Thyroid	0.1	pCi/g wet
	Cs-134, 137	0.1	pCi/g wet
	Gross Beta +	1.0	pCi/g wet
	Gamma Isotopic	0.2	pCi/g wet

° 0.5 pCi/l on milk samples collected during the pasture season.

+ Referenced to Cs-137

▲ 5.0 pCi/l on milk samples

TABLE 12.5-3 (Continued)

PRACTICAL LOWER LIMITS OF DETECTION (LLD)
FOR STANDARD ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

TABLE NOTATION

A. The LLD is the smallest concentration of radioactive material in the sample that will be detected with 95 percent probability with only 5% probability of falsely concluding that a blank observation represents a "real" sequal.

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

$$LLD = \frac{4.66 \cdot s_b}{A \cdot E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t) \cdot t}$$

Where:

LLD is the "a priori" lower limit of detection for a blank sample or background analysis as defined above (as pCi per unit mass or volume).

s_b is the square root of the background count or of a blank sample count; is the estimated standard error of a background count or a blank sample count as appropriate (in units of counts).

E is the counting efficiency (as counts per disintegration).

A is the number of gamma rays emitted per disintegration for gamma ray radionuclide analysis (A=1.0 for gross alpha and tritium measurements).

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

2.22 is the number of disintegrations per minute per picocurie.

Y is the fractional radio-chemical yield when applicable (otherwise Y = 1.0).

λ is the radioactive decay constant for the particular radionuclide (in units of reciprocal minutes).

Δt is the elapsed time between the midpoint of sample collection and the start time of counting. (Δt = 0.0 for environmental samples and for gross alpha measurements).

t is the duration of the count (in units of minutes).

TABLE 12.5-3 (Continued)

PRACTICAL LOWER LIMITS OF DETECTION (LLD)
FOR STANDARD ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

TABLE NOTATION

The value of "s_b" used in the calculation of the LLD for a detection system shall be based on an actual observed background count or a blank sample count (as appropriate) rather than on an unverified theoretically predicted value. Typical values of "E", "V", "Y", "t", and "Δt" shall be used in the calculation.

For gamma ray radionuclide analyses the background counts are determined from the total counts in the channels which are within plus or minus one FWHM (Full Width at Half Maximum) of the gamma ray photopeak energy normally used for the quantitative analysis for that radionuclide. Typical values of the FWHM shall be used in the calculation.

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

B. Other radionuclides which are measureable and identifiable by gamma-ray spectrometry, together with the nuclides indicated in Table 12.5-2, shall also be identified and reported when an actual analysis is performed on a sample. Nuclides which are below the LLD for the analyses shall not be reported as being present at the LLD level for that nuclide.

12.5.C RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1. Monitoring Program

The radiological monitoring program required by this specification provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides, which lead to the highest potential radiation exposures of individuals resulting from the station operation. This monitoring program thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. Program changes may be initiated based on operational experience.

The detection capabilities required by Table 12.5-3 are state-of-the-art for routine environmental measurements in industrial laboratories. The specified lower limits of detection for I-131 in water, milk and other food products correspond to approximately one-quarter of the Appendix I to 10 CFR Part 50 design objective dose-equivalent of 15 mrem/year for atmospheric releases and 10 mrem/year for liquid releases to the most sensitive organ and individual. They are based on the assumptions given in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", October 1977, except the change for an infant consuming 330 liter/year of drinking water instead of 510 liters/year.

2. Land Use Census

This specification is provided to ensure that changes in the use of unrestricted areas are identified and that modifications to the monitoring program are made if required by the results of this census. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50.

3. Interlaboratory Comparison Program

The requirement for participation in the interlaboratory comparison crosscheck program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

12.6 RECORD KEEPING AND REPORTING

12.6.1 Plant Operating Records

A. Records and/or logs relative to the following items shall be kept in a manner convenient for review and shall be retained for at least 5 years:

1. Records and periodic checks, inspection and/or calibrations performed to verify that the surveillance requirements (see Section 6.4 of the Technical Specifications) are being met (all equipment failing to meet surveillance requirements and the corrective action taken shall be recorded);

2. Records of radioactive shipments;

B. Records and/or logs relative to the following items shall be recorded in a manner convenient for review and shall be retained for the life of the plant:

1. Records of offsite environmental monitoring surveys;

2. Records of radioactivity in liquid and gaseous wastes released to the environment;

4. Records of reviews performed for changes made to the Offsite Dose Calculation Manual.

12.6.2 Reports

1. Radioactive Effluent Release Report

The Radioactive Effluent Release Report covering the operation of the unit during the previous 12 months of operation shall be submitted prior to April 1 of each year. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The material provided shall be (1) consistent with the objectives outlined in the ODCM and PCP and (2) in conformance with 10 CFR 50.36a and Section IV.B.1 of Appendix I to 10 CFR Part 50.

2. Annual Radiological Environmental Operating Report

An annual report containing the data taken in the standard radiological monitoring program (Table 12.5-1) shall be submitted prior to May 1 of each year. The content of the report shall include:

a. Results of all environmental measurements summarized in the format of the Regulatory Guide 4.8 Table 1 (December 1975). (Individual sample results will be retained at the Station). In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for missing results. Summaries, interpretations, and analysis of trends of the results are to be provided.

b. An assessment of the monitoring results and radiation dose via the principal pathways of exposure resulting from plant emissions of radioactivity including the maximum noble gas gamma and beta air doses in the unrestricted area. The assessment of radiation doses shall be performed in accordance with the Offsite Dose Calculation Manual (ODCM).

c. Results of the census to determine the locations of nearest residences and of nearby animals producing milk for human consumption (Table 12.5-1).

d. The reason for the emission if the nearest dairy to the station is not in the monitoring program (Table 12.5-1).

e. An annual summary of meteorological conditions concurrent with the releases of gaseous effluents in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.

f. The results of the Interlaboratory Comparison Program described in Section 12.5.C.3.

g. The results of the 40 CFR 190 uranium fuel cycle dose analysis for each calendar year.

h. A summary of the monitoring program, including maps showing sampling locations and tables giving distance and direction of sampling locations from the Station.

3. If a confirmed measured radionuclide concentration in an environmental sampling medium averaged over any calendar quarter sampling period exceeds the reporting level given in Table 12.5-2 and if the radioactivity is attributable to plant operation, a written report shall be submitted to the Administrator of the NRC Regional Office, with a copy to the Director, Office of Nuclear Reactor Regulation, within 30 days from the end of the quarter.

a. When more than one of the radionuclides in Table 12.5-2 are detected in the medium, the reporting level shall have been exceeded if

$$\frac{C_i}{R.L._i} \geq 1$$

where C_i is the average quarterly concentration of the i^{th} radionuclide in the medium and RL is the reporting level of radionuclide i.

b. If radionuclides other than those in Table 12.5-2 are detected and are due to plant effluents, a reporting level is exceeded if the potential annual dose to an individual is equal to or greater than the design objective doses of 10 CFR 50, Appendix 1.

c. This report shall include an evaluation of any release conditions, environmental factors, or other aspects necessary to explain the anomalous effect.

12.6.2.3 OFFSITE DOSE CALCULATION MANUAL (ODCM)

12.5.2.3.A. The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Radiological Environmental Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs described in section 12.5 and (2) descriptions of the information that should be included in the Semi-annual Radioactive Effluent Release Reports and in the Annual Radiological Environmental Operating Reports required by sections 12.6.2.1 and 12.6.2.2.

The ODCM shall be subject to review and approval by the Commission prior to implementation.

12.6.2.3.B. Changes to the ODCM

1. Shall be documented and records of reviews performed shall be retained as required by Specification 6.5.B.14. This documentation shall contain:

   a. Sufficient information to support the change together with the appropriate analyses or evaluations justifying the change(s) and

b. A determination that the change will maintain the level of radioactive effluent control required by 10 CFR 20.1302, 40 CFR Part 190, 10 CFR 50.36a, and Appendix I to 10 CFR Part 50 and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

2. Shall become effective after review and acceptance by the Onsite Review and Investigative Function and the approval of the Plant Manager on the date specified by the Onsite Review and Investigative Function.

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

12.6.2.4 MAJOR CHANGES TO RADIOACTIVE WASTE TREATMENT SYSTEMS (LIQUID AND GASEOUS)

A. Licensee initiated major changes to the radioactive waste systems may be made provided:

1. The change is reported in the Monthly Operating Report for the period in which the evaluation was reviewed by the onsite review function. The discussion of each change shall contain:

a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;

b. Sufficient detailed information to support the reason for the change;

c. A detailed description of the equipment, components, and process involved and the interfaces with other plant systems;

d. An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents and (or quantity of solid waste that differ from those previously predicted in the license application and amendments);

e. A comparison of the predicted releases of radioactive materials in liquid and gaseous effluents and in solid waste to the actual releases for the period in which the changes were made;

f. An estimate of the exposure to plant operating personnel as a result of the change; and

g. Documentation of the fact that the change was reviewed and found acceptable by the onsite review function.

2. The change shall become effective upon review and acceptance by onsite review function.

QUAD CITIES ANNEX INDEX

APPENDIX F

STATION-SPECIFIC DATA FOR QUAD CITIES UNITS 1 and 2

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STATION-SPECIFIC DATA FOR QUAD CITIES UNITS 1 and 2

F.1 INTRODUCTION

This appendix contains data relevant to the Quad Cities site. Included are a diagram of the unrestricted area boundary and tables of values of parameters used in offsite dose assessment.

F.2 REFERENCES

1. Sargent & Lundy, Analysis and Technology Division, Quad Cities Calculation No. ATD-0148, Revision 1.

2. Sargent & Lundy, Nuclear Safeguards and Licensing Division, Quad Cities Calculation No. QC-03-88, Revision 0.

3. "Quad Cities Public Water Supply" letter from B.S. Ferguson (NSEP) to G. Wassenhove U.S. Army Corps of Engineers, February 16, 1989.

4 "Verification of Environmental Parameters used for Commonwealth Edison Company's Offsite Dose Calculations", NUTECH Engineering Group, 1992.

5. "Verification of Environmental Parameters used for Commonwealth Edison Company's Offsite Dose Calculations", NUS Corporation, 1988.

Table F-1
Aquatic Environment Dose Parameters

General Information[a]

Existence of irrigation not mentioned in Quad Cities Final Safety Analysis Report (FSAR), UFSAR, or Plant Design Analysis.

Recreation includes one or more of the following: boating, water skiing, swimming and sport fishing.

The station liquid discharge flows into the Mississippi River. Mississippi River Lock and Dam Number 14 is located between the station discharge and the E. Moline intake (see Figure 12 of the Quad Cities Unit 1 Plant Design Analysis, Volume II, and Figure 2.4.1 of the Quad Cities Safety Analysis Report.)

Water and Fish Ingestion Parameters

Parameter[b]	Value
$1/M^a$, $1/M^f$	1.0
F^a, cfs	5.75E4
F^f, cfs	5.75E4
t^f, hr[c]	24.0
t^a, hr[d]	8.0

Limits on Radioactivity in Unprotected Outdoor Tanks

Not Applicable (See Section A.2.4 of Appendix A)

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[a] Quad Cities Updated Final Safety Analysis Report (USFAR) updated through Amendment 5 (9-3-87) Section 1.5.2 and Quad Cities Plant Design Analysis, Section 4.4

[b] The parameters are defined in Section A.2.1 of Appendix A.

[c] t^f (hr) = 24 hr (all stations) for the fish ingestion pathway

[d] $(t^a \ldots r)$ = 8 hr (Distance to the nearest public potable water ... e, E. Moline, is 16 miles; flow rate of 2 mph is assumed)

Table F-2
Station Characteristics

Station: Quad Cities Nuclear Power Station
Location: Cordova, Illinois

Characteristics of Elevated Release Point

1) Release Height = 94.49 m[a] 2) Diameter = 3.35 m

3) Exit Speed = 16.0 m s^{-1a} 4) Heat Content = 68 kCal s^{-1a}

Characteristics of Vent Stack Release Point

1) Release Height = 48.5 m[a] 2) Diameter = 2.74 m

3) Exit Speed = 14.8 m s^{-1a}

Characteristics of Ground Level Release

1) Releas. Height = 0 m

2) Building Factor (D) = 43.4 m[a]

Meterological Data

A 296 ft Tower is Located 1623 m SSE of Elevated Release Point

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Tower Data Used in Calculations

Release Point	Wind Speed and Direction	Differential Temperature
Elevated	296 ft	296-33 ft
Vent	196 ft	196-33 ft
Ground	33 ft	196-33 ft

[a]Used in calculating the meteorological and dose factors in Tables F-5, F-6, and F7. See Sections B.3 through B.6 of Appendix B.

Table F-3

Critical Ranges

Direction	Unrestricted Area Boundary[a] (m)	Restricted Area Boundary (m)	Nearest Resident[b] (m)	Nearest Dairy Farm Within 5 Miles[c] (m)
N	864	300	800	None
NNE	1029	300	1200	None
NE	1212	325	2000	None
ENE	1367	1210	2000	None
E	1170	1170	3600	None
ESE	1170	1125	4000	4800
SE	1189	475	4000	None
SSE	1422	475	1600	None
S	1198	325	1200	None
SSW	2140	325	4800	None
SW	1372	250	4800	None
WSW	823	200	3600	None
W	713	200	3600	None
WNW	713	200	3600	None
NW	823	200	3600	None
NNW	1481	200	2800	None

[a] Nearest land in unrestricted area. Used in calculating the meteorological dose factors in Tables F-5 and F-7. See Sections B.3 through B.6 of Appendix B.

[b] 1992 annual survey by Teledyne Isotopes Midwest Laboratories. The distances are rounded to the nearest conservative 100 meters.

[c] 1992 annual milch animal census, by Teledyne Isotopes Midwest Laboratories. Used in calculating the D/Q values in Table F-6. The distances are rounded to the nearest conservative 100 meters. A default value of 8000 meters is used when there are no dairies within 5 miles.

Table F-4

Average Wind Speeds

Downwind Direction	Average Wind Speed (m/sec)*		
	Elevated	Mixed Mode	Ground Level
N	6.9	5.0	2.6
NNE	6.2	4.6	2.8
NE	5.3	3.7	2.4
ENE	6.0	4.4	2.8
E	6.9	5.0	3.2
ESE	7.1	5.2	3.7
SE	6.5	4.9	3.6
SSE	5.7	4.5	3.5
S	5.6	4.4	3.4
SSW	5.6	4.4	3.3
SW	5.8	4.6	3.0
WSW	6.0	4.7	3.4
W	6.1	4.8	3.1
WNW	6.0	4.5	2.6
NW	5.9	4.4	2.4
NNW	6.5	4.7	2.5

*Based on Quad Cities site meteorological data, January 1978 through December 1987 data for ground level and mixed mode release analysis and 1982-1987 data for elevated releases. Calculated in Reference 1 of Section F.2 using formulas in Section B.1.3 of Appendix B.

Table F-5

X/Q and D/Q Maxima at or Beyond the Unrestricted Area Boundary

Downwind Direction	Elevated(Stack) Release				Mixed Mode(Vent) Release			Ground Level Release		
	Radius (meters)	X/Q (sec/m**3)	Radius (meters)	D/Q (1/m**2)	Radius (meters)	X/Q (sec/m**3)	D/Q (1/m**2)	Radius (meters)	X/Q (sec/m**3)	D/Q (1/m**2)
N	4400.	1.344E-08	864.	9.642E-10	864.	3.427E-07	2.869E-09	864.	3.817E-06	1.105E-08
NNE	4013.	1.703E-08	1029.	1.407E-09	1029.	2.219E-07	3.049E-09	1029.	2.597E-06	1.052E-08
NE	4828.	1.287E-08	1212.	7.019E-10	1212.	1.321E-07	1.299E-09	1212.	2.249E-06	6.701E-09
ENE	4400.	1.091E-08	1367.	6.723E-10	1367.	1.213E-07	1.319E-09	1367.	1.446E-06	4.806E-09
E	3600.	1.513E-08	1170.	1.139E-09	1170.	2.215E-07	2.811E-09	1170.	2.212E-06	9.318E-09
ESE	3600.	2.126E-08	1170.	1.536E-09	1170.	2.332E-07	3.437E-09	1170.	2.094E-06	1.047E-08
SE	4013.	1.758E-08	1189.	1.082E-09	1189.	1.439E-07	2.384E-09	1189.	1.255E-06	6.450E-09
SSE	4013.	1.259E-08	1422.	6.915E-10	1422.	8.279E-08	1.167E-09	1422.	6.885E-07	3.222E-09
S	4400.	1.005E-08	1500.	4.437E-10	1198.	6.887E-08	9.516E-10	1198.	8.371E-07	3.350E-09
SSW	4400.	8.621E-09	2140.	3.110E-10	2140.	5.104E-08	4.693E-10	2140.	4.296E-07	1.380E-09
SW	4400.	1.102E-08	1500.	4.856E-10	1372.	1.006E-07	1.116E-09	1372.	1.224E-06	3.856E-09
WSW	4400.	1.123E-08	1500.	4.674E-10	823.	2.158E-07	2.298E-09	823.	2.968E-06	1.093E-08
W	4828.	1.139E-08	1500.	4.704E-10	713.	3.445E-07	2.737E-09	713.	5.271E-06	1.522E-08
WNW	4828.	9.486E-09	1500.	4.025E-10	713.	5.025E-07	2.816E-09	713.	7.554E-06	1.788E-08
NW	4828.	9.752E-09	823.	5.475E-10	823.	2.981E-07	2.009E-09	823.	4.739E-06	1.144E-08
NNW	4400.	1.045E-08	1481.	6.126E-10	1481.	1.712E-07	1.202E-09	1481.	1.928E-06	4.543E-09

Quad Cities Site Meteorological Data 1/78 - 12/87

Note: Based on Reference 2 of Section F.2 and the formulas in Sections B.3 and B.4 of Appendix B.

X/Q is used for beta air, beta skin, and inhalation dose pathways. See Sections A.1.2, A.1.3, and A.1.4.2 of Appendix A.

D/Q is used for produce and leafy vegetable pathways. See Section A.1.4 of Appendix A.

Radius is the approximate distance from midpoint between gaseous effluent release points to location of highest X/Q or D/Q at or beyond the unrestricted area boundary (UAB).

Table F-5a

X/Q and D/Q Maxima at or Beyond the Restricted Area Boundary

Downwind Direction	Elevated(Stack) Release				Mixed Mode(Vent) Release			Ground Level Release		
	Radius (meters)	X/Q (sec/m**3)	Radius (meters)	D/Q (1/m**2)	Radius (meters)	X/Q (sec/m**3)	D/Q (1/m**2)	Radius (meters)	X/Q (sec/m**3)	D/Q (1/m**2)
N	4400.	1.344E-08	420.	1.244E-09	300.	1.824E-06	9.651E-09	300.	2.220E-05	5.676E-08
NNE	480.	2.173E-08	420.	2.103E-09	300.	1.278E-06	1.163E-08	300.	1.864E-05	7.192E-08
NE	4828.	1.287E-08	420.	1.006E-09	325.	7.600E-07	5.329E-09	325.	1.805E-05	5.345E-08
ENE	4400.	1.091E-08	1210.	6.945E-10	1210.	1.346E-07	1.516E-09	1210.	1.741E-06	5.907E-09
E	3600.	1.513E-08	1170.	1.139E-09	1170.	2.215E-07	2.811E-09	1170.	2.212E-06	9.318E-09
ESE	3600.	2.126E-08	1125.	1.557E-09	1125.	2.417E-07	3.600E-09	1125.	2.223E-06	1.118E-08
SE	4023.	1.758E-08	475.	1.434E-09	475.	4.201E-07	6.339E-09	475.	5.067E-06	2.813E-08
SSE	4023.	1.259E-08	475.	9.120E-10	475.	2.659E-07	3.632E-09	475.	3.727E-06	1.901E-08
S	4400.	1.005E-08	1500.	4.437E-10	325.	3.596E-07	3.512E-09	325.	6.585E-06	2.620E-08
SSW	4400.	8.621E-09	420.	4.004E-10	325.	4.288E-07	3.838E-09	325.	8.119E-06	2.902E-08
SW	4400.	1.102E-08	1500.	4.856E-10	250.	1.028E-06	6.593E-09	250.	1.950E-05	5.556E-08
WSW	4400.	1.123E-08	1500.	4.674E-10	200.	2.040E-06	1.182E-08	200.	3.239E-05	9.263E-08
W	4828.	1.139E-08	1500.	4.704E-10	200.	2.886E-06	1.260E-08	200.	4.733E-05	1.025E-07
WNW	4828.	9.486E-09	420.	4.079E-10	200.	4.445E-06	1.331E-08	200.	6.984E-05	1.203E-07
NW	4828.	9.752E-09	420.	6.595E-10	200.	3.175E-06	1.065E-08	200.	5.467E-05	9.706E-08
NNW	4400.	1.045E-08	420.	1.027E-09	200.	3.784E-06	1.367E-08	200.	5.476E-05	1.023E-07

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Table F-6

D/Q at the Nearest Milk Cow and Meat Animal Locations within 5 miles

Downwind Direction	Nearest Milk Cow Radius (meters)	Nearest Milk Cow D/Q(1/m**2) Elevated Release	Nearest Milk Cow D/Q(1/m**2) Mixed Release	Nearest Meat Animal Radius (meters)	Nearest Meat Animal D/Q(1/m**2) Elevated Release	Nearest Meat Animal D/Q(1/m**2) Mixed Release
N	8000.	1.019E-10	1.079E-10	6400.	1.455E-10	1.572E-10
NNE	8000.	1.354E-10	1.475E-10	5600.	2.357E-10	2.662E-10
NE	8000.	9.339E-11	9.377E-11	4800.	2.004E-10	2.134E-10
ENE	8000.	9.066E-11	9.792E-11	4800.	1.946E-10	2.262E-10
E	8000.	1.364E-10	1.620E-10	4800.	2.934E-10	3.775E-10
ESE	4800.	4.243E-10	4.692E-10	2800.	7.722E-10	1.080E-09
SE	8000.	1.542E-10	1.454E-10	7600.	1.680E-10	1.587E-10
SSE	8000.	1.026E-10	9.303E-11	4400.	2.451E-10	2.454E-10
S	8000.	7.650E-11	6.524E-11	2400.	3.247E-10	4.141E-10
SSW	8000.	6.616E-11	6.303E-11	8000.	6.616E-11	6.303E-11
SW	8000.	8.419E-11	8.742E-11	2800.	3.124E-10	4.479E-10
WSW	8000.	8.454E-11	1.002E-10	5600.	1.467E-10	1.814E-10
W	8000.	8.206E-11	9.545E-11	3600.	2.429E-10	3.461E-10
WNW	8000.	6.761E-11	8.718E-11	5600.	1.173E-10	1.585E-10
NW	8000.	7.046E-11	7.767E-11	6400.	1.007E-10	1.131E-10
NNW	8000.	7.938E-11	9.082E-11	3600.	2.444E-10	3.316E-10

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Note:Based on Reference 2 of Section F.2 and the formulas in Section B.4 of Appendix B.

Table F-7

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-83m

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	1.193E-06	8.998E-07	864.	4.094E-05	3.087E-05	864.	3.885E-04	2.929E-04
NNE	1029.	1029.	1.785E-06	1.346E-06	1029.	2.796E-05	2.108E-05	1029.	2.651E-04	1.999E-04
NE	1212.	1212.	9.747E-07	7.349E-07	1212.	1.639E-05	1.236E-05	1212.	2.162E-04	1.630E-04
ENE	1367.	1367.	9.035E-07	6.812E-07	1367.	1.409E-05	1.063E-05	1367.	1.373E-04	1.036E-04
E	1170.	1170.	1.378E-06	1.039E-06	1170.	2.602E-05	1.962E-05	1170.	2.220E-04	1.674E-04
ESE	1170.	1170.	1.775E-06	1.338E-06	1170.	2.752E-05	2.075E-05	1170.	2.113E-04	1.593E-04
SE	1189.	1189.	1.266E-06	9.695E-07	1189.	1.748E-05	1.318E-05	1189.	1.248E-04	9.407E-05
SSE	1422.	1422.	9.303E-07	7.014E-07	1422.	9.663E-06	7.286E-06	1422.	6.648E-05	5.012E-05
S	1198.	1198.	4.932E-07	3.719E-07	1198.	8.591E-06	6.478E-06	1198.	8.157E-05	6.150E-05
SSW	2140.	2140.	6.664E-07	5.025E-07	2140.	5.469E-06	4.124E-06	2140.	3.670E-05	2.767E-05
SW	1372.	1372.	6.134E-07	4.625E-07	1372.	1.175E-05	8.862E-06	1372.	1.164E-04	8.775E-05
WSW	823.	823.	4.376E-07	3.300E-07	823.	2.665E-05	2.010E-05	823.	3.016E-04	2.274E-04
W	713.	713.	4.936E-07	3.722E-07	713.	4.059E-05	3.060E-05	713.	5.263E-04	3.968E-04
WNW	713.	713.	4.839E-07	3.648E-07	713.	5.484E-05	4.135E-05	713.	7.361E-04	5.550E-04
NW	823.	823.	8.023E-07	6.049E-07	823.	3.493E-05	2.634E-05	823.	4.707E-04	3.549E-04
NNW	1481.	1481.	9.575E-07	7.220E-07	1481.	1.950E-05	1.470E-05	1481.	1.814E-04	1.368E-04

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Note: Based on References 1 and 2 of Section F.2 and the formulas in Sections B.5 and B.6 of Appendix B.

Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-85m

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release			Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	1.266E-04	1.225E-04	864.	4.908E-04	4.728E-04	864.	2.089E-03	2.000E-03
NNE	1029.	1029.	1.322E-04	1.278E-04	1029.	4.358E-04	4.204E-04	1029.	1.591E-03	1.525E-03
NE	1212.	1212.	8.448E-05	8.172E-05	1212.	2.793E-04	2.694E-04	1212.	1.382E-03	1.326E-03
ENE	1367.	1367.	5.783E-05	5.593E-05	1367.	2.056E-04	1.983E-04	1367.	9.249E-04	8.872E-04
E	1170.	1170.	8.118E-05	7.850E-05	1170.	3.308E-04	3.187E-04	1170.	1.393E-03	1.336E-03
ESE	1170.	1170.	1.067E-04	1.032E-04	1170.	3.662E-04	3.530E-04	1170.	1.337E-03	1.282E-03
SE	1189.	1189.	9.118E-05	8.820E-05	1189.	2.618E-04	2.525E-04	1189.	8.091E-04	7.760E-04
SSE	1422.	1422.	5.797E-05	5.606E-05	1422.	1.518E-04	1.464E-04	1422.	4.523E-04	4.340E-04
S	1198.	1198.	5.611E-05	5.428E-05	1198.	1.469E-04	1.417E-04	1198.	5.192E-04	4.978E-04
SSW	2140.	2140.	3.024E-05	2.924E-05	2140.	7.862E-05	7.579E-05	2140.	2.775E-04	2.663E-04
SW	1372.	1372.	5.402E-05	5.226E-05	1372.	1.697E-04	1.636E-04	1372.	7.514E-04	7.204E-04
WSW	823.	823.	8.767E-05	8.484E-05	823.	3.499E-04	3.372E-04	823.	1.633E-03	1.564E-03
W	713.	713.	1.112E-04	1.076E-04	713.	4.644E-04	4.473E-04	713.	2.573E-03	2.461E-03
WNW	713.	713.	1.000E-04	9.678E-05	713.	5.046E-04	4.854E-04	713.	3.454E-03	3.302E-03
NW	823.	823.	9.794E-05	9.476E-05	823.	3.993E-04	3.846E-04	823.	2.406E-03	2.302E-03
NNW	1481.	1481.	6.223E-05	6.018E-05	1481.	2.449E-04	2.360E-04	1481.	1.147E-03	1.099E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-85

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	1.753E-06	1.695E-06	864.	5.814E-06	5.622E-06	864.	2.347E-05	2.269E-05
NNE	1029.	1029.	1.834E-06	1.773E-06	1029.	5.237E-06	5.064E-06	1029.	1.792E-05	1.733E-05
NE	1212.	1212.	1.185E-06	1.146E-06	1212.	3.399E-06	3.287E-06	1212.	1.595E-05	1.542E-05
ENE	1367.	1367.	8.083E-07	7.817E-07	1367.	2.473E-06	2.391E-06	1367.	1.072E-05	1.037E-05
E	1170.	1170.	1.116E-06	1.079E-06	1170.	3.908E-06	3.779E-06	1170.	1.578E-05	1.525E-05
ESE	1170.	1170.	1.461E-06	1.413E-06	1170.	4.335E-06	4.192E-06	1170.	1.510E-05	1.460E-05
SE	1189.	1189.	1.259E-06	1.217E-06	1189.	3.118E-06	3.015E-06	1189.	9.186E-06	8.883E-06
SSE	1422.	1422.	8.057E-07	7.791E-07	1422.	1.829E-06	1.769E-06	1422.	5.211E-06	5.039E-06
S	1198.	1198.	7.916E-07	7.655E-07	1198.	1.774E-06	1.716E-06	1198.	5.956E-06	5.760E-06
SSW	2140.	2140.	4.230E-07	4.090E-07	2140.	9.632E-07	9.314E-07	2140.	3.375E-06	3.264E-06
SW	1372.	1372.	7.572E-07	7.322E-07	1372.	2.039E-06	1.971E-06	1372.	8.743E-06	8.454E-06
WSW	823.	823.	1.239E-06	1.198E-06	823.	4.157E-06	4.020E-06	823.	1.828E-05	1.768E-05
W	713.	713.	1.570E-06	1.519E-06	713.	5.481E-06	5.300E-06	713.	2.847E-05	2.753E-05
WNW	713.	713.	1.414E-06	1.367E-06	713.	5.906E-06	5.711E-06	713.	3.816E-05	3.690E-05
NW	823.	823.	1.372E-06	1.327E-06	823.	4.734E-06	4.578E-06	823.	2.700E-05	2.610E-05
NNW	1481.	1481.	8.575E-07	8.292E-07	1481.	2.931E-06	2.834E-06	1481.	1.350E-05	1.305E-05

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-87

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release			Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	6.162E-04	5.987E-04	864.	1.698E-03	1.649E-03	864.	5.808E-03	5.639E-03
NNE	1029.	1029.	6.389E-04	6.207E-04	1029.	1.557E-03	1.512E-03	1029.	4.508E-03	4.377E-03
NE	1212.	1212.	4.118E-04	4.001E-04	1212.	9.907E-04	9.622E-04	1212.	3.742E-03	3.633E-03
ENE	1367.	1367.	2.753E-04	2.675E-04	1367.	7.128E-04	6.923E-04	1367.	2.504E-03	2.432E-03
E	1170.	1170.	3.853E-04	3.743E-04	1170.	1.146E-03	1.113E-03	1170.	3.929E-03	3.815E-03
ESE	1170.	1170.	5.023E-04	4.880E-04	1170.	1.270E-03	1.234E-03	1170.	3.806E-03	3.695E-03
SE	1189.	1189.	4.324E-04	4.201E-04	1189.	9.253E-04	8.936E-04	1189.	2.291E-03	2.225E-03
SSE	1422.	1422.	2.723E-04	2.646E-04	1422.	5.290E-04	5.137E-04	1422.	1.256E-03	1.220E-03
S	1198.	1198.	2.704E-04	2.628E-04	1198.	5.202E-04	5.052E-04	1198.	1.424E-03	1.383E-03
SSW	2140.	2140.	1.354E-04	1.315E-04	2140.	2.615E-04	2.540E-04	2140.	7.068E-04	6.863E-04
SW	1372.	1372.	2.581E-04	2.507E-04	1372.	5.872E-04	5.702E-04	1372.	2.001E-03	1.943E-03
WSW	823.	823.	4.379E-04	4.255E-04	823.	1.238E-03	1.202E-03	823.	4.588E-03	4.454E-03
W	713.	713.	5.602E-04	5.443E-04	713.	1.632E-03	1.585E-03	713.	7.313E-03	7.101E-03
WNW	713.	713.	5.039E-04	4.896E-04	713.	1.729E-03	1.679E-03	713.	9.810E-03	9.525E-03
NW	823.	823.	4.859E-04	4.721E-04	823.	1.388E-03	1.348E-03	823.	6.654E-03	6.461E-03
NNW	1481.	1481.	2.903E-04	2.820E-04	1481.	8.192E-04	7.955E-04	1481.	2.955E-03	2.869E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-88

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	1.594E-03	1.551E-03	864.	4.220E-03	4.104E-03	864.	1.481E-02	1.436E-02
NNE	1029.	1029.	1.665E-03	1.621E-03	1029.	3.885E-03	3.779E-03	1029.	1.143E-02	1.111E-02
NE	1212.	1212.	1.083E-03	1.054E-03	1212.	2.515E-03	2.447E-03	1212.	9.828E-03	9.548E-03
ENE	1367.	1367.	7.271E-04	7.078E-04	1367.	1.805E-03	1.756E-03	1367.	6.599E-03	6.411E-03
E	1170.	1170.	1.002E-03	9.755E-04	1170.	2.853E-03	2.775E-03	1170.	1.001E-02	9.728E-03
ESE	1170.	1170.	1.301E-03	1.266E-03	1170.	3.165E-03	3.078E-03	1170.	9.639E-03	9.364E-03
SE	1189.	1189.	1.124E-03	1.094E-03	1189.	2.307E-03	2.244E-03	1189.	5.837E-03	5.671E-03
SSE	1422.	1422.	7.148E-04	6.957E-04	1422.	1.340E-03	1.303E-03	1422.	3.258E-03	3.165E-03
S	1198.	1198.	7.126E-04	6.937E-04	1198.	1.312E-03	1.276E-03	1198.	3.701E-03	3.596E-03
SSW	2140.	2140.	3.636E-04	3.539E-04	2140.	6.814E-04	6.628E-04	2140.	1.963E-03	1.908E-03
SW	1372.	1372.	6.784E-04	6.604E-04	1372.	1.485E-03	1.444E-03	1372.	5.313E-03	5.161E-03
WSW	823.	823.	1.144E-03	1.114E-03	823.	3.068E-03	2.984E-03	823.	1.160E-02	1.127E-02
W	713.	713.	1.459E-03	1.420E-03	713.	4.024E-03	3.913E-03	713.	1.827E-02	1.774E-02
WNW	713.	713.	1.313E-03	1.278E-03	713.	4.274E-03	4.156E-03	713.	2.451E-02	2.379E-02
NW	823.	823.	1.265E-03	1.231E-03	823.	3.457E-03	3.357E-03	823.	1.699E-02	1.650E-02
NNW	1481.	1481.	7.588E-04	7.386E-04	1481.	2.083E-03	2.026E-03	1481.	8.020E-03	7.791E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-89

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	7.380E-04	7.172E-04	864.	1.425E-03	1.385E-03	864.	2.034E-03	1.976E-03
NNE	1029.	1029.	6.261E-04	6.085E-04	1029.	1.149E-03	1.116E-03	1029.	1.603E-03	1.557E-03
NE	1212.	1212.	3.167E-04	3.078E-04	1212.	5.081E-04	4.936E-04	1212.	7.823E-04	7.598E-04
ENE	1367.	1367.	2.047E-04	1.989E-04	1367.	3.701E-04	3.595E-04	1367.	5.059E-04	4.914E-04
E	1170.	1170.	3.698E-04	3.594E-04	1170.	8.126E-04	7.894E-04	1170.	1.310E-03	1.273E-03
ESE	1170.	1170.	5.046E-04	4.904E-04	1170.	9.740E-04	9.462E-04	1170.	1.566E-03	1.522E-03
SE	1189.	1189.	4.116E-04	4.000E-04	1189.	6.659E-04	6.469E-04	1189.	9.264E-04	8.998E-04
SSE	1422.	1422.	2.003E-04	1.946E-04	1422.	2.810E-04	2.730E-04	1422.	3.822E-04	3.712E-04
S	1198.	1198.	2.189E-04	2.127E-04	1198.	3.175E-04	3.084E-04	1198.	4.622E-04	4.490E-04
SSW	2140.	2140.	5.751E-05	5.588E-05	2140.	7.519E-05	7.304E-05	2140.	8.761E-05	8.510E-05
SW	1372.	1372.	1.914E-04	1.860E-04	1372.	3.241E-04	3.149E-04	1372.	4.441E-04	4.313E-04
WSW	823.	823.	4.790E-04	4.655E-04	823.	1.113E-03	1.081E-03	823.	2.203E-03	2.140E-03
W	713.	713.	6.760E-04	6.569E-04	713.	1.569E-03	1.524E-03	713.	3.460E-03	3.361E-03
WNW	713.	713.	6.075E-04	5.904E-04	713.	1.513E-03	1.470E-03	713.	4.161E-03	4.041E-03
NW	823.	823.	5.447E-04	5.293E-04	823.	1.114E-03	1.082E-03	823.	2.198E-03	2.135E-03
NNW	1481.	1481.	2.270E-04	2.206E-04	1481.	3.806E-04	3.697E-04	1481.	3.958E-04	3.844E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Kr-90

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	1.025E-04	9.947E-05	864.	1.001E-04	9.715E-05	864.	3.226E-05	3.128E-05
NNE	1029.	1029.	4.953E-05	4.807E-05	1029.	4.309E-05	4.181E-05	1029.	1.549E-05	1.502E-05
NE	1212.	1212.	1.210E-05	1.174E-05	1212.	7.167E-06	6.953E-06	1212.	2.958E-06	2.869E-06
ENE	1367.	1367.	8.572E-06	8.320E-06	1367.	7.121E-06	6.908E-06	1367.	3.357E-06	3.255E-06
E	1170.	1170.	2.876E-05	2.792E-05	1170.	3.061E-05	2.970E-05	1170.	1.687E-05	1.636E-05
ESE	1170.	1170.	4.141E-05	4.019E-05	1170.	3.846E-05	3.731E-05	1170.	2.748E-05	2.665E-05
SE	1189.	1189.	2.685E-05	2.606E-05	1189.	2.120E-05	2.056E-05	1189.	1.306E-05	1.267E-05
SSE	1422.	1422.	5.661E-06	5.494E-06	1422.	4.092E-06	3.970E-06	1422.	2.460E-06	2.385E-06
S	1198.	1198.	9.811E-06	9.523E-06	1198.	7.891E-06	7.656E-06	1198.	6.776E-06	6.571E-06
SSW	2140.	2140.	5.194E-07	5.040E-07	2140.	2.996E-07	2.907E-07	2140.	1.827E-07	1.772E-07
SW	1372.	1372.	6.788E-06	6.588E-06	1372.	6.147E-06	5.963E-06	1372.	3.347E-06	3.246E-06
WSW	823.	823.	5.697E-05	5.530E-05	823.	8.167E-05	7.923E-05	823.	8.406E-05	8.151E-05
W	713.	713.	1.054E-04	1.023E-04	713.	1.550E-04	1.504E-04	713.	1.486E-04	1.441E-04
WNW	713.	713.	9.367E-05	9.092E-05	713.	1.286E-04	1.247E-04	713.	1.211E-04	1.174E-04
NW	823.	823.	6.316E-05	6.131E-05	823.	6.467E-05	6.275E-05	823.	3.606E-05	3.497E-05
NNW	1481.	1481.	8.234E-06	7.992E-06	1481.	6.106E-06	5.924E-06	1481.	1.127E-06	1.093E-06

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-131m

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release			Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	S	SBAR	Radius (meters)	V	VBAR	Radius (meters)	G	GBAR
			(mrad/yr)/(uCi/sec)			(mrad/yr)/(uCi/sec)			(mrad/yr)/(uCi/sec)	
N	864.	864.	3.647E-06	3.327E-06	864.	4.407E-05	3.544E-05	864.	3.834E-04	2.985E-04
NNE	1029.	1029.	4.237E-06	3.798E-06	1029.	3.179E-05	2.595E-05	1029.	2.633E-04	2.057E-04
NE	1212.	1212.	2.587E-06	2.338E-06	1212.	1.947E-05	1.596E-05	1212.	2.279E-04	1.782E-04
ENE	1367.	1367.	1.965E-06	1.747E-06	1367.	1.602E-05	1.302E-05	1367.	1.466E-04	1.149E-04
E	1170.	1170.	2.839E-06	2.511E-06	1170.	2.808E-05	2.266E-05	1170.	2.237E-04	1.750E-04
ESE	1170.	1170.	3.680E-06	3.262E-06	1170.	2.997E-05	2.426E-05	1170.	2.118E-04	1.657E-04
SE	1189.	1189.	2.967E-06	2.654E-06	1189.	1.963E-05	1.599E-05	1189.	1.267E-04	9.918E-05
SSE	1422.	1422.	1.993E-06	1.769E-06	1422.	1.114E-05	9.095E-06	1422.	6.993E-05	5.482E-05
S	1198.	1198.	1.599E-06	1.463E-06	1198.	1.013E-05	8.309E-06	1198.	8.492E-05	6.642E-05
SSW	2140.	2140.	1.206E-06	1.050E-06	2140.	6.337E-06	5.144E-06	2140.	4.359E-05	3.422E-05
SW	1372.	1372.	1.650E-06	1.493E-06	1372.	1.332E-05	1.082E-05	1372.	1.252E-04	9.792E-05
WSW	823.	823.	2.220E-06	2.075E-06	823.	2.888E-05	2.335E-05	823.	2.959E-04	2.304E-04
W	713.	713.	2.761E-06	2.589E-06	713.	4.243E-05	3.407E-05	713.	4.991E-04	3.877E-04
WNW	713.	713.	2.521E-06	2.357E-06	713.	5.524E-05	4.391E-05	713.	6.941E-04	5.386E-04
NW	823.	823.	2.732E-06	2.507E-06	823.	3.710E-05	2.977E-05	823.	4.622E-04	3.593E-04
NNW	1481.	1481.	2.099E-06	1.868E-06	1481.	2.184E-05	1.759E-05	1481.	1.999E-04	1.561E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-133m

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	1.894E-05	1.812E-05	864.	1.039E-04	9.305E-05	864.	6.441E-04	5.482E-04
NNE	1029.	1029.	2.025E-05	1.928E-05	1029.	8.483E-05	7.710E-05	1029.	4.614E-04	3.957E-04
NE	1212.	1212.	1.285E-05	1.226E-05	1212.	5.369E-05	4.897E-05	1212.	4.033E-04	3.465E-04
ENE	1367.	1367.	9.011E-06	8.562E-06	1367.	4.123E-05	3.733E-05	1367.	2.642E-04	2.277E-04
E	1170.	1170.	1.267E-05	1.202E-05	1170.	6.835E-05	6.147E-05	1170.	3.977E-04	3.419E-04
ESE	1170.	1170.	1.660E-05	1.576E-05	1170.	7.460E-05	6.727E-05	1170.	3.783E-04	3.255E-04
SE	1189.	1189.	1.402E-05	1.334E-05	1189.	5.149E-05	4.671E-05	1189.	2.278E-04	1.962E-04
SSE	1422.	1422.	9.051E-06	8.594E-06	1422.	2.975E-05	2.704E-05	1422.	1.270E-04	1.096E-04
S	1198.	1198.	8.431E-06	8.074E-06	1198.	2.808E-05	2.563E-05	1198.	1.505E-04	1.293E-04
SSW	2140.	2140.	4.938E-06	4.658E-06	2140.	1.613E-05	1.459E-05	2140.	8.011E-05	6.932E-05
SW	1372.	1372.	8.224E-06	7.852E-06	1372.	3.413E-05	3.088E-05	1372.	2.212E-04	1.900E-04
WSW	823.	823.	1.283E-05	1.234E-05	823.	7.137E-05	6.430E-05	823.	4.990E-04	4.250E-04
W	713.	713.	1.619E-05	1.558E-05	713.	9.876E-05	8.833E-05	713.	8.170E-04	6.918E-04
WNW	713.	713.	1.461E-05	1.405E-05	713.	1.166E-04	1.029E-04	713.	1.121E-03	9.465E-04
NW	823.	823.	1.457E-05	1.396E-05	823.	8.573E-05	7.661E-05	823.	7.625E-04	6.468E-04
NNW	1481.	1481.	9.664E-06	9.184E-06	1481.	5.202E-05	4.667E-05	1481.	3.480E-04	2.982E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-133

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	1.741E-05	1.678E-05	864.	1.161E-04	1.068E-04	864.	7.126E-04	6.308E-04
NNE	1029.	1029.	1.886E-05	1.810E-05	1029.	9.493E-05	8.825E-05	1029.	5.171E-04	4.609E-04
NE	1212.	1212.	1.186E-05	1.140E-05	1212.	5.974E-05	5.567E-05	1212.	4.541E-04	4.054E-04
ENE	1367.	1367.	8.561E-06	8.203E-06	1367.	4.602E-05	4.266E-05	1367.	2.989E-04	2.675E-04
E	1170.	1170.	1.214E-05	1.162E-05	1170.	7.658E-05	7.065E-05	1170.	4.478E-04	4.000E-04
ESE	1170.	1170.	1.606E-05	1.538E-05	1170.	8.356E-05	7.724E-05	1170.	4.264E-04	3.811E-04
SE	1189.	1189.	1.340E-05	1.286E-05	1189.	5.757E-05	5.344E-05	1189.	2.572E-04	2.301E-04
SSE	1422.	1422.	8.767E-06	8.399E-06	1422.	3.309E-05	3.076E-05	1422.	1.438E-04	1.289E-04
S	1198.	1198.	7.778E-06	7.503E-06	1198.	3.131E-05	2.919E-05	1198.	1.695E-04	1.513E-04
SSW	2140.	2140.	4.975E-06	4.743E-06	2140.	1.790E-05	1.657E-05	2140.	9.115E-05	8.184E-05
SW	1372.	1372.	7.778E-06	7.484E-06	1372.	3.803E-05	3.523E-05	1372.	2.491E-04	2.224E-04
WSW	823.	823.	1.135E-05	1.099E-05	823.	7.956E-05	7.348E-05	823.	5.527E-04	4.896E-04
W	713.	713.	1.419E-05	1.375E-05	713.	1.096E-04	1.006E-04	713.	8.936E-04	7.872E-04
WNW	713.	713.	1.281E-05	1.241E-05	713.	1.283E-04	1.166E-04	713.	1.218E-03	1.070E-03
NW	823.	823.	1.308E-05	1.262E-05	823.	9.513E-05	8.731E-05	823.	8.374E-04	7.389E-04
NNW	1481.	1481.	9.317E-06	8.932E-06	1481.	5.833E-05	5.372E-05	1481.	3.907E-04	3.480E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-135m

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	2.899E-04	2.803E-04	864.	8.530E-04	8.236E-04	864.	2.453E-03	2.363E-03
NNE	1029.	1029.	2.877E-04	2.781E-04	1029.	7.645E-04	7.384E-04	1029.	1.941E-03	1.870E-03
NE	1212.	1212.	1.756E-04	1.697E-04	1212.	4.447E-04	4.296E-04	1212.	1.382E-03	1.332E-03
ENE	1367.	1367.	1.163E-04	1.125E-04	1367.	3.217E-04	3.107E-04	1367.	9.117E-04	8.789E-04
E	1170.	1170.	1.741E-04	1.683E-04	1170.	5.632E-04	5.438E-04	1170.	1.662E-03	1.602E-03
ESE	1170.	1170.	2.308E-04	2.231E-04	1170.	6.317E-04	6.100E-04	1170.	1.681E-03	1.620E-03
SE	1189.	1189.	1.959E-04	1.894E-04	1189.	4.536E-04	4.381E-04	1189.	1.003E-03	9.670E-04
SSE	1422.	1422.	1.166E-04	1.127E-04	1422.	2.398E-04	2.316E-04	1422.	5.084E-04	4.901E-04
S	1198.	1198.	1.163E-04	1.124E-04	1198.	2.423E-04	2.340E-04	1198.	5.714E-04	5.507E-04
SSW	2140.	2140.	5.156E-05	4.984E-05	2140.	1.028E-04	9.925E-05	2140.	2.160E-04	2.082E-04
SW	1372.	1372.	1.099E-04	1.063E-04	1372.	2.682E-04	2.590E-04	1372.	7.263E-04	7.000E-04
WSW	823.	823.	1.979E-04	1.914E-04	823.	6.335E-04	6.118E-04	823.	2.055E-03	1.979E-03
W	713.	713.	2.585E-04	2.499E-04	713.	8.524E-04	8.229E-04	713.	3.381E-03	3.255E-03
WNW	713.	713.	2.323E-04	2.246E-04	713.	8.874E-04	8.564E-04	713.	4.500E-03	4.332E-03
NW	823.	823.	2.227E-04	2.153E-04	823.	6.913E-04	6.674E-04	823.	2.772E-03	2.670E-03
NNW	1481.	1481.	1.264E-04	1.222E-04	1481.	3.575E-04	3.452E-04	1481.	9.461E-04	9.117E-04

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-135

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	1.787E-04	1.729E-04	864.	6.779E-04	6.555E-04	864.	2.851E-03	2.753E-03
NNE	1029.	1029.	1.867E-04	1.807E-04	1029.	6.045E-04	5.847E-04	1029.	2.178E-03	2.103E-03
NE	1212.	1212.	1.196E-04	1.158E-04	1212.	3.894E-04	3.766E-04	1212.	1.917E-03	1.851E-03
ENE	1367.	1367.	8.192E-05	7.928E-05	1367.	2.860E-04	2.766E-04	1367.	1.285E-03	1.242E-03
E	1170.	1170.	1.145E-04	1.108E-04	1170.	4.571E-04	4.420E-04	1170.	1.913E-03	1.848E-03
ESE	1170.	1170.	1.504E-04	1.456E-04	1170.	5.067E-04	4.900E-04	1170.	1.833E-03	1.771E-03
SE	1189.	1189.	1.287E-04	1.246E-04	1189.	3.627E-04	3.508E-04	1189.	1.113E-03	1.075E-03
SSE	1422.	1422.	8.204E-05	7.939E-05	1422.	2.113E-04	2.044E-04	1422.	6.264E-04	6.052E-04
S	1198.	1198.	7.961E-05	7.705E-05	1198.	2.044E-04	1.977E-04	1198.	7.175E-04	6.931E-04
SSW	2140.	2140.	4.304E-05	4.165E-05	2140.	1.103E-04	1.067E-04	2140.	3.945E-04	3.812E-04
SW	1372.	1372.	7.655E-05	7.409E-05	1372.	2.359E-04	2.282E-04	1372.	1.046E-03	1.010E-03
WSW	823.	823.	1.242E-04	1.202E-04	823.	4.833E-04	4.674E-04	823.	2.225E-03	2.149E-03
W	713.	713.	1.573E-04	1.522E-04	713.	6.395E-04	6.183E-04	713.	3.478E-03	3.358E-03
WNW	713.	713.	1.415E-04	1.370E-04	713.	6.923E-04	6.693E-04	713.	4.660E-03	4.498E-03
NW	823.	823.	1.384E-04	1.340E-04	823.	5.510E-04	5.328E-04	823.	3.277E-03	3.164E-03
NNW	1481.	1481.	8.796E-05	8.512E-05	1481.	3.406E-04	3.293E-04	1481.	1.605E-03	1.550E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-137

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	9.587E-05	9.280E-05	864.	2.169E-04	2.100E-04	864.	3.650E-04	3.532E-04
NNE	1029.	1029.	8.396E-05	8.127E-05	1029.	1.789E-04	1.731E-04	1029.	2.883E-04	2.789E-04
NE	1212.	1212.	4.406E-05	4.265E-05	1212.	8.327E-05	8.059E-05	1212.	1.506E-04	1.457E-04
ENE	1367.	1367.	2.876E-05	2.784E-05	1367.	6.062E-05	5.866E-05	1367.	9.706E-05	9.393E-05
E	1170.	1170.	5.014E-05	4.854E-05	1170.	1.280E-04	1.239E-04	1170.	2.375E-04	2.298E-04
ESE	1170.	1170.	6.821E-05	6.603E-05	1170.	1.517E-04	1.468E-04	1170.	2.747E-04	2.658E-04
SE	1189.	1189.	5.604E-05	5.425E-05	1189.	1.044E-04	1.010E-04	1189.	1.631E-04	1.578E-04
SSE	1422.	1422.	2.842E-05	2.751E-05	1422.	4.591E-05	4.443E-05	1422.	6.975E-05	6.749E-05
S	1198.	1198.	3.027E-05	2.930E-05	1198.	5.064E-05	4.901E-05	1198.	8.267E-05	7.999E-05
SSW	2140.	2140.	8.925E-06	8.639E-06	2140.	1.344E-05	1.301E-05	2140.	1.753E-05	1.696E-05
SW	1372.	1372.	2.697E-05	2.611E-05	1372.	5.261E-05	5.091E-05	1372.	8.334E-05	8.064E-05
WSW	823.	823.	6.236E-05	6.037E-05	823.	1.682E-04	1.628E-04	823.	3.760E-04	3.638E-04
W	713.	713.	8.655E-05	8.378E-05	713.	2.349E-04	2.274E-04	713.	5.968E-04	5.775E-04
WNW	713.	713.	7.777E-05	7.529E-05	713.	2.298E-04	2.224E-04	713.	7.354E-04	7.115E-04
NW	823.	823.	7.090E-05	6.863E-05	823.	1.705E-04	1.650E-04	823.	3.973E-04	3.845E-04
NNW	1481.	1481.	3.192E-05	3.090E-05	1481.	6.298E-05	6.095E-05	1481.	7.935E-05	7.678E-05

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Xe-138

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	7.602E-04	7.388E-04	864.	1.909E-03	1.854E-03	864.	5.007E-03	4.860E-03
NNE	1029.	1029.	7.527E-04	7.315E-04	1029.	1.728E-03	1.679E-03	1029.	3.991E-03	3.874E-03
NE	1212.	1212.	4.600E-04	4.471E-04	1212.	1.005E-03	9.759E-04	1212.	2.814E-03	2.731E-03
ENE	1367.	1367.	3.014E-04	2.929E-04	1367.	7.202E-04	5.995E-04	1367.	1.859E-03	1.804E-03
E	1170.	1170.	4.505E-04	4.378E-04	1170.	1.258E-03	1.222E-03	1170.	3.418E-03	3.318E-03
ESE	1170.	1170.	5.943E-04	5.775E-04	1170.	1.414E-03	1.373E-03	1170.	3.473E-03	3.371E-03
SE	1189.	1189.	5.059E-04	4.916E-04	1189.	1.022E-03	9.929E-04	1189.	2.076E-03	2.015E-03
SSE	1422.	1422.	2.995E-04	2.910E-04	1422.	5.384E-04	5.229E-04	1422.	1.049E-03	1.018E-03
S	1198.	1198.	3.027E-04	2.941E-04	1198.	5.469E-04	5.312E-04	1198.	1.174E-03	1.139E-03
SSW	2140.	2140.	1.297E-04	1.260E-04	2140.	2.269E-04	2.204E-04	2140.	4.390E-04	4.262E-04
SW	1372.	1372.	2.843E-04	2.763E-04	1372.	6.005E-04	5.832E-04	1372.	1.480E-03	1.436E-03
WSW	823.	823.	5.252E-04	5.104E-04	823.	1.428E-03	1.387E-03	823.	4.220E-03	4.095E-03
W	713.	713.	6.885E-04	6.691E-04	713.	1.914E-03	1.859E-03	713.	6.917E-03	6.712E-03
WNW	713.	713.	6.188E-04	6.014E-04	713.	1.974E-03	1.917E-03	713.	9.182E-03	8.910E-03
NW	823.	823.	5.894E-04	5.728E-04	823.	1.550E-03	1.505E-03	823.	5.640E-03	5.474E-03
NNW	1481.	1481.	3.244E-04	3.152E-04	1481.	7.909E-04	7.681E-04	1481.	1.903E-03	1.847E-03

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Table F-7 (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Unrestricted Area Boundary for Ar-41

Downwind Direction	Unrestricted Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	864.	864.	9.169E-04	8.875E-04	864.	2.639E-03	2.555E-03	864.	9.453E-03	9.150E-03
NNE	1029.	1029.	9.534E-04	9.229E-04	1029.	2.410E-03	2.333E-03	1029.	7.295E-03	7.061E-03
NE	1212.	1212.	6.143E-04	5.947E-04	1212.	1.545E-03	1.496E-03	1212.	6.170E-03	5.973E-03
ENE	1367.	1367.	4.130E-04	3.998E-04	1367.	1.116E-03	1.080E-03	1367.	4.131E-03	3.999E-03
E	1170.	1170.	5.748E-04	5.564E-04	1170.	1.782E-03	1.725E-03	1170.	6.371E-03	6.167E-03
ESE	1170.	1170.	7.494E-04	7.254E-04	1170.	1.976E-03	1.913E-03	1170.	6.148E-03	5.951E-03
SE	1189.	1189.	6.447E-04	6.241E-04	1189.	1.435E-03	1.389E-03	1189.	3.710E-03	3.591E-03
SSE	1422.	1422.	4.090E-04	3.959E-04	1422.	8.282E-04	8.017E-04	1422.	2.052E-03	1.986E-03
S	1198.	1198.	4.040E-04	3.910E-04	1198.	8.103E-04	7.843E-04	1198.	2.334E-03	2.259E-03
SSW	2140.	2140.	2.070E-04	2.004E-04	2140.	4.157E-04	4.024E-04	2140.	1.195E-03	1.157E-03
SW	1372.	1372.	3.864E-04	3.740E-04	1372.	9.192E-04	8.898E-04	1372.	3.318E-03	3.212E-03
WSW	823.	823.	6.504E-04	6.296E-04	823.	1.917E-03	1.856E-03	823.	7.433E-03	7.196E-03
W	713.	713.	8.303E-04	8.037E-04	713.	2.525E-03	2.445E-03	713.	1.179E-02	1.141E-02
WNW	713.	713.	7.474E-04	7.235E-04	713.	2.689E-03	2.603E-03	713.	1.583E-02	1.532E-02
NW	823.	823.	7.219E-04	6.988E-04	823.	2.157E-03	2.088E-03	823.	1.085E-02	1.050E-02
NNW	1481.	1481.	4.362E-04	4.222E-04	1481.	1.291E-03	1.249E-03	1481.	4.963E-03	4.805E-03

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Table F-7a

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Kr-83m

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	7.953E-07	5.996E-07	300.	1.795E-04	1.353E-04	300.	1.938E-03	1.461E-03
NNE	300.	300.	1.313E-06	9.897E-07	300.	1.448E-04	1.092E-04	300.	1.809E-03	1.364E-03
NE	325.	325.	7.351E-07	5.543E-07	325.	8.809E-05	6.642E-05	325.	1.740E-03	1.312E-03
ENE	1210.	1210.	9.009E-07	6.793E-07	1210.	1.602E-05	1.208E-05	1210.	1.688E-04	1.273E-04
E	1170.	1170.	1.378E-06	1.039E-06	1170.	2.602E-05	1.962E-05	1170.	2.220E-04	1.674E-04
ESE	1125.	1125.	1.778E-06	1.340E-06	1125.	2.874E-05	2.167E-05	1125.	2.255E-04	1.700E-04
SE	475.	475.	1.799E-06	1.357E-06	475.	5.328E-05	4.017E-05	475.	5.475E-04	4.128E-04
SSE	475.	475.	9.937E-07	7.492E-07	475.	3.379E-05	2.547E-05	475.	3.931E-04	2.964E-04
S	325.	325.	3.591E-07	2.707E-07	325.	4.296E-05	3.239E-05	325.	6.418E-04	4.839E-04
SSW	325.	325.	3.038E-07	2.291E-07	325.	4.855E-05	3.661E-05	325.	7.603E-04	5.733E-04
SW	250.	250.	3.014E-07	2.273E-07	250.	1.026E-04	7.733E-05	250.	1.652E-03	1.245E-03
WSW	200.	200.	3.517E-07	2.652E-07	200.	1.842E-04	1.389E-04	200.	2.503E-03	1.887E-03
W	200.	200.	4.135E-07	3.118E-07	200.	2.314E-04	1.745E-04	200.	3.341E-03	2.519E-03
WNW	200.	200.	3.679E-07	2.774E-07	200.	3.157E-04	2.381E-04	200.	4.573E-03	3.448E-03
NW	200.	200.	4.282E-07	3.229E-07	200.	2.468E-04	1.861E-04	200.	3.784E-03	2.853E-03
NNW	200.	200.	5.028E-07	3.791E-07	200.	3.009E-04	2.269E-04	200.	3.901E-03	2.941E-03

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Note: Based on Reference 1 of Section F.2 and the formulas in Sections B.5 and B.6 of Appendix B.

Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Kr-85m

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	3.440E-04	3.330E-04	300.	1.565E-03	1.505E-03	300.	7.885E-03	7.526E-03
NNE	300.	300.	4.237E-04	4.100E-04	300.	1.663E-03	1.602E-03	300.	7.799E-03	7.450E-03
NE	325.	325.	2.890E-04	2.797E-04	325.	1.104E-03	1.064E-03	325.	7.549E-03	7.211E-03
ENE	1210.	1210.	6.453E-05	6.242E-05	1210.	2.333E-04	2.249E-04	1210.	1.091E-03	1.046E-03
E	1170.	1170.	8.118E-05	7.850E-05	1170.	3.308E-04	3.187E-04	1170.	1.393E-03	1.336E-03
ESE	1125.	1125.	1.106E-04	1.070E-04	1125.	3.817E-04	3.679E-04	1125.	1.409E-03	1.351E-03
SE	475.	475.	2.157E-04	2.087E-04	475.	6.976E-04	6.724E-04	475.	2.702E-03	2.585E-03
SSE	475.	475.	1.584E-04	1.532E-04	475.	4.768E-04	4.597E-04	475.	1.918E-03	1.835E-03
S	325.	325.	1.887E-04	1.826E-04	325.	5.731E-04	5.524E-04	325.	2.792E-03	2.667E-03
SSW	325.	325.	1.661E-04	1.608E-04	325.	5.652E-04	5.445E-04	325.	3.247E-03	3.101E-03
SW	250.	250.	2.612E-04	2.529E-04	250.	1.020E-03	9.822E-04	250.	6.563E-03	6.262E-03
WSW	200.	200.	3.394E-04	3.285E-04	200.	1.593E-03	1.532E-03	200.	9.455E-03	9.015E-03
W	200.	200.	3.795E-04	3.673E-04	200.	1.823E-03	1.752E-03	200.	1.215E-02	1.158E-02
WNW	200.	200.	3.412E-04	3.303E-04	200.	2.037E-03	1.955E-03	200.	1.618E-02	1.541E-02
NW	200.	200.	3.796E-04	3.674E-04	200.	1.863E-03	1.790E-03	200.	1.375E-02	1.310E-02
NNW	200.	200.	4.103E-04	3.972E-04	200.	2.187E-03	2.100E-03	200.	1.432E-02	1.365E-02

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Kr-85

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/	/BAR i/sec)	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	4.841E-06	4.682E-06	300.	1.820E-05	1.760E-05	300.	8.527E-05	8.246E-05
NNE	300.	300.	6.016E-06	5.817E-06	300.	1.965E-05	1.900E-05	300.	8.415E-05	8.137E-05
NE	325.	325.	4.147E-06	4.010E-06	325.	1.322E-05	1.278E-05	325.	8.181E-05	7.911E-05
ENE	1210.	1210.	9.034E-07	8.736E-07	1210.	2.801E-06	2.708E-06	1210.	1.252E-05	1.210E-05
E	1170.	1170.	1.116E-06	1.079E-06	1170.	3.908E-06	3.779E-06	1170.	1.578E-05	1.525E-05
ESE	1125.	1125.	1.515E-06	1.465E-06	1125.	4.518E-06	4.368E-06	1125.	1.587E-05	1.535E-05
SE	475.	475.	3.013E-06	2.914E-06	475.	8.268E-06	7.995E-06	475.	2.946E-05	2.848E-05
SSE	475.	475.	2.238E-06	2.164E-06	475.	5.695E-06	5.507E-06	475.	2.092E-05	2.023E-05
S	325.	325.	2.703E-06	2.614E-06	325.	6.845E-06	6.619E-06	325.	3.022E-05	2.923E-05
SSW	325.	325.	2.389E-06	2.310E-06	325.	6.715E-06	6.493E-06	325.	3.516E-05	3.400E-05
SW	250.	250.	3.748E-06	3.624E-06	250.	1.202E-05	1.163E-05	250.	7.075E-05	6.841E-05
WSW	200.	200.	4.863E-06	4.703E-06	200.	1.861E-05	1.800E-05	200.	1.015E-04	9.820E-05
W	200.	200.	5.424E-06	5.245E-06	200.	2.118E-05	2.048E-05	200.	1.304E-04	1.261E-04
WNW	200.	200.	4.877E-06	4.716E-06	200.	2.340E-05	2.263E-05	200.	1.737E-04	1.680E-04
NW	200.	200.	5.415E-06	5.237E-06	200.	2.162E-05	2.090E-05	200.	1.479E-04	1.430E-04
NNW	200.	200.	5.816E-06	5.624E-06	200.	2.526E-05	2.443E-05	200.	1.540E-04	1.490E-04

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Kr-87

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	1.764E-03	1.713E-03	300.	5.505E-03	5.347E-03	300.	2.333E-02	2.265E-02
NNE	300.	300.	2.207E-03	2.144E-03	300.	6.066E-03	5.891E-03	300.	2.334E-02	2.266E-02
NE	325.	325.	1.538E-03	1.495E-03	325.	4.104E-03	3.985E-03	325.	2.228E-02	2.163E-02
ENE	1210.	1210.	3.112E-04	3.024E-04	1210.	8.155E-04	7.920E-04	1210.	2.990E-03	2.903E-03
E	1170.	1170.	3.853E-04	3.743E-04	1170.	1.146E-03	1.113E-03	1170.	3.929E-03	3.815E-03
ESE	1125.	1125.	5.225E-04	5.076E-04	1125.	1.327E-03	1.289E-03	1125.	4.021E-03	3.904E-03
SE	475.	475.	1.087E-03	1.056E-03	475.	2.539E-03	2.466E-03	475.	8.000E-03	7.768E-03
SSE	475.	475.	8.111E-04	7.880E-04	475.	1.747E-03	1.697E-03	475.	5.666E-03	5.501E-03
S	325.	325.	9.932E-04	9.650E-04	325.	2.122E-03	2.060E-03	325.	8.268E-03	8.027E-03
SSW	325.	325.	8.813E-04	8.563E-04	325.	2.067E-03	2.008E-03	325.	9.605E-03	9.326E-03
SW	250.	250.	1.392E-03	1.352E-03	250.	3.712E-03	3.605E-03	250.	1.953E-02	1.897E-02
WSW	200.	200.	1.802E-03	1.751E-03	200.	5.733E-03	5.567E-03	200.	2.837E-02	2.754E-02
W	200.	200.	2.016E-03	1.953E-03	200.	6.487E-03	6.300E-03	200.	3.652E-02	3.546E-02
WNW	200.	200.	1.805E-03	1.754E-03	200.	7.089E-03	6.885E-03	200.	4.869E-02	4.728E-02
NW	200.	200.	2.004E-03	1.947E-03	200.	6.600E-03	6.409E-03	200.	4.117E-02	3.997E-02
NNW	200.	200.	2.139E-03	2.078E-03	200.	7.684E-03	7.463E-03	200.	4.284E-02	4.159E-02

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Kr-88

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR (mrad/yr)/(uCi/sec)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR (mrad/yr)/(uCi/sec)	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR (mrad/yr)/(uCi/sec)
N	300.	300.	4.530E-03	4.410E-03	300.	1.338E-02	1.301E-02	300.	5.642E-02	5.476E-02
NNE	300.	300.	5.692E-03	5.541E-03	300.	1.477E-02	1.436E-02	300.	5.602E-02	5.438E-02
NE	325.	325.	3.989E-03	3.884E-03	325.	1.008E-02	9.801E-03	325.	5.398E-02	5.240E-02
ENE	1210.	1210.	8.199E-04	7.981E-04	1210.	2.055E-03	1.999E-03	1210.	7.784E-03	7.562E-03
E	1170.	1170.	1.002E-03	9.755E-04	1170.	2.853E-03	2.775E-03	1170.	1.001E-02	9.728E-03
ESE	1125.	1125.	1.353E-03	1.317E-03	1125.	3.302E-03	3.211E-03	1125.	1.016E-02	9.866E-03
SE	475.	475.	2.803E-03	2.728E-03	475.	6.203E-03	6.033E-03	475.	1.942E-02	1.886E-02
SSE	475.	475.	2.101E-03	2.045E-03	475.	4.291E-03	4.174E-03	475.	1.378E-02	1.338E-02
S	325.	325.	2.576E-03	2.508E-03	325.	5.192E-03	5.050E-03	325.	1.998E-02	1.940E-02
SSW	325.	325.	2.291E-03	2.230E-03	325.	5.061E-03	4.922E-03	325.	2.324E-02	2.255E-02
SW	250.	250.	3.602E-03	3.507E-03	250.	9.036E-03	8.787E-03	250.	4.701E-02	4.562E-02
WSW	200.	200.	4.653E-03	4.530E-03	200.	1.390E-02	1.351E-02	200.	6.790E-02	6.589E-02
W	200.	200.	5.188E-03	5.051E-03	200.	1.570E-02	1.526E-02	200.	8.738E-02	8.478E-02
WNW	200.	200.	4.657E-03	4.534E-03	200.	1.714E-02	1.666E-02	200.	1.165E-01	1.131E-01
NW	200.	200.	5.165E-03	5.028E-03	200.	1.599E-02	1.555E-02	200.	9.883E-02	9.589E-02
NNW	200.	200.	5.499E-03	5.353E-03	200.	1.860E-02	1.808E-02	200.	1.029E-01	9.982E-02

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Kr-89

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	3.077E-03	2.990E-03	300.	7.981E-03	7.753E-03	300.	2.179E-02	2.116E-02
NNE	300.	300.	3.724E-03	3.619E-03	300.	9.220E-03	8.957E-03	300.	2.524E-02	2.452E-02
NE	325.	325.	2.456E-03	2.387E-03	325.	5.602E-03	5.442E-03	325.	1.977E-02	1.920E-02
ENE	1210.	1210.	2.566E-04	2.494E-04	1210.	4.839E-04	4.701E-04	1210.	7.310E-04	7.100E-04
E	1170.	1170.	3.698E-04	3.594E-04	1170.	8.126E-04	7.894E-04	1170.	1.310E-03	1.273E-03
ESE	1125.	1125.	5.387E-04	5.235E-04	1125.	1.052E-03	1.022E-03	1125.	1.733E-03	1.684E-03
SE	475.	475.	1.650E-03	1.604E-03	475.	3.389E-03	3.292E-03	475.	7.434E-03	7.220E-03
SSE	475.	475.	1.171E-03	1.138E-03	475.	2.185E-03	2.123E-03	475.	5.107E-03	4.960E-03
S	325.	325.	1.575E-03	1.531E-03	325.	3.048E-03	2.961E-03	325.	8.314E-03	8.075E-03
SSW	325.	325.	1.381E-03	1.342E-03	325.	2.939E-03	2.855E-03	325.	9.463E-03	9.191E-03
SW	250.	250.	2.400E-03	2.332E-03	250.	5.828E-03	5.662E-03	250.	2.103E-02	2.043E-02
WSW	200.	200.	3.234E-03	3.143E-03	200.	9.620E-03	9.345E-03	200.	3.510E-02	3.409E-02
W	2 ..	200.	3.631E-03	3.529E-03	200.	1.075E-02	1.044E-02	200.	4.413E-02	4.286E-02
WNW	200.	200.	3.262E-03	3 170E-03	200.	1.123E-02	1.091E-02	200.	5.787E-02	5.620E-02
NW	200.	200.	3.652E-03	3.549E-03	200.	1.054E-02	1.024E-02	200.	4.587E-02	4.455E-02
NNW	200.	200.	3.963E-03	3.851E-03	200.	1.229E-02	1.194E-02	200.	4.744E-02	4.607E-02

Quad Cities Site Meteorological Data 1/78 - 12/87

Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Kr-90

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release			Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	1.558E-03	1.512E-03	300.	2.684E-03	2.604E-03	300.	3.025E-03	2.933E-03
NNE	300.	300.	1.673E-03	1.624E-03	300.	3.000E-03	2.911E-03	300.	4.213E-03	4.084E-03
NE	325.	325.	8.837E-04	8.578E-04	325.	1.302E-03	1.263E-03	325.	2.182E-03	2.115E-03
ENE	1210.	1210.	1.434E-05	1.392E-05	1210.	1.294E-05	1.255E-05	1210.	6.697E-06	6.494E-06
E	1170.	1170.	2.876E-05	2.792E-05	1170.	3.061E-05	2.970E-05	1170.	1.687E-05	1.636E-05
ESE	1125.	1125.	4.806E-05	4.665E-05	1125.	4.598E-05	4.460E-05	1125.	3.402E-05	3.299E-05
SE	475.	475.	5.097E-04	4.947E-04	475.	7.089E-04	6.878E-04	475.	8.952E-04	8.679E-04
SSE	475.	475.	3.075E-04	2.985E-04	475.	3.993E-04	3.874E-04	475.	5.764E-04	5.588E-04
S	325.	325.	6.028E-04	5.852E-04	325.	8.849E-04	8.585E-04	325.	1.565E-03	1.517E-03
SSW	325.	325.	5.150E-04	4.999E-04	325.	8.626E-04	8.368E-04	325.	1.683E-03	1.631E-03
SW	250.	250.	1.184E-03	1.150E-03	250.	2.311E-03	2.242E-03	250.	4.598E-03	4.457E-03
WSW	200.	200.	1.907E-03	1.852E-03	200.	4.742E-03	4.600E-03	200.	1.108E-02	1.074E-02
W	200.	200.	2.179E-03	2.115E-03	200.	5.116E-03	4.963E-03	200.	1.147E-02	1.112E-02
WNW	200.	200.	1.957E-03	1.899E-03	200.	4.847E-03	4.702E-03	200.	1.265E-02	1.226E-02
NW	200.	200.	2.194E-03	2.130E-03	200.	4.603E-03	4.465E-03	200.	9.815E-03	9.513E-03
NNW	200.	200.	2.522E-03	2.448E-03	200.	5.495E-03	5.331E-03	200.	1.032E-02	1.001E-02

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Xe-131m

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	7.919E-06	7.533E-06	300.	1.746E-04	1.386E-04	300.	1.725E-03	1.335E-03
NNE	300.	300.	1.002E-05	9.476E-06	300.	1.482E-04	1.192E-04	300.	1.605E-03	1.244E-03
NE	325.	325.	6.711E-06	6.373E-06	325.	9.259E-05	7.474E-05	325.	1.564E-03	1.212E-03
ENE	1210.	1210.	2.101E-06	1.881E-06	1210.	1.811E-05	1.471E-05	1210.	1.761E-04	1.378E-04
E	1170.	1170.	2.839E-06	2.511E-06	1170.	2.808E-05	2.266E-05	1170.	2.237E-04	1.750E-04
ESE	1125.	1125.	3.764E-06	3.342E-06	1125.	3.124E-05	2.528E-05	1125.	2.248E-04	1.758E-04
SE	475.	475.	5.987E-06	5.494E-06	475.	5.658E-05	4.578E-05	475.	5.013E-04	3.898E-04
SSE	475.	475.	4.145E-06	3.846E-06	475.	3.671E-05	2.982E-05	475.	3.604E-04	2.801E-04
S	325.	325.	4.292E-06	4.095E-06	325.	4.579E-05	3.709E-05	325.	5.754E-04	4.460E-04
SSW	325.	325.	3.771E-06	3.599E-06	325.	5.003E-05	4.024E-05	325.	6.811E-04	5.276E-04
SW	250.	250.	5.781E-06	5.546E-06	250.	1.017E-04	8.122E-05	250.	1.457E-03	1.127E-03
WSW	200.	200.	7.477E-06	7.179E-06	200.	1.771E-04	1.406E-04	200.	2.181E-03	1.685E-03
W	200.	200.	8.374E-06	8.037E-06	200.	2.188E-04	1.730E-04	200.	2.896E-03	2.235E-03
WNW	200.	200.	7.527E-06	7.225E-06	200.	2.898E-04	2.274E-04	200.	3.952E-03	3.049E-03
NW	200.	200.	8.386E-06	8.046E-06	200.	2.324E-04	1.834E-04	200.	3.293E-03	2.542E-03
NNW	200.	200.	9.093E-06	8.719E-06	200.	2.814E-04	2.218E-04	200.	3.400E-03	2.625E-03

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Xe-133m

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release			Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	4.925E-05	4.753E-05	300.	3.633E-04	3.201E-04	300.	2.684E-03	2.250E-03
NNE	300.	300.	6.093E-05	5.876E-05	300.	3.485E-04	3.121E-04	300.	2.551E-03	2.148E-03
NE	325.	325.	4.145E-05	4.000E-05	325.	2.257E-04	2.030E-04	325.	2.483E-03	2.090E-03
ENE	1210.	1210.	9.950E-06	9.471E-06	1210.	4.664E-05	4.222E-05	1210.	3.138E-04	2.699E-04
E	1170.	1170.	1.267E-05	1.202E-05	1170.	6.835E-05	6.147E-05	1170.	3.971E-04	3.419E-04
ESE	1125.	1125.	1.715E-05	1.628E-05	1125.	7.772E-05	7.008E-05	1125.	4.[illegible]E-04	3.439E-04
SE	475.	475.	3.195E-05	3.061E-05	475.	1.407E-04	1.268E-04	475.	8.309E-04	7.051E-04
SSE	475.	475.	2.322E-05	2.230E-05	475.	9.430E-05	8.534E-05	475.	5.945E-04	5.041E-04
S	325.	325.	2.700E-05	2.607E-05	325.	1.149E-04	1.037E-04	325.	9.151E-04	7.704E-04
SSW	325.	325.	2.377E-05	2.296E-05	325.	1.182E-04	1.059E-04	325.	1.076E-03	9.049E-04
SW	250.	250.	3.717E-05	3.593E-05	250.	2.246E-04	1.995E-04	250.	2.254E-03	1.887E-03
WSW	200.	200.	4.824E-05	4.664E-05	200.	3.688E-04	3.249E-04	200.	3.326E-03	2.776E-03
W	200.	200.	5.395E-05	5.215E-05	200.	4.381E-04	3.837E-04	200.	4.366E-03	3.636E-03
WNW	200.	200.	4.851E-05	4.689E-05	200.	5.352E-04	4.628E-04	200.	5.911E-03	4.914E-03
NW	200.	200.	5.396E-05	5.216E-05	200.	4.567E-04	3.989E-04	200.	4.960E-03	4.129E-03
NNW	200.	200.	5.835E-05	5.639E-05	200.	5.447E-04	4.747E-04	200.	5.137E-03	4.279E-03

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Xe-133

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	4.270E-05	4.147E-05	300.	3.950E-04	3.582E-04	300.	2.859E-03	2.493E-03
NNE	300.	300.	5.247E-05	5.091E-05	300.	3.809E-04	3.498E-04	300.	2.746E-03	2.404E-03
NE	325.	325.	3.494E-05	3.393E-05	325.	2.450E-04	2.257E-04	325.	2.674E-03	2.341E-03
ENE	1210.	1210.	9.307E-06	8.931E-06	1210.	5.206E-05	4.825E-05	1210.	3.540E-04	3.163E-04
E	1170.	1170.	1.214E-05	1.162E-05	1170.	7.658E-05	7.065E-05	1170.	4.478E-04	4.000E-04
ESE	1125.	1125.	1.650E-05	1.581E-05	1125.	8.707E-05	8.048E-05	1125.	4.504E-04	4.023E-04
SE	475.	475.	2.856E-05	2.755E-05	475.	1.562E-04	1.443E-04	475.	9.121E-04	8.051E-04
SSE	475.	475.	2.032E-05	1.965E-05	475.	1.042E-04	9.655E-05	475.	6.513E-04	5.745E-04
S	325.	325.	2.272E-05	2.207E-05	325.	1.256E-04	1.160E-04	325.	9.860E-04	8.636E-04
SSW	325.	325.	1.988E-05	1.932E-05	325.	1.288E-04	1.183E-04	325.	1.156E-03	1.011E-03
SW	250.	250.	3.098E-05	3.013E-05	250.	2.427E-04	2.214E-04	250.	2.393E-03	2.083E-03
WSW	200.	200.	4.018E-05	3.909E-05	200.	3.963E-04	3.591E-04	200.	3.501E-03	3.038E-03
W	200.	200.	4.515E-05	4.392E-05	200.	4.689E-04	4.229E-04	200.	4.563E-03	3.949E-03
WNW	200.	200.	4.058E-05	3.948E-05	200.	5.668E-04	5.057E-04	200.	6.143E-03	5.305E-03
NW	200.	200.	4.529E-05	4.405E-05	200.	4.874E-04	4.385E-04	200.	5.179E-03	4.481E-03
NNW	200.	200.	4.951E-05	4.815E-05	200.	5.823E-04	5.230E-04	200.	5.375E-03	4.654E-03

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Xe-135m

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	8.787E-04	8.497E-04	300.	3.156E-03	3.045E-03	300.	1.293E-02	1.244E-02
NNE	300.	300.	1.083E-03	1.047E-03	300.	3.479E-03	3.358E-03	300.	1.348E-02	1.297E-02
NE	325.	325.	7.388E-04	7.144E-04	325.	2.270E-03	2.192E-03	325.	1.218E-02	1.172E-02
ENE	1210.	1210.	1.339E-04	1.295E-04	1210.	3.795E-04	3.664E-04	1210.	1.148E-03	1.106E-03
E	1170.	1170.	1.741E-04	1.683E-04	1170.	5.632E-04	5.438E-04	1170.	1.662E-03	1.602E-03
ESE	1125.	1125.	2.410E-04	2.330E-04	1125.	6.647E-04	6.418E-04	1125.	1.799E-03	1.733E-03
SE	475.	475.	5.283E-04	5.108E-04	475.	1.419E-03	1.370E-03	475.	4.359E-03	4.198E-03
SSE	475.	475.	3.868E-04	3.740E-04	475.	9.531E-04	9.205E-04	475.	3.061E-03	2.948E-03
S	325.	325.	4.757E-04	4.600E-04	325.	1.190E-03	1.149E-03	325.	4.606E-03	4.433E-03
SSW	325.	325.	4.188E-04	4.050E-04	325.	1.158E-03	1.118E-03	325.	5.329E-03	5.129E-03
SW	250.	250.	6.775E-04	6.552E-04	250.	2.140E-03	2.065E-03	250.	1.118E-02	1.075E-02
WSW	200.	200.	8.861E-04	8.568E-04	200.	3.377E-03	3.258E-03	200.	1.684E-02	1.620E-02
W	200.	200.	9.907E-04	9.580E-04	200.	3.837E-03	3.702E-03	200.	2.178E-02	2.095E-02
WNW	200.	200.	8.901E-04	8.607E-04	200.	4.195E-03	4.045E-03	200.	2.905E-02	2.793E-02
NW	200.	200.	9.927E-04	9.599E-04	200.	3.872E-03	3.735E-03	200.	2.403E-02	2.310E-02
NNW	200.	200.	1.070E-03	1.035E-03	200.	4.530E-03	4.369E-03	200.	2.493E-02	2.398E-02

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Xe-135

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release			Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	S	SBAR	Radius (meters)	V	VBAR	Radius (meters)	G	GBAR
			(mrad/yr)/(uCi/sec)			(mrad/yr)/(uCi/sec)			(mrad/yr)/(uCi/sec)	
N	300.	300.	4.855E-04	4.700E-04	300.	2.135E-03	2.064E-03	300.	1.048E-02	1.011E-02
NNE	300.	300.	5.984E-04	5.792E-04	300.	2.283E-03	2.207E-03	300.	1.038E-02	1.002E-02
NE	325.	325.	4.086E-04	3.955E-04	325.	1.519E-03	1.469E-03	325.	1.007E-02	9.718E-03
ENE	1210.	1210.	9.137E-05	8.842E-05	1210.	3.240E-04	3.134E-04	1210.	1.508E-03	1.457E-03
E	1170.	1170.	1.145E-04	1.108E-04	1170.	4.571E-04	4.420E-04	1170.	1.913E-03	1.848E-03
ESE	1125.	1125.	1.559E-04	1.509E-04	1125.	5.278E-04	5.104E-04	1125.	1.930E-03	1.864E-03
SE	475.	475.	3.041E-04	2.944E-04	475.	9.601E-04	9.285E-04	475.	3.628E-03	3.503E-03
SSE	475.	475.	2.237E-04	2.165E-04	475.	6.578E-04	6.362E-04	475.	2.575E-03	2.486E-03
S	325.	325.	2.669E-04	2.584E-04	325.	7.892E-04	7.632E-04	325.	3.722E-03	3.593E-03
SSW	325.	325.	2.351E-04	2.276E-04	325.	7.768E-04	7.511E-04	325.	4.326E-03	4.175E-03
SW	250.	250.	3.694E-04	3.575E-04	250.	1.396E-03	1.350E-03	250.	8.701E-03	8.396E-03
WSW	200.	200.	4.798E-04	4.644E-04	200.	2.172E-03	2.099E-03	200.	1.249E-02	1.205E-02
W	200.	200.	5.363E-04	5.191E-04	200.	2.479E-03	2.396E-03	200.	1.601E-02	1.544E-02
WNW	200.	200.	4.823E-04	4.668E-04	200.	2.754E-03	2.661E-03	200.	2.128E-02	2.053E-02
NW	200.	200.	5.363E-04	5.191E-04	200.	2.531E-03	2.446E-03	200.	1.813E-02	1.749E-02
NNW	200.	200.	5.794E-04	5.608E-04	200.	2.967E-03	2.867E-03	200.	1.889E-02	1.823E-02

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Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Xe-137

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	3.700E-04	3.581E-04	300.	1.124E-03	1.088E-03	300.	3.439E-03	3.327E-03
NNE	300.	300.	4.473E-04	4.330E-04	300.	1.283E-03	1.241E-03	300.	3.916E-03	3.789E-03
NE	325.	325.	2.955E-04	2.861E-04	325.	7.857E-04	7.604E-04	325.	3.145E-03	3.043E-03
ENE	1210.	1210.	3.536E-05	3.423E-05	1210.	7.773E-05	7.523E-05	1210.	1.371E-04	1.327E-04
E	1170.	1170.	5.014E-05	4.854E-05	1170.	1.280E-04	1.239E-04	1170.	2.375E-04	2.298E-04
ESE	1125.	1125.	7.243E-05	7.011E-05	1125.	1.631E-04	1.578E-04	1125.	3.022E-04	2.924E-04
SE	475.	475.	2.037E-04	1.972E-04	475.	4.822E-04	4.667E-04	475.	1.172E-03	1.134E-03
SSE	475.	475.	1.449E-04	1.403E-04	475.	3.122E-04	3.022E-04	475.	8.078E-04	7.816E-04
S	325.	325.	1.899E-04	1.839E-04	325.	4.252E-04	4.115E-04	325.	1.292E-03	1.250E-03
SSW	325.	325.	1.663E-04	1.610E-04	325.	4.115E-04	3.982E-04	325.	1.475E-03	1.427E-03
SW	250.	250.	2.847E-04	2.756E-04	250.	8.031E-04	7.792E-04	250.	3.244E-03	3.138E-03
WSW	200.	200.	3.814E-04	3.692E-04	200.	1.321E-03	1.279E-03	200.	5.309E-03	5.137E-03
W	200.	200.	4.285E-04	4.148E-04	200.	1.485E-03	1.437E-03	200.	6.737E-03	6.518E-03
WNW	200.	200.	3.849E-04	3.726E-04	200.	1.571E-03	1.520E-03	200.	8.876E-03	8.587E-03
NW	200.	200.	4.310E-04	4.172E-04	200.	1.463E-03	1.415E-03	200.	7.069E-03	6.839E-03
NNW	200.	200.	4.686E-04	4.536E-04	200.	1.711E-03	1.656E-03	200.	7.311E-03	7.073E-03

Quad Cities Site Meteorological Data 1/78 - 12/87

Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Xe-138

Downwind Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	2.359E-03	2.292E-03	300.	7.082E-03	6.877E-03	300.	2.670E-02	2.591E-02
NNE	300.	300.	2.928E-03	2.845E-03	300.	7.932E-03	7.704E-03	300.	2.797E-02	2.714E-02
NE	325.	325.	2.022E-03	1.965E-03	325.	5.224E-03	5.074E-03	325.	2.515E-02	2.440E-02
ENE	1210.	1210.	3.494E-04	3.395E-04	1210.	8.520E-04	8.275E-04	1210.	2.345E-03	2.277E-03
E	1170.	1170.	4.505E-04	4.378E-04	1170.	1.258E-03	1.222E-03	1170.	3.418E-03	3.318E-03
ESE	1125.	1125.	6.219E-04	6.043E-04	1125.	1.488E-03	1.446E-03	1125.	3.716E-03	3.607E-03
SE	475.	475.	1.410E-03	1.370E-03	475.	3.232E-03	3.139E-03	475.	9.053E-03	8.786E-03
SSE	475.	475.	1.039E-03	1.010E-03	475.	2.178E-03	2.116E-03	475.	6.351E-03	6.164E-03
S	325.	325.	1.293E-03	1.256E-03	325.	2.730E-03	2.652E-03	325.	9.534E-03	9.251E-03
SSW	325.	325.	1.143E-03	1.111E-03	325.	2.642E-03	2.566E-03	325.	1.102E-02	1.069E-02
SW	250.	250.	1.853E-03	1.801E-03	250.	4.875E-03	4.734E-03	250.	2.313E-02	2.244E-02
WSW	200.	200.	2.418E-03	2.350E-03	200.	7.648E-03	7.427E-03	200.	3.493E-02	3.389E-02
W	200.	200.	2.700E-03	2.624E-03	200.	8.042E-03	8.391E-03	200.	4.516E-02	4.381E-02
WNW	200.	200.	2.425E-03	2.357E-03	200.	9.352E-03	9.080E-03	200.	6.021E-02	5.840E-02
NW	200.	200.	2.702E-03	2.626E-03	200.	8.707E-03	8.454E-03	200.	4.973E-02	4.824E-02
NNW	200.	200.	2.896E-03	2.815E-03	200.	1.015E-02	9.853E-03	200.	5.160E-02	5.005E-02

Quad Cities Site Meteorological Data 1/78 - 12/87

Table F-7a (Continued)

Maximum Offsite Finite Plume Gamma Dose Factors Based on 1 cm Depth at the Restricted Area Boundary for Ar-41

Downwird Direction	Controlled Area Bound (meters)	Elevated(Stack) Release Radius (meters)	S (mrad/yr)/(uCi/sec)	SBAR	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	300.	300.	2.602E-03	2.519E-03	300.	8.480E-03	8.209E-03	300.	3.703E-02	3.585E-02
NNE	300.	300.	3.254E-03	3.150E-03	300.	9.298E-03	9.000E-03	300.	3.685E-02	3.567E-02
NE	325.	325.	2.263E-03	2.190E-03	325.	6.288E-03	6.087E-03	325.	3.538E-02	3.424E-02
ENE	1210.	1210.	4.650E-04	4.501E-04	1210.	1.272E-03	1.231E-03	1210.	4.905E-03	4.748E-03
E	1170.	1170.	5.748E-04	5.564E-04	1170.	1.782E-03	1.725E-03	1170.	6.371E-03	6.167E-03
ESE	1125.	1125.	7.790E-04	7.541E-04	1125.	2.062E-03	1.996E-03	1125.	6.487E-03	6.280E-03
SE	475.	475.	1.609E-03	1.557E-03	475.	3.895E-03	3.770E-03	475.	1.269E-02	1.228E-02
SSE	475.	475.	1.199E-03	1.161E-03	475.	2.684E-03	2.598E-03	475.	8.994E-03	8.706E-03
S	325.	325.	1.464E-03	1.417E-03	325.	3.250E-03	3.146E-03	325.	1.311E-02	1.269E-02
SSW	325.	325.	1.298E-03	1.257E-03	325.	3.173E-03	3.072E-03	325.	1.524E-02	1.475E-02
SW	250.	250.	2.046E-03	1.981E-03	250.	5.695E-03	5.513E-03	250.	3.093E-02	2.994E-02
WSW	200.	200.	2.652E-03	2.567E-03	200.	8.799E-03	8.518E-03	200.	4.480E-02	4.337E-02
W	200.	200.	2.955E-03	2.860E-03	200.	9.972E-03	9.652E-03	200.	5.769E-02	5.584E-02
WNW	200.	200.	2.656E-03	2.571E-03	200.	1.094E-02	1.059E-02	200.	7.694E-02	7.448E-02
NW	200.	200.	2.947E-03	2.853E-03	200.	1.016E-02	9.831E-03	200.	6.515E-02	6.306E-02
NNW	200.	200.	3.150E-03	3.049E-03	200.	1.183E-02	1.145E-02	200.	6.780E-02	6.563E-02

Quad Cities Site Meteorological Data 1/78 - 12/87

Table F-8
Parameters for Calculations of N-16 Skyshine Radiation From Quad Cities

Location Number k	Activity	Occupancy Hours OH_k[a]	Occupancy Factor OF_k	Shielding Factor SF_k	Distance R_k (m)
1	Living at home (nearest resident)	8160	0.93	0.7	800[b]
2	Fishing	50	0.005	1.0	140[c]
3	Fishing	50	0.005	1.0	170[c]
4	Fishing	100	0.01	1.0	200[c]
5	Fishing	400	0.05	1.0	400[c]

K = 3.80E-05 mrem/(MWe-hr)

These parameters are used to obtain an initial estimate of skyshine dose to the maximally exposed member of the public using Equation A-34 in Appendix A. If desired, more realistic parameters could be used in place of these to refine the estimate. For example, one could determine whether the nearest resident really fishes the specified number of hours at the specified location.

[a] The amount of time in a year that a maximally exposed fisherman would spend fishing near the site is estimated as 12 hours per week for 8 months per year. This yields an estimate of:

[12 hours/week] [(8 months/yr)/(12 months/yr)] x [52 weeks/yr] = 416 hours/yr

The remaining time is assumed to be spent at the nearest residence.

[b] Distance to nearest residence (See Table F-3).

[c] Estimated from a drawing of the site.

[d] The OF_k is the quotient of the number of hours a location is occupied and the number of hours in a year. Thus OH_k/8760 hours = OF_k rounded to the 0.01 digit.

Supplemental Table A

Elevated Level Joint Frequency Distribution Table Summary

296 Foot Elevation Data

Summary Table of Percent by Direction and Class

Class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
A	.076	.064	.045	.031	.086	.064	.164	.192	.236	.574	.211	.229	.457	.571	.360	.179	3.541
B	.060	.075	.073	.060	.050	.064	.129	.189	.249	.385	.183	.199	.273	.324	.218	.158	2.690
C	.147	.136	.185	.155	.151	.151	.168	.343	.391	.529	.312	.281	.478	.658	.440	.309	4.832
D	2.472	2.105	2.729	2.803	2.669	2.152	2.062	2.103	2.755	3.314	2.630	2.527	3.654	5.503	4.501	3.027	47.006
E	1.175	1.004	1.363	1.533	1.992	1.651	1.775	2.131	3.111	3.193	2.229	1.520	1.773	1.916	1.871	1.219	29.457
F	.287	.267	.324	.324	.601	.815	.936	.979	1.128	1.010	.593	.365	.352	.469	.397	.353	9.200
G	.042	.069	.060	.083	.117	.168	.400	.517	.574	.482	.294	.136	.111	.097	.076	.045	3.273
Total	4.260	3.720	4.778	4.989	5.666	5.066	5.634	6.454	8.445	9.487	6.453	5.258	7.097	9.538	7.864	5.291	100.000

Summary Table of Percent by Direction and Speed

Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
.45	.008	.009	.010	.005	.013	.007	.005	.002	.004	.005	.000	.006	.001	.000	.003	.005	.082
1.05	.021	.025	.025	.035	.029	.023	.029	.026	.022	.032	.038	.038	.041	.038	.031	.031	.485
2.05	.182	.182	.196	.192	.218	.199	.220	.190	.208	.325	.397	.299	.221	.239	.193	.188	3.650
3.05	.428	.366	.451	.407	.441	.406	.453	.384	.434	.787	.752	.473	.478	.500	.481	.393	7.632
4.05	.552	.561	.627	.643	.624	.596	.598	.608	.643	1.136	.897	.589	.563	.636	.680	.681	10.634
5.05	.684	.649	.752	.722	.803	.664	.756	.759	.831	1.264	1.130	.674	.692	.885	.977	.801	13.043
6.05	.712	.602	.725	.749	.939	.712	.913	.967	1.229	1.448	1.130	.812	.948	1.248	1.199	1.029	15.361
8.05	1.143	.796	1.190	1.247	1.481	1.515	1.714	2.013	2.538	2.516	1.459	1.341	2.022	2.883	2.324	1.494	27.676
10.05	.363	.314	.548	.611	.653	.671	.793	.979	1.544	1.250	.464	.588	1.254	1.804	1.347	.514	13.697
13.05	.149	.173	.218	.324	.375	.245	.141	.440	.866	.596	.144	.321	.653	1.078	.568	.136	6.428
18.00	.016	.042	.035	.054	.086	.028	.013	.084	.123	.125	.042	.116	.212	.218	.062	.019	1.276
99.00	.001	.001	.000	.000	.001	.000	.000	.001	.003	.004	.000	.003	.012	.009	.000	.000	.037
Total	4.260	3.720	4.778	4.989	5.666	5.066	5.634	6.454	8.445	9.487	6.453	5.258	7.097	9.538	7.864	5.291	100.000

NOTE: Wind directions in tables are presented in "wind from" and not "wind to" direction.

Supplemental Table A -Continued

Elevated Level Joint Frequency Distribution Table Summary

296 Foot Elevation Data

Summary Table of Percent by Speed and Class

Class Speed	A	B	C	D	E	F	G
.45	.000	.006	.003	.016	.031	.019	.007
1.05	.003	.006	.006	.158	.170	.089	.053
2.05	.066	.045	.119	1.692	1.012	.478	.237
3.05	.176	.185	.308	3.840	1.925	.777	.422
4.05	.289	.299	.522	5.012	2.924	1.105	.484
5.05	.369	.362	.716	5.799	3.931	1.367	.498
6.05	.571	.400	.736	6.691	4.835	1.596	.532
8.05	.998	.718	1.272	12.230	8.759	2.859	.841
10.05	.588	.391	.661	7.034	4.032	.804	.186
13.05	.391	.214	.385	3.767	1.557	.100	.013
18.00	.085	.056	.101	.753	.274	.007	.000
99.00	.006	.009	.004	.012	.006	.000	.000

Supplemental Table B

Mixed Mode Joint Frequency Distribution Table Summaries

Summary Table of Percent by Direction and Class — 196 Foot Elevation Data

Class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
A	.158	.151	.168	.127	.107	.161	.192	.324	.365	.741	.187	.212	.416	.453	.539	.252	4.552
B	.049	.044	.070	.046	.043	.087	.073	.068	.100	.212	.080	.060	.117	.177	.156	.078	1.459
C	.130	.135	.172	.194	.185	.164	.170	.211	.283	.494	.269	.242	.395	.421	.350	.247	4.063
D	1.397	1.290	1.866	2.073	1.889	1.508	1.388	1.441	1.735	2.308	1.967	1.899	2.881	3.767	2.712	1.908	32.028
E	1.025	.905	1.323	1.778	2.029	1.551	1.643	1.947	2.558	3.048	2.280	1.841	2.437	2.656	2.102	1.157	30.281
F	.342	.319	.433	.501	.726	.863	.776	.936	1.291	1.051	.506	.337	.415	.475	.374	.311	9.655
G	.125	.127	.167	.203	.380	.598	.843	.980	.955	.767	.306	.174	.203	.148	.102	.118	6.196
Total	3.225	2.970	4.200	4.922	5.359	4.932	5.086	5.907	7.287	8.620	5.596	4.765	6.865	8.097	6.334	4.071	88.234

Summary Table of Percent by Direction and Speed

Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
.45	.006	.015	.006	.006	.006	.006	.009	.010	.012	.008	.018	.009	.002	.015	.000	.006	.131
1.05	.046	.035	.064	.050	.048	.062	.058	.079	.060	.075	.097	.064	.054	.064	.052	.050	.959
2.05	.305	.265	.255	.356	.348	.342	.367	.391	.385	.621	.719	.499	.445	.383	.362	.331	6.372
3.05	.520	.477	.702	.680	.787	.767	.699	.711	.744	1.289	1.295	.769	.790	.792	.810	.607	12.440
4.05	.761	.665	.769	.981	.975	.886	1.081	1.172	1.228	1.725	1.389	1.000	1.217	1.191	1.132	.809	16.983
5.05	.607	.611	.848	.963	1.069	1.014	1.116	1.138	1.376	1.673	.991	.912	1.308	1.603	1.240	.796	17.265
6.05	.426	.372	.645	.684	.801	.760	.850	.899	1.266	1.303	.563	.631	1.099	1.435	1.024	.656	13.415
8.05	.412	.399	.650	.832	.821	.782	.721	.953	1.406	1.337	.453	.603	1.272	1.745	1.208	.643	14.237
10.05	.113	.086	.226	.302	.389	.249	.147	.417	.661	.520	.056	.220	.509	.702	.412	.156	5.165
13.05	.028	.045	.034	.068	.111	.064	.036	.133	.144	.068	.014	.053	.160	.163	.094	.016	1.232
18.00	.000	.000	.002	.001	.003	.000	.000	.004	.004	.001	.001	.005	.008	.004	.000	.001	.034
99.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Total	3.225	2.970	4.200	4.922	5.359	4.932	5.086	5.907	7.287	8.620	5.596	4.765	6.865	8.097	6.334	4.071	88.234

NOTE: Wind directions in tables are presented in "wind from" and not "wind to" direction.

In order to determine the final mixed mode values, 88.234% of the elevated value (presented in the 296 FT Mixed Mode table) and 11.766% of the ground level value (presented in the 33 FT Mixed Mode table) are used to calculate the final values.

Supplemental Table B - Continued

Mixed Mode Joint Frequency Distribution Table Summaries

196 Foot Elevation Data

Summary Table of Percent by Speed and Class

Class Speed	A	B	C	D	E	F	G
.45	.000	.000	.000	.023	.056	.014	.039
1.05	.002	.002	.008	.249	.307	.166	.224
2.05	.089	.050	.184	2.680	1.748	.785	.837
3.05	.358	.180	.684	4.451	3.666	1.724	1.378
4.05	.794	.331	.869	5.305	5.832	2.387	1.466
5.05	.885	.309	.724	5.544	6.119	2.367	1.317
6.05	.850	.190	.640	4.731	4.847	1.458	.699
8.05	1.026	.281	.610	5.969	5.482	.655	.216
10.05	.459	.102	.267	2.423	1.798	.096	.020
13.05	.089	.014	.077	.636	.411	.004	.000
18.00	.001	.000	.000	.018	.015	.000	.000
99.00	.000	.000	.000	.000	.000	.000	.000

Supplemental Table B - Continued

Mixed Mode Joint Frequency Distribution Table Summaries

33 Foot Elevation Data

Summary Table of Percent by Direction and Class

Class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
A	.022	.020	.015	.017	.018	.036	.033	.064	.067	.131	.026	.023	.079	.076	.069	.037	.732
B	.006	.006	.008	.005	.006	.011	.013	.009	.012	.027	.008	.010	.018	.026	.027	.009	.202
C	.016	.019	.017	.024	.023	.023	.025	.028	.041	.057	.024	.026	.063	.069	.041	.028	.527
D	.186	.203	.226	.328	.270	.190	.152	.170	.213	.268	.224	.335	.547	.815	.405	.247	4.779
E	.097	.102	.171	.263	.290	.277	.245	.345	.394	.383	.225	.252	.453	.379	.245	.126	4.247
F	.012	.026	.048	.048	.084	.116	.099	.117	.104	.059	.022	.022	.045	.036	.018	.014	.868
G	.003	.006	.007	.017	.058	.133	.052	.053	.036	.009	.006	.003	.013	.006	.005	.002	.410
Total	.341	.382	.493	.702	.749	.786	.619	.787	.868	.934	.535	.672	1.218	1.408	.810	.463	11.766

Summary Table of Percent by Direction and Speed

Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
.45	.000	.000	.000	.001	.000	.001	.001	.001	.003	.000	.001	.001	.000	.001	.000	.000	.010
1.05	.004	.005	.008	.012	.020	.036	.030	.036	.031	.009	.012	.010	.009	.005	.005	.005	.239
2.05	.029	.031	.056	.058	.107	.167	.131	.163	.160	.091	.077	.078	.092	.072	.038	.032	1.381
3.05	.047	.058	.090	.121	.126	.153	.149	.173	.206	.245	.173	.139	.231	.159	.097	.066	2.234
4.05	.066	.078	.106	.151	.123	.137	.132	.159	.175	.283	.144	.137	.247	.275	.176	.114	2.503
5.05	.068	.069	.089	.115	.101	.096	.073	.094	.121	.163	.075	.105	.214	.291	.174	.111	1.961
6.05	.044	.055	.056	.084	.091	.090	.050	.077	.091	.068	.024	.063	.136	.244	.140	.076	1.390
8.05	.051	.040	.056	.109	.116	.074	.040	.076	.071	.064	.014	.047	.156	.240	.145	.046	1.343
10.05	.025	.040	.032	.049	.042	.028	.009	.008	.009	.011	.014	.080	.093	.110	.035	.010	.594
13.05	.006	.006	.000	.002	.022	.003	.004	.000	.000	.000	.000	.014	.034	.011	.000	.003	.105
18.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.006	.000	.000	.000	.006
99.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Total	.341	.382	.493	.702	.749	.786	.619	.787	.868	.934	.535	.672	1.218	1.408	.810	.463	11.766

NOTE: Wind directions in tables are presented in "wind from" and not "wind to" direction.

Supplemental Table B - Continued

Mixed Mode Joint Frequency Distribution Table Summaries

33 Foot Elevation Data

Summary Table of Percent by Speed and Class

Class Speed	A	B	C	D	E	F	G
.45	.000	.000	.000	.000	.001	.002	.007
1.05	.008	.000	.000	.008	.042	.078	.103
2.05	.018	.006	.010	.149	.509	.457	.231
3.05	.095	.023	.068	.644	1.105	.244	.055
4.05	.197	.053	.128	1.080	.981	.059	.004
5.05	.177	.044	.122	.981	.617	.017	.002
6.05	.131	.035	.075	.767	.373	.004	.005
8.05	.093	.027	.090	.742	.383	.005	.002
10.05	.012	.011	.031	.340	.199	.002	.000
13.05	.001	.001	.003	.067	.032	.000	.000
18.00	.000	.000	.000	.000	.006	.000	.000
99.00	.000	.000	.000	.000	.000	.000	.000

Supplemental Table C

Ground Level Joint Frequency Distribution Table Summary

Summary Table of Percent by Direction and Class

Class	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
A	.180	.185	.133	.155	.133	.224	.243	.352	.363	.856	.294	.247	.556	.539	.516	.303	5.280
B	.058	.058	.071	.048	.044	.095	.093	.079	.087	.222	.122	.083	.164	.180	.168	.085	1.658
C	.151	.189	.195	.201	.187	.195	.211	.220	.267	.527	.350	.313	.454	.527	.342	.253	4.582
D	1.614	1.666	1.966	2.403	2.014	1.814	1.586	1.537	1.562	2.410	2.476	2.451	3.540	4.726	2.898	2.124	36.786
E	.946	1.011	1.561	2.128	2.275	2.129	1.985	2.335	2.585	3.085	2.739	2.277	3.197	3.168	1.953	1.169	34.543
F	.255	.383	.631	.574	.863	1.222	1.085	1.175	1.016	.718	.491	.403	.619	.564	.296	.227	10.523
G	.088	.151	.205	.279	.886	1.841	.863	.691	.457	.212	.241	.126	.265	.175	.082	.068	6.628
Total	3.291	3.644	4.763	5.788	6.402	7.519	6.065	6.389	6.337	8.030	6.712	5.900	8.795	9.879	6.255	4.229	100.000

Summary Table of Percent by Direction and Speed

Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
.45	.047	.055	.086	.089	.083	.095	.132	.146	.115	.070	.123	.083	.073	.068	.054	.039	1.358
1.05	.214	.257	.417	.419	.723	.991	.860	.898	.730	.593	.782	.583	.504	.394	.214	.172	8.753
2.05	.612	.713	1.138	1.109	1.629	2.537	1.901	1.965	1.826	1.789	2.096	1.700	1.967	1.611	.987	.663	24.241
3.05	.713	.825	1.061	1.281	1.341	1.609	1.443	1.476	1.601	2.434	2.038	1.534	2.336	2.005	1.285	.935	23.916
4.05	.624	.701	.875	1.103	.983	.881	.925	.985	1.051	1.814	1.041	.974	1.629	1.905	1.395	.974	17.860
5.05	.489	.473	.576	.719	.607	.595	.429	.481	.576	.881	.452	.493	1.088	1.617	1.034	.751	11.259
6.05	.265	.323	.317	.471	.454	.446	.257	.278	.305	.299	.124	.296	.632	1.188	.717	.437	6.808
8.05	.263	.205	.238	.504	.481	.296	.102	.153	.124	.133	.037	.133	.413	.910	.504	.228	4.723
10.05	.056	.085	.056	.091	.073	.064	.012	.008	.010	.015	.019	.091	.114	.170	.066	.027	.956
13.05	.008	.008	.000	.002	.029	.006	.004	.000	.000	.000	.000	.014	.035	.012	.000	.004	.120
18.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.006	.000	.000	.000	.006
99.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Total	3.291	3.644	4.763	5.788	6.402	7.519	6.065	6.389	6.337	8.030	6.712	5.900	8.795	9.879	6.255	4.229	100.000

NOTE: Wind directions in tables are presented in "wind from" and not "wind to" direction.

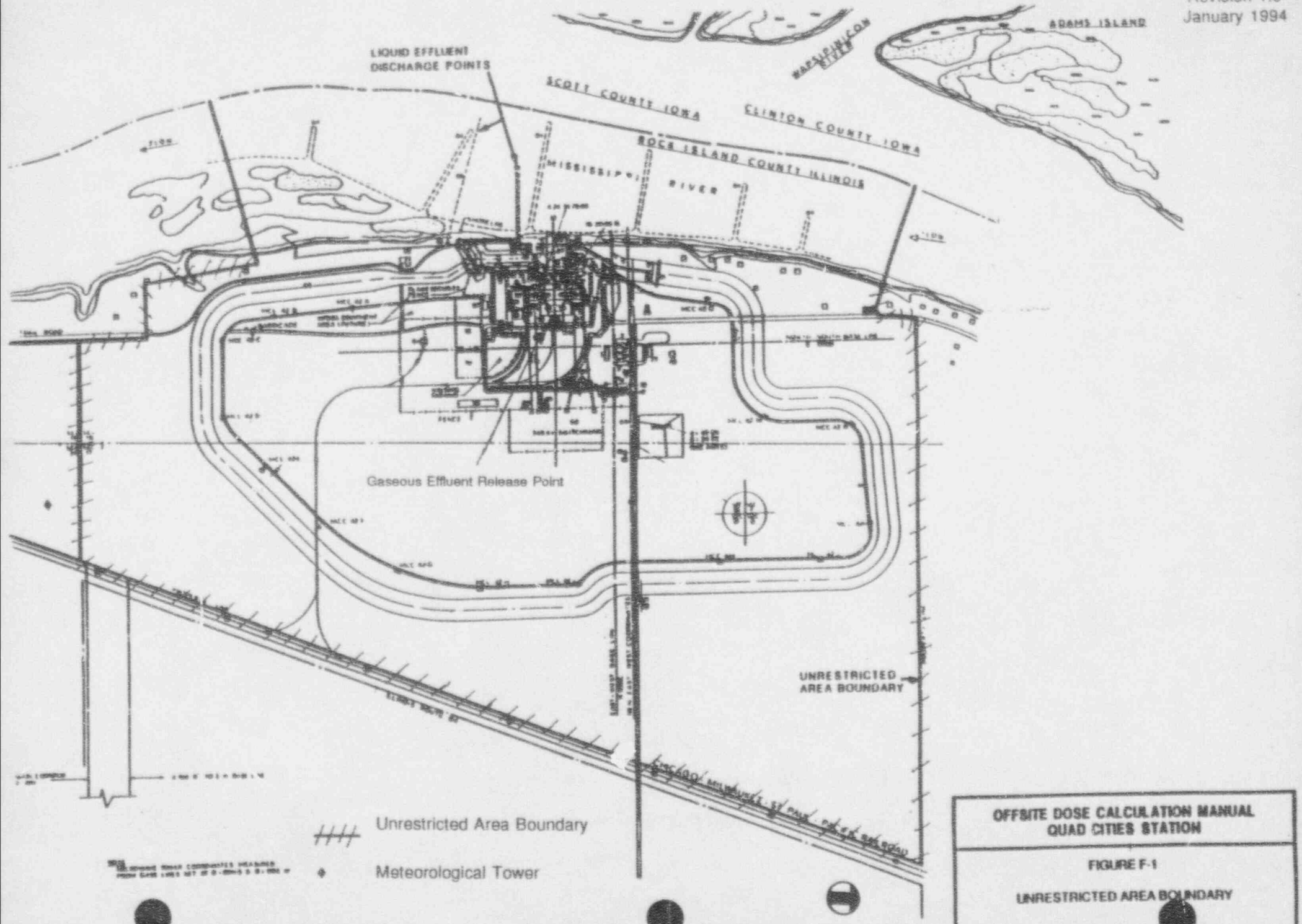
Supplemental Table C - Continued

Ground Level Joint Frequency Distribution Table Summary

33 Foot Elevation Data

Summary Table of Percent by Speed and Class

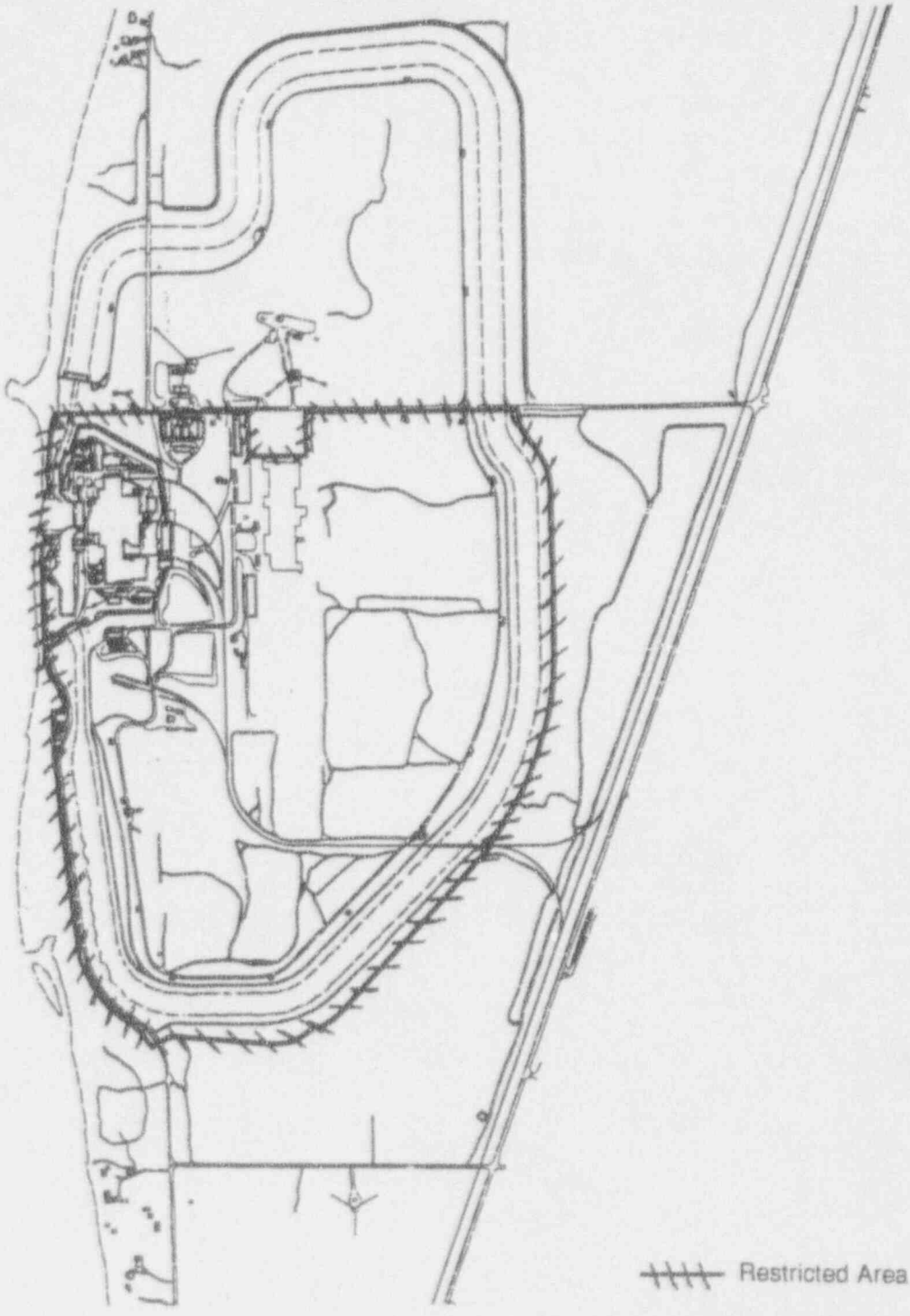
Class Speed	A	B	C	D	E	F	G
.45	.000	.000	.002	.056	.299	.375	.626
1.05	.041	.012	.054	.902	2.390	2.569	2.786
2.05	.439	.158	.553	5.844	9.138	5.363	2.747
3.05	1.285	.481	1.321	8.821	9.831	1.773	.404
4.05	1.544	.462	1.109	8.235	6.180	.307	.0[illegible]
5.05	1.012	.255	.765	5.683	3.435	.097	.0[illegible]
6.05	.618	.182	.388	3.856	1.721	.017	.025
8.05	.313	.089	.328	2.755	1.215	.017	.006
10.05	.027	.017	.058	.556	.294	.004	.000
13.05	.002	.002	.004	.077	.035	.000	.000
18.00	.000	.000	.000	.000	.006	.000	.000
99.00	.000	.000	.000	.000	.000	.000	.000



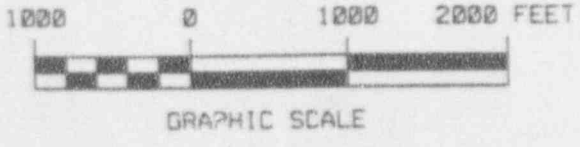
OFFSITE DOSE CALCULATION MANUAL
QUAD CITIES STATION

FIGURE F-1

UNRESTRICTED AREA BOUNDARY



Restricted Area Boundary



OFFSITE DOSE CALCULATION MANUAL
QUAD CITIES STATION

FIGURE F-2

RESTRICTED AREA BOUNDARY