BRAIDWOOD ANNEX INDEX

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CHAPTER 10

RADIOACTIVE EFFLUENT TREATMENT AND MONITORING

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RADIOACTIVE EFFLUENT TREATMENT AND MONITORING

10.1 AIRBORNE RELEASES

10.1.1 System Description

A simplified HVAC and gaseous effluent flow diagram is provided in Figure 10-1. The principal release points for potentially radioactive airborne effluents are the two auxiliary building vent stacks (designated Unit 1 Vent Stack and Unit 2 Vent Stack in Figure 10-1). In the classification scheme of Section 4.1.4, each is classified as a vent release point (see Table A-1 of Appendix A).

10.1.1.1 Waste Gas Holdup System

The waste gas holdup system is designed and installed to reduce radioactive gaseous effluents by collecting reactor coolant system off-gases from the reactor coolant system and providing for delay or holdup to reduce the total radioactivity by radiodecay prior to release to the environment. The system is described in Section 11.3.2 of the Byron/Braidwood 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 gaseous effluents by passing ventilation or vent exhaust gases through HEPA filters (and charcoal adsorbers when required to mitigate potential iodine releases) 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 Auxiliary Building Vent Effluent Monitors

Monitors 1RE-PR028 (Unit 1) and 2RE-PR028 (Unit 2) continuously monitor the final effluent from the auxiliary building vent stacks.

Both vent stack monitors feature automatic isokinetic sampling, grab sampling, and tritium sampling.

In normal operation all three noble gas channels (low, mid-range, high) are on line and active. On a high alarm the low and mid-range noble gas channels are closed and only the high range noble gas channel remains active. The iodine and particulate channels, however, continue to operate under all conditions.

No automatic isolation or control functions are performed by these monitors. Pertinent information on these monitors is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.2 Containment Purge Effluent Monitors

Monitors 1RE-PR001 (Unit 1) and 2RE-PR001 (Unit 2) continuously monitor the effluent from the Unit 1 and Unit 2 containments, respectively. When airborne radioactivity in the containment purge effluent stream exceeds a specified level, station personnel will follow established procedures to terminate the release by manually activating the containment purge valves. Additionally, the auxiliary building vent effluent monitors provide an independent, redundant means of monitoring the containment purge effluent.

No automatic isolation or control functions are performed by these monitors.

Pertinent information on these monitors is provided in Byron/Braidwood UFSAR Table 11.5-1.

Area Radiation Monitors 1(2) RE-AR011 and 1(2) RE-AR012 monitor the containment atmosphere. On high alarm during a containment purge, these monitors will automatically terminate the purge.

10.1.2.3 Waste Gas Decay Tank Monitors

Monitors 0RE-PR002A/B continuously monitor the noble gas activity released from the gas decay tanks.

On high alarm, the monitors automatically initiate closure of the valve 0GW014 thus terminating the release.

Pertinent information on these monitors and associated control devices is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.4 Gland Steam and Condenser Air Ejector Monitors

Monitors 1RE-PR027 and 2RE-PR027 continuously monitor the condenser air ejector gas from Units 1 and 2, respectively. On high alarm 1(2)RE-PR027 initiates startup of the offgas treatment system.

Pertinent information on these monitors is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.5 Radwaste Building Ventilation Monitor

Monitor 0RE-PR026 continuously monitors radioactivity in the radwaste building ventilation system. No control device is initiated by this channel.

Pertinent information on this monitor is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.6 Component Cooling Water Monitor

Monitors 0RE-PR009 (common), 1RE-PR009 (Unit 1), and 2RE-PR009 (Unit 2) continuously monitor the component cooling water heat exchanger outlets. On high alarm 0RE-PR009 initiates closure of both component cooling water surge tank (CCWST) vents, 1RE-PR009 initiates closure of the Unit 1 CCWST vent, and 2RE-PR009 initiates closure of the Unit 2 CCWST vent.

Pertinent information on this monitor is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.2.7 Miscel- neous Ventilation Monitors

Monitor 0RE-PR003 continuously monitors radioactivity in the ventilation exhaust from the laboratory fume hoods. No control device is initiated by this channel.

Pertinent information on this monitor and associated devices is provided in Byron/Braidwood UFSAR Table 11.5-1.

10.1.3 Alarm and Trip Setpoints

10.1.3.1 Setpoint Calculations

10.1.3.1.1 Auxiliary Building Vent Effluent Monitors

The setpoints for the low range noble gas channel are conservatively established at 5% of the maximum permissible station release rate for the high alarm and 1/2% of the maximum release rate for the alert alarm.

The setpoints for the high range noble gas channel are conservatively established at 50% of the maximum permissible station release rate for the high alarm and 25% of the maximum release rate for the alert alarm.

10.1.3.1.2 Containment Purge Effluent Monitors

The setpoints are established at 1.50 times the analyzed containment noble gas activity during purge, plus the background reading of the monitor prior to purge.

10.1.3.1.3 Waste Gas Decay Tank Effluent Monitors

The setpoints are established at 1.50 times the analyzed waste gas tank activity during release.

10.1.3.1.4 Component Cooling Water Monitors

The setpoint is based on the radionuclide mix in Table 10-1. The total calculated detector response is divided by 2 to obtain the final setpoint. (See section 10.2.3.5 for the conversion factor).

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 limits are found by solving Equations 10-1 and 10-2 for the total allowed release rate of vent releases, Q_{tv}.

$$(1.11)Q_{tv}\sum(\overline{V_i}f_i) \leq 500\ mrem/yr \qquad (10\text{-}1)$$

$$Q_{tv}\sum\{(f_i)[\overline{L_i}(X/Q)_v \exp(-\lambda_i R/3600u_v)^{*} + 1.11V_i]\} < 3000\ mrem/yr \qquad (10\text{-}2)$$

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

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

$\exp(-\lambda_i R/3600U_v)$ is set equal to 1.0 for setpoint calculations.

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).

Since the solution to Equation 10-2 is more conservative than the solution to Equation 10-1, the value of Equation 10-2 (3.09×10^5 µCi/sec) is used as the limiting noble gas release rate. During evolutions involving releases from the containment or waste gas decay tanks, the release rate from each release path is procedurally limited to 1×10^4 µCi/sec (less than 1/3 the maximum permissible station 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 setpoints, the radioactivity mixture in exhaust air is assumed to have the radionuclide composition of Table 10-1.

10.1.3.4 Conversion Factors

The response curves used to determine the monitor count rates are based on the sensitivity to Xe-133 for conservatism.

10.1.3.5 HVAC Flow Rates

The plant vent stack flow rates are obtained from 1/2 PR28J. However, if the readout indicates "0" flow, the following minimum rated fan flow values are currently used:

Unit 1 - 6.15×10^5 cc/sec
Unit 2 - 4.55×10^5 cc/sec

10.1.4 Allocation of Effluents from Common Release Points

Radioactive gaseous effluents released from the auxiliary building, miscellaneous ventilation systems and the gas decay tanks are comprised of contributions from both units. Consequently, allocation is made evenly between units.

10.1.5 Dose Projections for Batch Releases

Dose projections are not made prior to release. Doses are calculated after purging the containment or venting the waste gas decay tanks. Per procedure, representative samples are obtained and analyzed, and the doses calculated on a monthly basis to verify compliance with 10CFR50.

10.2 LIQUID RELEASES

10.2.1 System Description

A simplified liquid effluent flow diagram is provided in Figure 10-3. A simplified liquid waste processing diagram is provided in Figure 10-2.

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 or a concentrator for the purpose of reducing the total radioactivity prior to release to the environment. The system is described in Section 11.2.2 of the Byron/Braidwood Updated Final Safety Analysis Report.

10.2.1.1 Release Tanks

There are two radwaste release tanks (OWX01T - 33,100 gallon capacity, and OWX26T - 33750 gallon capacity) which receive liquid waste before discharge to the Kankakee river.

10.2.2 Radiation Monitors

10.2.2.1 Liquid Radwaste Effluent Monitors

Monitor 0RE-PR001 is used to monitor all releases from the release tanks. On high alarm, the monitor automatically initiates closure of valves OWX-353 and OWX-896 to terminate the release.

Pertinent information on the monitor and associated control devices is provided in Byron/Braidwood UFSAR Table 11.5-2.

10.2.2.2 Station Blowdown Monitor

Monitor 0RE-PR010 continuously monitors the circulating water blowdown. No control device is initiated by this channel.

Pertinent information on this monitor is provided in Byron/Braidwood UFSAR Table 11.5-2.

10.2.2.3 Reactor Containment Fan Cooler (RCFC) and Essential Service Water (ESSW) Outlet Line Monitors

Monitors 1RE-PR02, 2RE-PR002, 1RE-PR003, and 2RE-PR003 continuously monitor the RCFC and ESSW outlet lines.

No control device is initiated by these channels.

Pertinent information on these monitors is provided in Byron/Braidwood UFSAR Table 11.5-2.

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 RETS and 10CFR20 are not exceeded in the unrestricted area.

10.2.3.1.1 Liquid Radwaste Effluent Monitor

During release the setpoint is established at 1.5 times the analyzed tank activity plus the background reading.

10.2.3.1.2 Station Blowdown Monitor

The monitor setpoint is found by solving equation 10-3.

$$P \leq C^{CW} + \left(1.25 \times C^{T}\right) \times \left(F^{I}_{max} / \left(F^{CW} + F^{I}_{max}\right)\right) \qquad (10\text{-}3)$$

P Release Setpoint [µCi/mℓ]

1.25 Factor to account for minor fluctuations in count rate.

C^{CW} Concentration of activity in the circulating water blowdown at the time of discharge. ("Background reading") [µCi/mℓ]

C^{T} Analyzed activity in the release tank [µCi/mℓ]

F^{CW} Circulating Water Blowdown Rate [gpm]

F^r_{max} Maximum Release Tank Discharge Flow Rate [gpm]

The flow rate from the radwaste discharge tank.

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 waste sample determine the discharge rate of each batch as follows:

$$F^r_{max} = 0.5(F^d_{act}/\sum (C^T_i/10*DWC_i)) \quad (10\text{-}4)$$

The summation is over radionuclides i.

0.5 Factor for conservatism

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

The maximum permitted flow rate from the radwaste discharge tank based on radiological limits (not chemistry limits which may be more restrictive)

F^d_{act} Circulating Water Blowdown Rate [gpm]

C^T_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 [µCi/mℓ]

The concentration of radionuclide i given in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402.

10 Multiplier

10.2.3.3 Release Limits

Release limits are determined from RETS. Discharge rates and setpoints are adjusted to ensure that 50% of applicable RETS are not exceeded. (See Section 10.2.3.2)

10.2.3.4 Release Mixture

For monitors 0RE-PR001 and ORE-PR010 the release mixture used for the setpoint determination is the radionuclide mix identified in the grab sample isotopic analysis or the mix in Table 10-2.

For monitors 1RE-PR001, 1RE-PR002, 2RE-PR001, and 2RE-PR002, the release mixture is the radionuclides which are listed in Table 10-2. Each nuclide in the mix is at a concentration which is 10% of the RETS value given in Appendix B, Table 2, Column 2 to 10CFR20.1001 - 20.2402.

10.2.3.5 Conversion Factors

The readouts for the liquid effluent monitors are in µCi/mℓ. The cpm to µCi/mℓ conversion is based on the detector sensitivity to Cs-137.

10.2.3.6 Liquid Dilution Flow Rates

Dilution flow rates are obtained from circulating water blowdown transmitter loop OFT-CW032.

10.2.4 Allocation of Effluents from Common Release Points

Radioactive liquid effluents released from either release tank (0WX01T or 0WX26T) are comprised of contributions from both units. Under normal operating conditions, it is difficult to apportion the radioactivity between the units. Consequently, allocation is made evenly between units.

10.2.5 Projected Concentrations for Releases

After determining F^{I}_{max} from Equation 10-4, RETS compliance is verified using Equations 10-5 and 10-6.

$$C_i^a = C_i^T [F^I_{max} / (F^I_{max} + F^a_{act})] \qquad (10\text{-}5)$$

$$\sum (C_i^a / 10 * DWC_i) \leq 0.5 \qquad (10\text{-}6)$$

The summation is over radionuclides i.

C_i^a Concentration of Radionuclide i in the Unrestricted Area [µCi/mℓ]

The calculated concentration of radionuclide i in the unrestricted area as determined by Equation 10-5.

C_i^T	Concentration of Radionuclide i in the Release Tank The concentration of radioactivity in the radwaste discharge tank based on measurements of a sample drawn from the tank.	[µCi/ml]
DWC_i	Derived Water Concentration of Radionuclide i The concentration of radionuclide i given in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402.	[µCi/ml]
10	Multiplier	
F_{max}^T	Maximum Releaso Tank Discharge Flow Rate	[gpm]
F_{AC}^B	Circulating Water Blowdown Rate	[gpm]
0.5	Factor for conservatism	

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 system.

Table 10-1

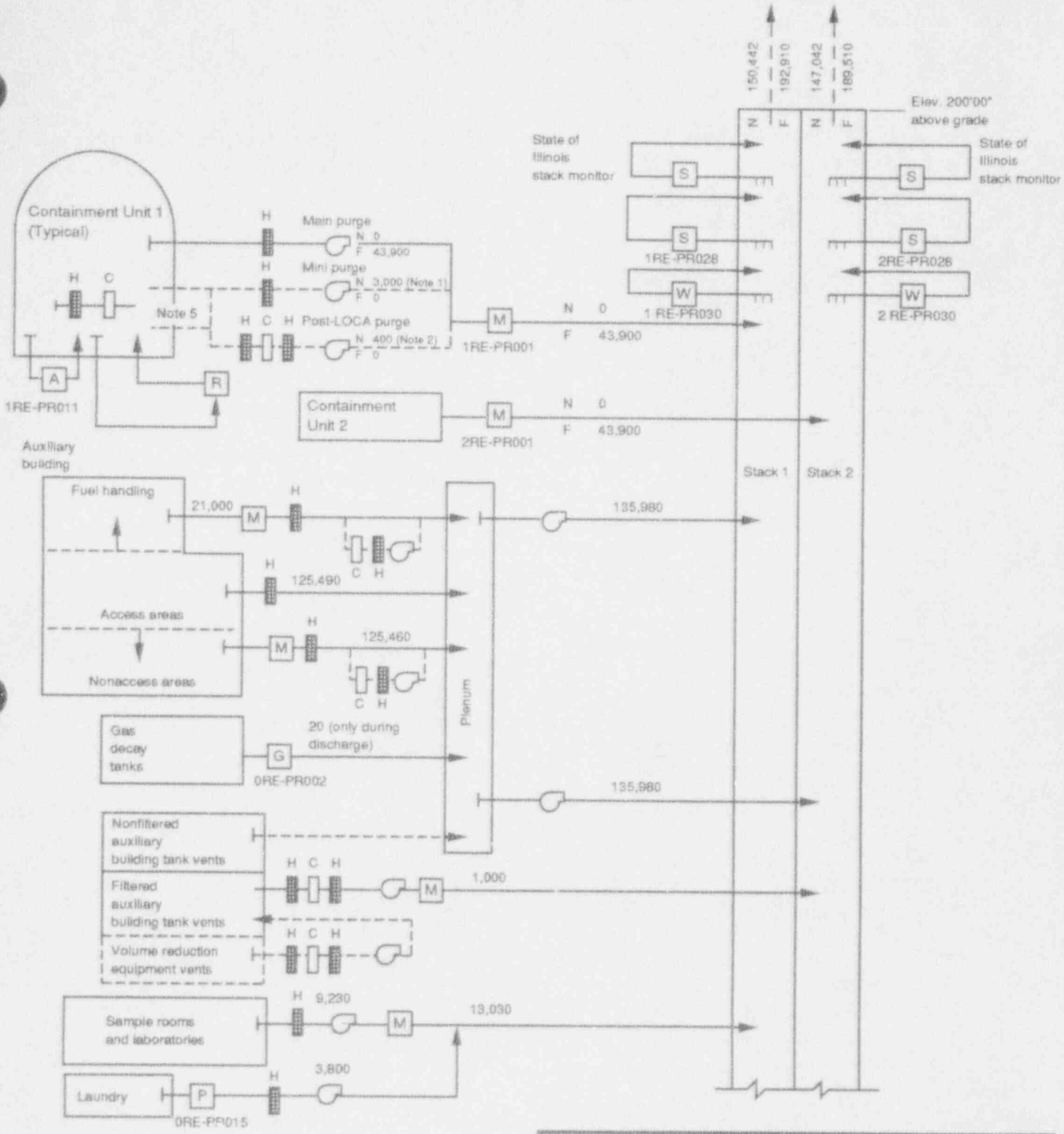
Assumed Composition of the Braidwood Station
Noble Gas Effluent

Isotope	Percent of Total Annual Release
Ar-41	00.89
Kr-85m	00.18
Kr-85	24.9
Kr-87	00.04
Kr-88	00.28
Xe-131m	01.4
Xe-133m	00.57
Xe-133	71.1
Xe-135	00.53
Xe-138	00.04

Table 10-2

Assumed Composition of the Braidwood Station Liquid Effluent

Isotope	Concentration (µCi/ml)	Isotope	Concentration (µCi/ml)
Ru-103	8.00E - 06	Mn-54	1.00E - 05
Ag-110m	3.00E - 06	Fe-59	5.00E - 06
Te-127	2.00E - 05	Co-58	9.00E - 06
Te-129m	2.00E - 06	Co-60	3.00E - 06
Te-131m	4.00E - 06	Rb-86	2.00E - 06
Te-132	2.00E - 06	Zr-95	6.00E - 06
I-130	3.00E - 07	Nb-95	1.00E - 05
I-131	3.00E - 08	Mo-99	4.00E - 06
I-132	8.00E - 07		
I-133	1.00E - 07		
I-135	4.00E - 07		
Cs-134	9.00E - 07		
Cs-136	9.00E - 06		
Cs-137	2.00E - 06		
Ce-144	1.00E - 06		
Np-239	1.00E - 05		

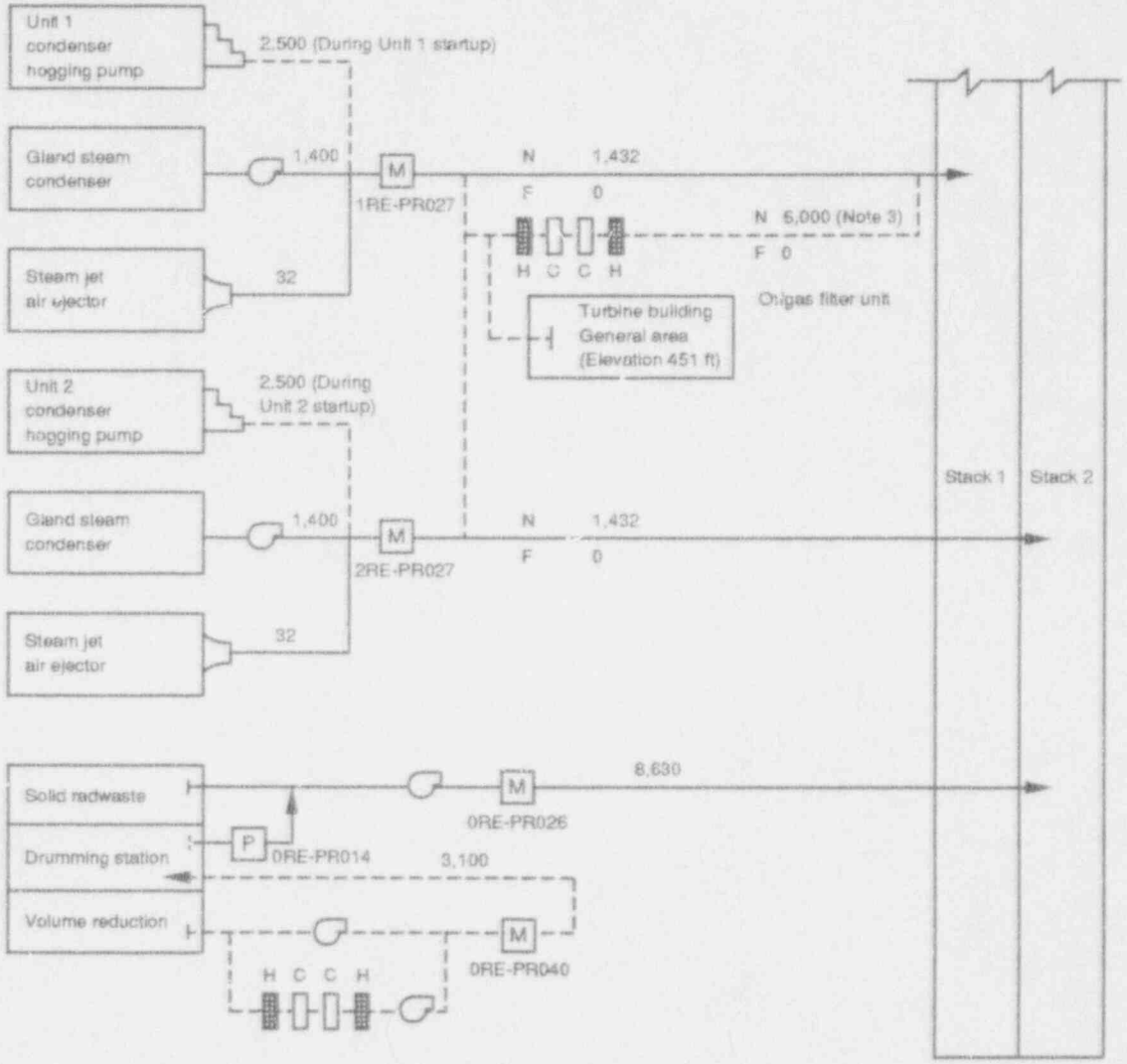


OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 10-1

SIMPLIFIED HVAC AND GASEOUS EFFLUENT FLOW DIAGRAM (SHEET 1 OF 2)

M2464.001a 06-93



Legend

——	Normal or frequent flow path
- - - -	Occasional flow path
A	Containment atmosphere radiation monitor
C	Charcoal filter
F	Refueling
G	Noble gas radiation monitor (offline)
H	HEPA filter
M	Three-channel radiation monitor for particulate, iodine, and noble gas (offline)
N	Normal operation
P	particulate monitor (offline)
R	Hydrogen recombiner
S	Normal range stack radiation monitor (particulate, iodine, and noble gas)
W	Wide-range stack noble radiation monitor

Notes

1. Used intermittently to vent containment during normal operation.
2. Used only during postaccident operation.
3. Filter unit operates only when high radiation is detected in offgas system effluent.
4. All flow rates are design flow rates in cubic feet per minute.
5. Integrated Leak Rate Test (ILRT) pressure relief point (an alternate release point that is seldom used).

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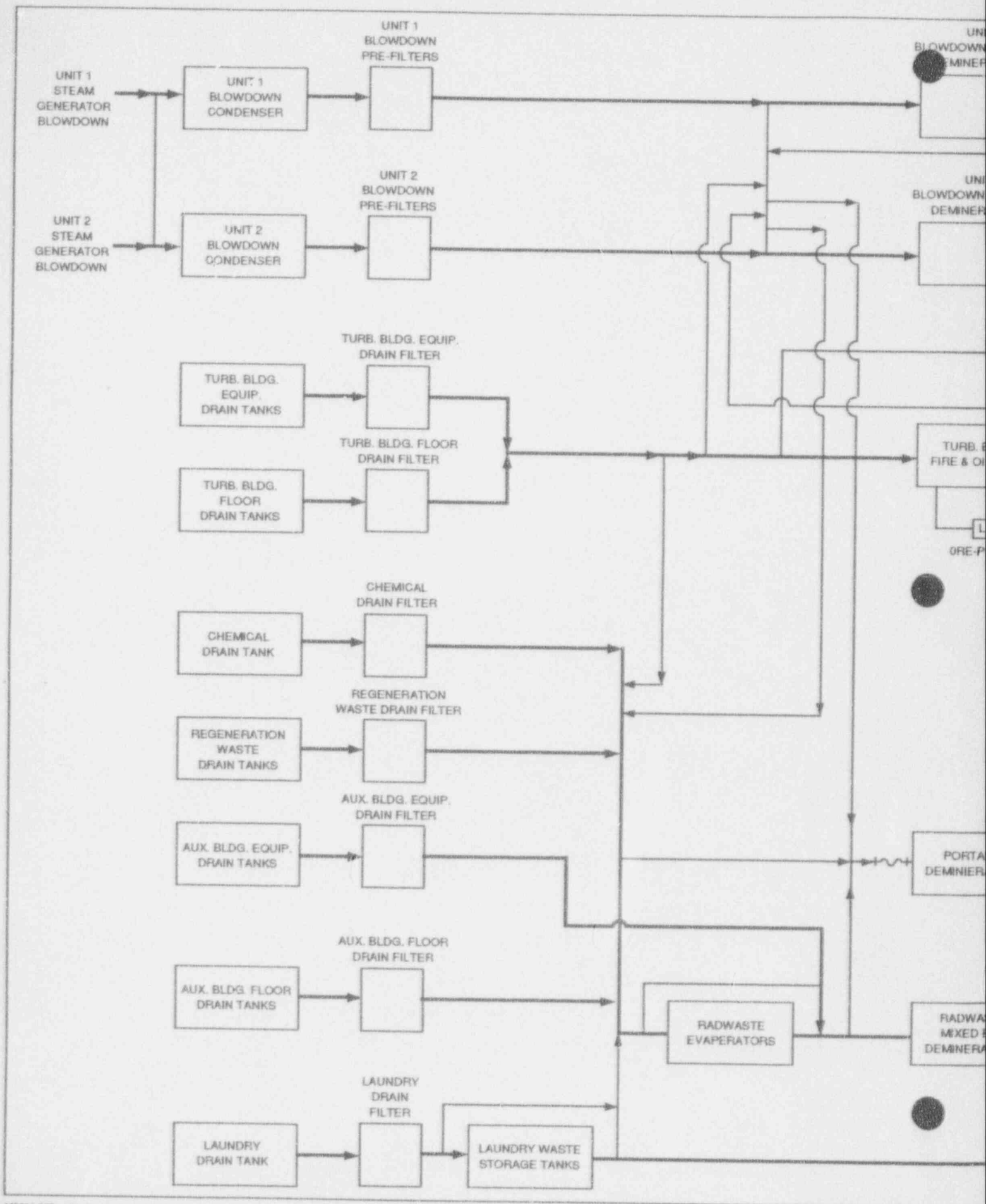
FIGURE 10-1

SIMPLIFIED HVAC AND GASEOUS EFFLUENT FLOW DIAGRAM (SHEET 2 OF 2)

M2464.002a 06-93



M5839.005a 06-93

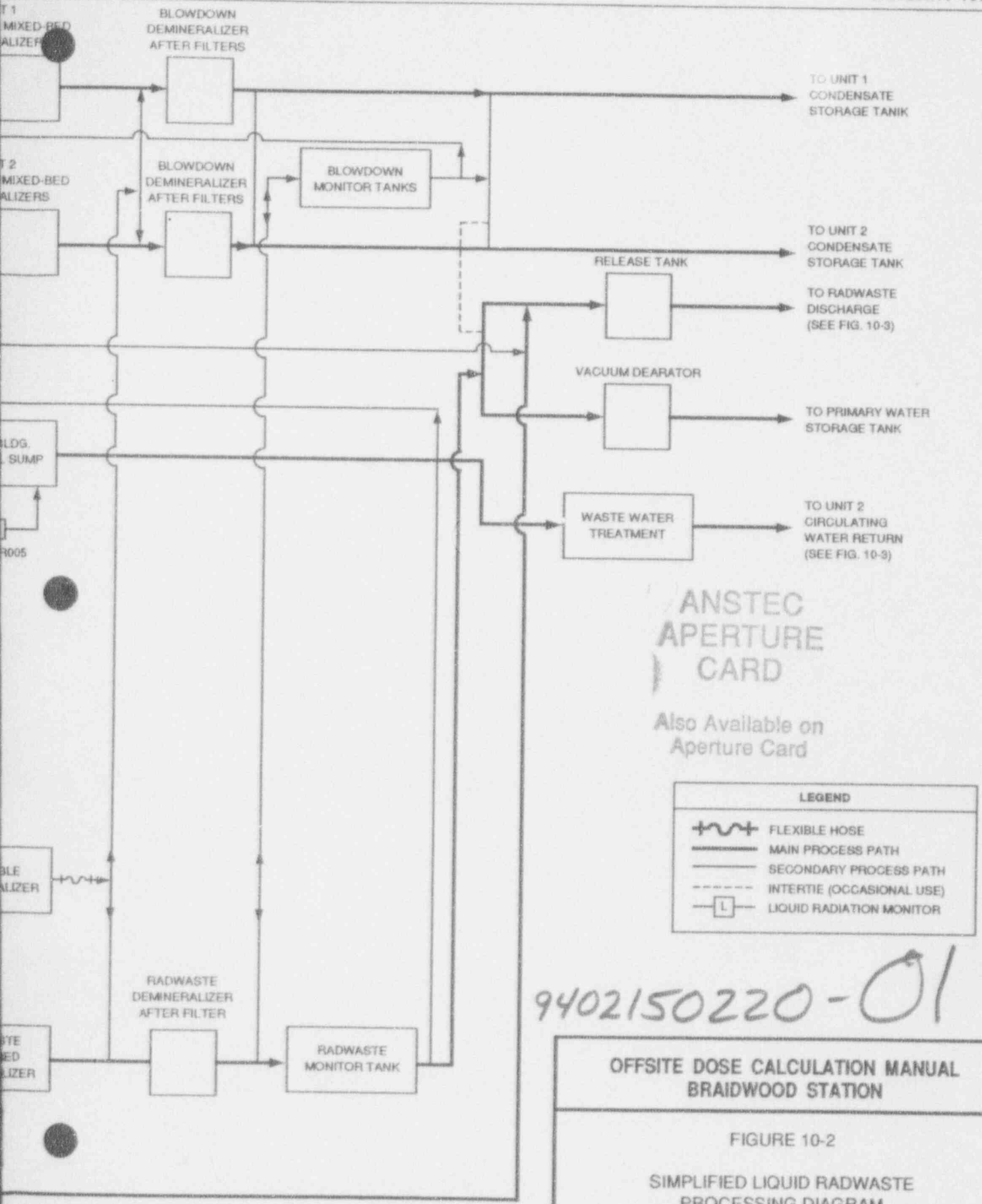


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FIGURE 10-2

SIMPLIFIED LIQUID RADWASTE PROCESSING DIAGRAM

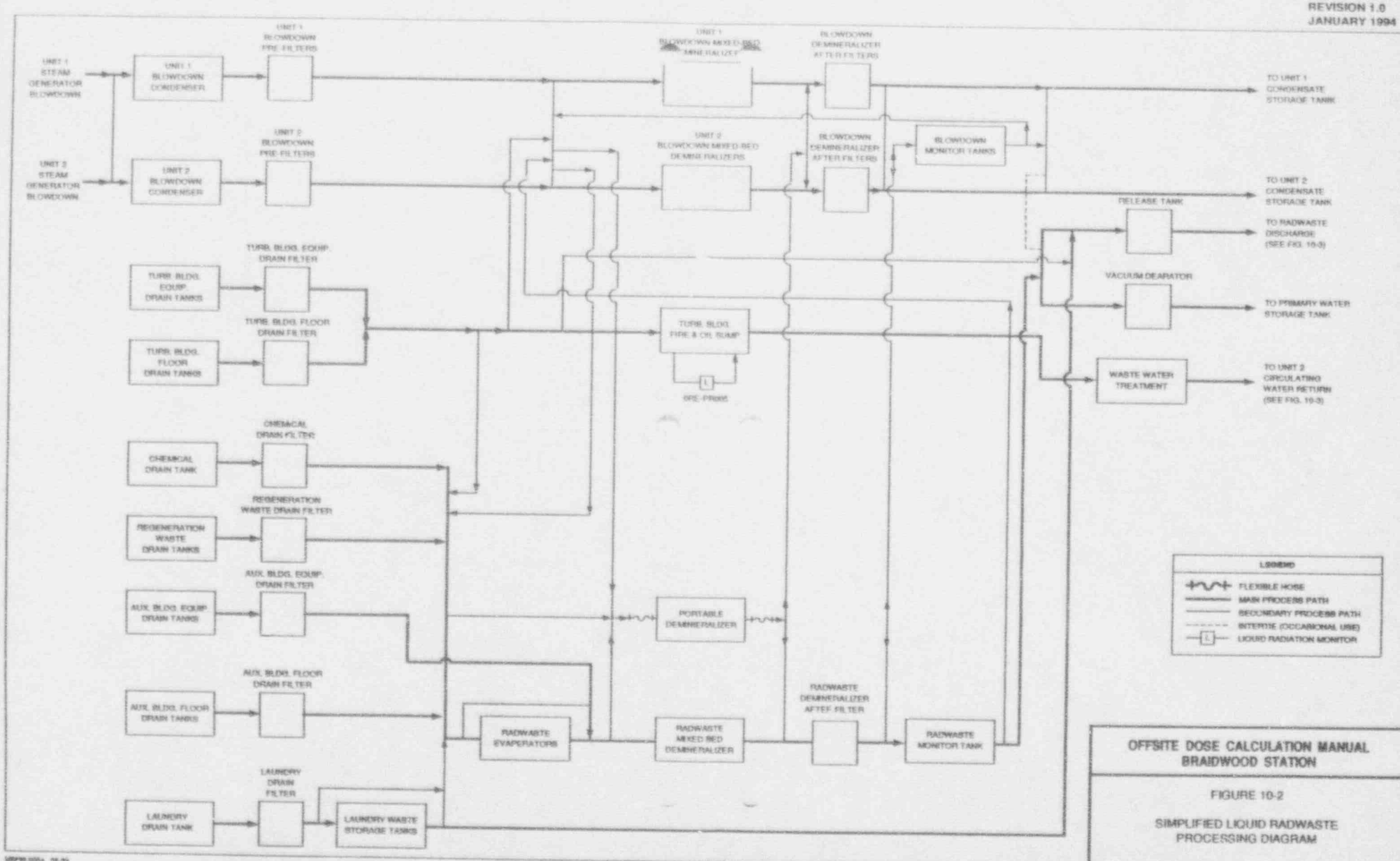

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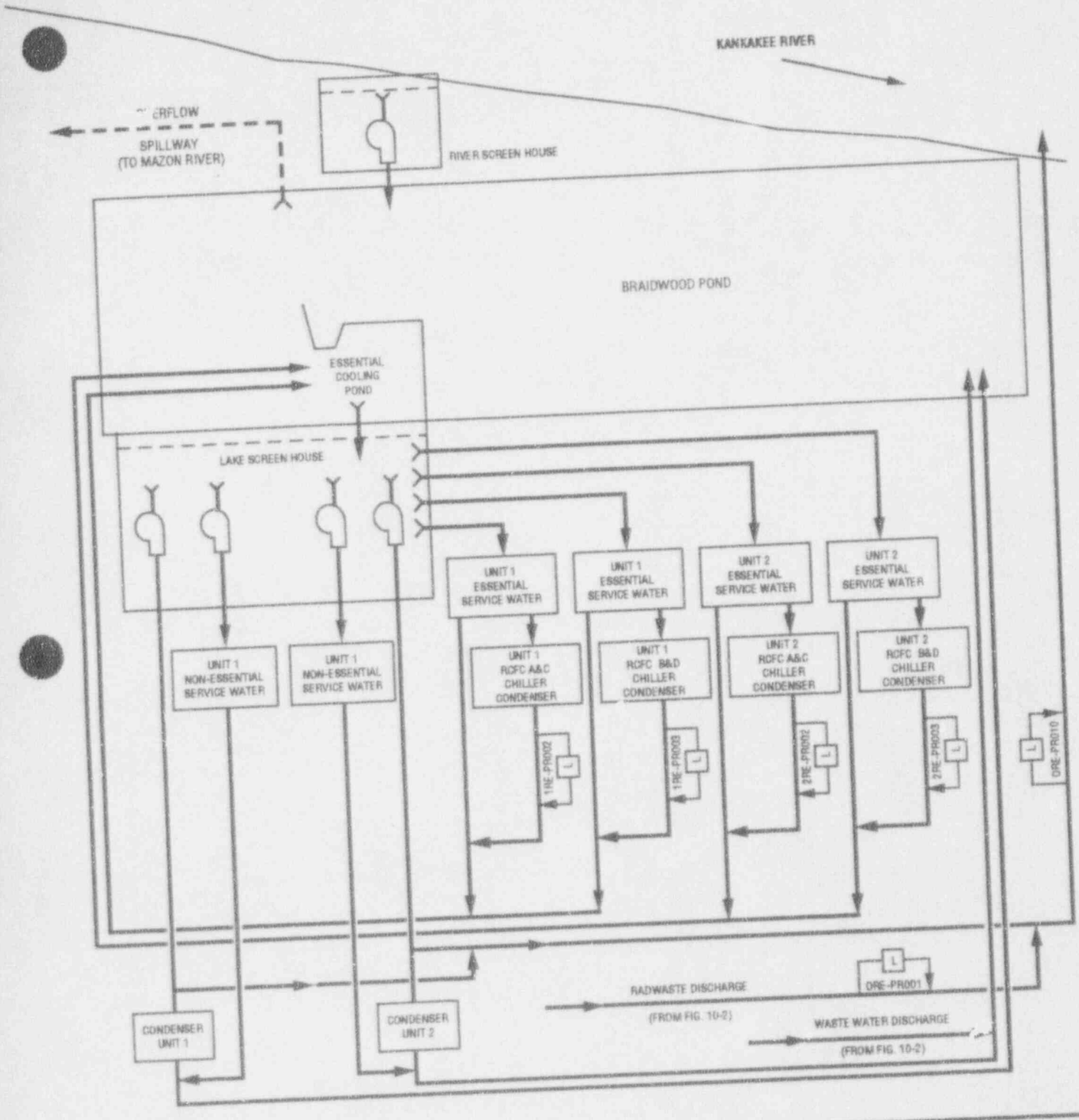
FIGURE 10-2

SIMPLIFIED LIQUID RADWASTE PROCESSING DIAGRAM



LEGEND AND NOTES

L — LIQUID RADIATION MONITOR

RCFC=REACTOR CONTAINMENT FAN COOLER IN EACH UNIT, ONLY THE A&C OR B&D CHILLER CONDENSERS ARE OPERATING AT ONE TIME.

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FIGURE 10-3

SIMPLIFIED LIQUID EFFLUENT FLOW DIAGRAM

M5839.019 06-93

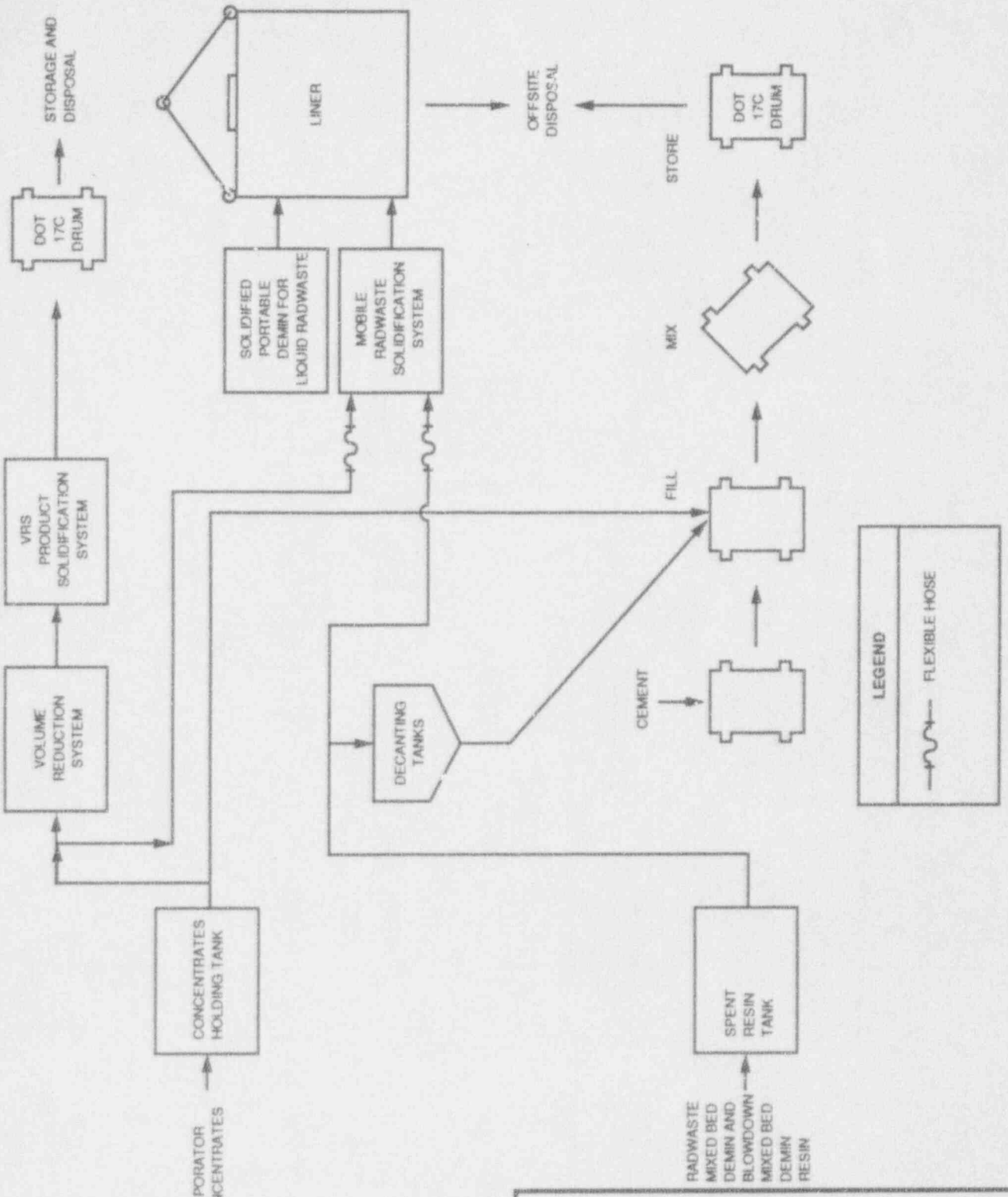

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FIGURE 10-4

SIMPLIFIED SOLID RADWASTE PROCESSING DIAGRAM

M6839.007 06-93

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CHAPTER 11

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The parameters of the radiological environmental monitoring program for the environs around Braidwood Station are given in Table 11-1. The reporting levels for radioactivity concentrations in environmental samples are given in Table 11-2. The lower limits of detection for this program are given in Table 11-3.

Figure 11-1 shows the fixed air sampling sites and TLD locations. Figure 11-2 shows the locations of the inner ring TLDs. The TLDs are code numbered as follows:

XYYz-N

X = 1 means inner ring,

X = 2 means outer ring, and

YYz-N is an identification code (YY and N are numbers; z is an optional letter).

Figure 11-3 shows the ingestion and waterborne exposure pathway sample locations.

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 Radioiodine and Particulates	a. Onsite and Near Field[b] Indicators BD-01, Braidwood, 1.5 mi NE (2.4 km C) BD-06, Godley, 0.5 mi WSW (0.8 km M) BD-19, Nearsite NW, 0.3 mi NW (0.5 km Q) BD-20, Nearsite N, 0.6 mi N (1.0 km A) BD-21, Nearsite NE, 0.5 mi NNE (0.8 km B) b. Far Field[b] Indicators BD-02, Custer Park, 5.0 mi E (8.0 km E) BD-04, Essex, 4.8 mi SSE (7.7 km H) BD-05, Gardner, 5.5 mi SW (8.8 km L) Controls BD-03, County Line Road, 6.2 mi ESE (10.0 km F)	Continuous sampler operation with sample collection weekly	Radioiodine Canisters: I-131 analysis weekly Particulate Sampler: a. Gross beta analysis following filter change[d] b. Gamma isotopic analysis on quarterly composite (by location) Sampling Train: Test and maintenance weekly

Table 11-1 (Continued)

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	a. Inner Ring[f]	Quarterly	Gamma dose quarterly
	Indicators		
	BD-101-1, 0.6 mi N (1.0 km A)		
	BD-101-2, 0.6 mi N (1.0 km A)		
	BD-101-3, 0.5 mi N (0.8 km A)		
	BD-101-4, 0.5 mi N (0.8 km A)		
	BD-102-1, 1.2 mi NNE (1.9 km B)		
	BD-102-2, 1.1 mi NNE (1.8 km B)		
	BD-103-1, 1.0 mi NE (1.6 km C)		
	BD-103-2, 1.0 mi NE (1.6 km C)		
	BD-104-1, 0.7 mi ENE (1.1 km C)		
	BD-104-2, 0.7 mi ENE (1.1 km D)		
	BD-105-1, 1.5 mi E (2.4 km E)		
	BD-105-2, 1.5 mi E (2.4 km E)		
	BD-106-1, 1.7 mi ESE (2.7 km F)		
	BD-106-2, 1.7 mi ESE (2.7 km F)		
	BD-107-1, 2.0 mi SE (3.2 km G)		
	BD-107-2, 2.0 mi SE (3.2 km G)		
	BD-108-1, 2.0 mi SSE (3.2 km H)		
	BD-108-2, 2.0 mi SSE (3.2 km H)		
	BD-109-1, 2.5 mi S (4.0 km J)		
	BD-109-2, 2.5 mi S (4.0 km J)		
	BD-110-1, 1.8 mi SSW (2.9 km K)		
	BD-110-2, 1.8 mi SSW (2.9 km K)		
	BD-111a-1, 1.4 mi SW (2.2 km L)		
	BD-111a-2, 1.4 mi SW (2.2 km L)		
	BD-111b-1, 1.1 mi SW (1.8 km L)		
	BD-111b-2, 1.1 mi SW (1.8 km L)		
	BD-112-1, 0.7 mi WSW (1.1 km M)		
	BD-112-2, 0.7 mi WSW (1.1 km M)		

Table 11-1 (Continued)

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)	BD-113a-1, 0.5 mi W (0.8 km N)		
	BD-113a-2, 0.5 mi W (0.8 km N)		
	BD-113b-1, 0.4 mi W (0.6 km N)		
	BD-113b-2, 0.4 mi W (0.6 km N)		
	BD-114-1, 0.4 mi WNW (0.6 km P)		
	BD-114-2, 0.4 mi WNW (0.6 km P)		
	BD-115-1, 0.3 mi NW (0.5 km Q)		
	BD-115-2, 0.3 mi NW (0.5 km Q)		
	BD-116-1, 0.4 mi NNW (0.6 km R)		
	BD-116-2, 0.5 mi NNW (0.8 km R)		
b.	Outer Ring[a]	Quarterly	Gamma dose quarterly
	Indicators		
	BD-201-1, 4.2 mi N (6.8 km A)		
	BD-201-2, 4.2 mi N (6.8 km A)		
	BD-202-1, 4.8 mi NNE (7.7 km B)		
	BD-202-2, 4.8 mi NNE (7.7 km B)		
	BD-203-1, 4.9 mi NE (7.9 km C)		
	BD-203-2, 4.9 mi NE (7.9 km C)		
	BD-204-1, 4.3 mi ENE (6.9 km D)		
	BD-204-2, 4.3 mi ENE (6.9 km D)		
	BD-205-1, 4.0 mi E (6.4 km E)		
	BD-205-2, 4.0 mi E (6.4 km E)		
	BD-206-1, 4.5 mi ESE (7.2 km F)		
	BD-206-2, 4.5 mi ESE (7.2 km F)		
	BD-207-1, 4.1 mi ESE (6.6 km F)		
	BD-207-2, 4.1 mi ESE (6.6 km F)		
	BD-208-1, 4.5 mi SSE (7.2 km H)		
	BD-208-2, 4.5 mi SSE (7.2 km H)		

Table 11-1 (Continued)

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)	BD-209-1, 4.8 mi S (7.7 km J) BD-209-2, 4.8 mi S (7.7 km J) BD-210-1, 4.9 mi SSW (7.9 km K) BD-210-2, 4.9 mi SSW (7.9 km K) BD-211-1, 4.8 mi SW (7.7 km L) BD-211-2, 4.8 mi SW (7.7 km L) BD-212-1, 4.7 mi WSW (7.6 km M) BD-212-2, 4.7 mi WSW (7.6 km M) BD-212-3, 5.0 mi WSW (8.0 km M) BD-212-4, 5.0 mi WSW (8.0 km M) BD-213-1, 4.5 mi W (7.2 km N) BD-213-2, 4.5 mi W (7.2 km N) BD-213-3, 4.8 mi W (7.7 km N) BD-213-4, 4.8 mi W (7.7 km N) BD-214-1, 4.3 mi WNW (6.9 km P) BD-214-2, 4.3 mi WNW (6.9 km P) BD-215-1, 4.5 mi NW (7.2 km Q) BD-215-2, 4.5 mi NW (7.2 km Q) BD-216-1, 4.4 mi NNW (7.1 km R) BD-216-2, 4.4 mi NNW (7.1 km R)		
	c. Special Interest Indicators Two TLDs at each of the airborne pathway indicator locations specified in Part 1 of this table.	Quarterly	Gamma dose quarterly on each TLD.

Table 11-1 (Continued)

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)	Controls		
	Two TLDs at each of the airborne pathway control locations specified in Part 1 of this table.		Gamma dose quarterly on each TLD.
3. Waterborne[e]			
a. Public Water	BD-22, Wilmington, 5.0 mi NNE (8.0 km B)	Weekly	Gross beta and gamma isotopic analyses monthly composite. Tritium analysis on quarterly composite.
b. Surface	BD-07, Kankakee River upstream of discharge, 5.4 mi E (8.4 km E)	Weekly	Gamma isotopic analysis on monthly composite from each location. Tritium analysis on quarterly composite from each location.
	BD-10, Kankakee River downstream of discharge, 5.0 mi ENE (8.0 km D)		
	BD-25, Kankakee River upstream of discharge, 9.6 mi E (15.4 km E)		
c. Ground/Well	BD-13, Braidwood City Hall Well, 1.7 mi NNE (2.7 km B)	Biweekly[f]	Gross beta and gamma isotopic analysis on monthly composite. Tritium analysis on quarterly composite. I-131 analysis biweekly when the dose calculated for consumption is greater than 1 mrem/yr.

Table 11-1 (Continued)

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations*	Sampling or Collection Frequency	Type and Frequency of Analysis
3. Waterborne* (Cont'd)			
d. Cooling Water	BD-08, Intake Pipe No. 3, 5.0 mi E (8.0 km E) BD-09, Discharge Pipe No. 4, 5.0 mi E (8.0 km E)	Weekly	Gross beta analysis
e. Shoreline Sediments	BD-10, Kankakee River downstream of discharge, 5.0 mi ENE (8.0 km D)	Semiannually	Gamma isotopic analysis on each sample.
4. Ingestion*			
a. Milk	Indicators BD-17, Halpin's Dairy, 5.5 mi SSW (8.8 km K) BD-26, Gaddis Farm, 11.0 mi ESE (17.6 km F) BD-27, Prussner Farm, 11.0 mi S (17.7 km J) Controls BD-18, Biros Farm, 10.5 mi W (16.9 km N)	Semimonthly: May to October Monthly: November to April	Gamma isotopic and I-131 analysis on each sample.
b. Fish	BD-07, Kankakee River upstream of discharge, 5.4 mi E (8.7 km E) BD-10, Kankakee River downstream of discharge, 5.0 mi ENE (8.0 km D)	Three times a year (spring, summer, and fall)	Gamma isotopic analysis on edible portions.
c. Vegetables	BD-14, Pinnick Farm, 1.8 mi N (2.9 km A) BD-15, Girot Farm, 1.4 mi N (2.2 km A) BD-16, Clark Farm, 3.3 mi ENE (5.5 km D)	Annually	Gamma isotopic analysis on edible portions.

Table 11-1 (Continued)

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations*	Sampling or Collection Frequency	Type and Frequency of Analysis
4. Ingestion* (Cont'd)			
d. Food Products			
Indicators Samples of three different kinds of broadleaf vegetation	Grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q (see Table F-5).	Monthly when available and required; required only if milk sampling is not performed.	Gamma isotopic and I-131 analysis.
Controls One sample each of broadleaf vegetation similar to that collected for the above requirement	From a location 15 to 30 km from the station in direction of least prevalent wind direction.	Monthly when available and required; required only if milk sampling not performed.	Gamma isotopic and I-131 analysis.
5. and 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 (Continued)

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 (Continued)

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Sampling or Monitoring Locations*	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 for definitions of sector codes used with kilometer distances.

b See Figure 11-1, "Fixed Air Sampling Sites and Outer Ring TLD Locations."

c See Figure 11-2, "Inner Ring TLD Locations."

d Perform gamma isotopic analysis on each sample when gross beta activity is greater than (>) 10 times the yearly mean of control samples.

e See Figure 11-3, "Ingestion and Waterborne Exposure Pathway Sample Locations."

f Biweekly means every two weeks.

Table 11-2

Reporting Levels for Radioactivity Concentrations in Environmental Samples

Analysis	Water (pCi/L)	Airborne Particulate or Gases (pCi/m³)	Fish (pCi/Kg, wet)	Milk (pCi/L)	Food Products (pCi/Kg, wet)
H-3	20,000*				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

*For drinking water samples. This is a 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/L may be used.

Table 11-3

Detection Capabilities for Environmental Sample Analysis

Analysis	Lower Limit of Detection (LLD)[a]					
	Water (pCi/L)	Airborne Particulate or Gases (pCi/m³)	Fish (pCi/kg, wet)	Milk (pCi/L)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2000[b]					
Mn-54	15		130			
Fe-59	30		260			
Co-58,60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1[c]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		

Table 11-3 (Continued)

Detection Capabilities for Environmental Sample Analysis

General Notes:

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

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

Footnotes:

[a] The LLD is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% 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)

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

LLD The *a priori* lower limit of detection (picocuries per unit mass or volume).

s_b The standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute).

E The counting efficiency (counts per disintegration).

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

2.22 The number of disintegrations per minute per picocurie.

Y The fractional radiochemical yield, when applicable.

λ The radioactive decay constant for the particular radionuclide (sec^{-1}).

Table 11-3 (Continued)

Detection Capabilities for Environmental Sample Analysis

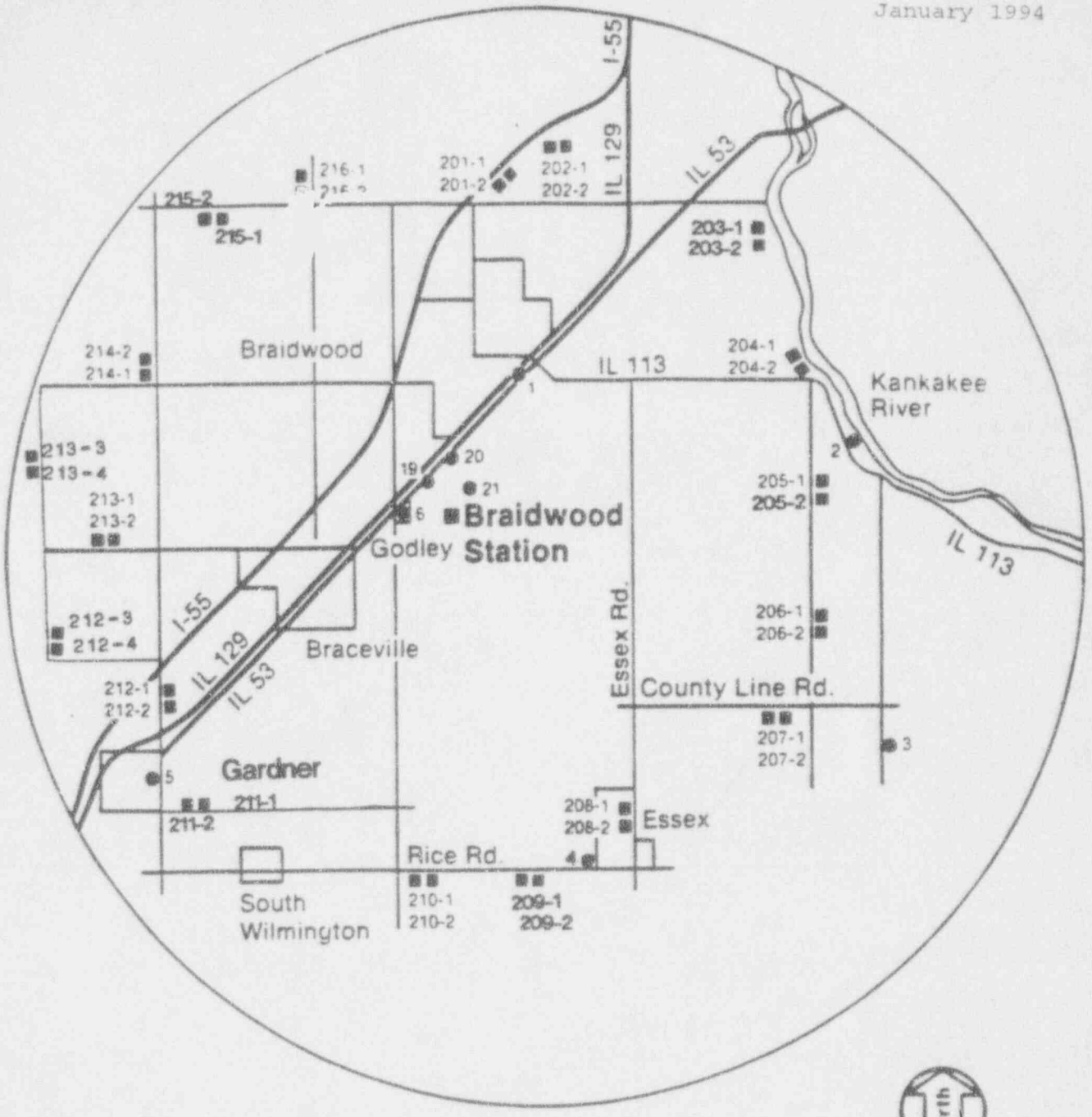
Δ The elapsed time between sample collection or end of the sample collection period and time of counting (sec).

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

It should be recognized that the LLD 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. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

b If no drinking water pathway exists, a value of 3000 pCi/L may be used.

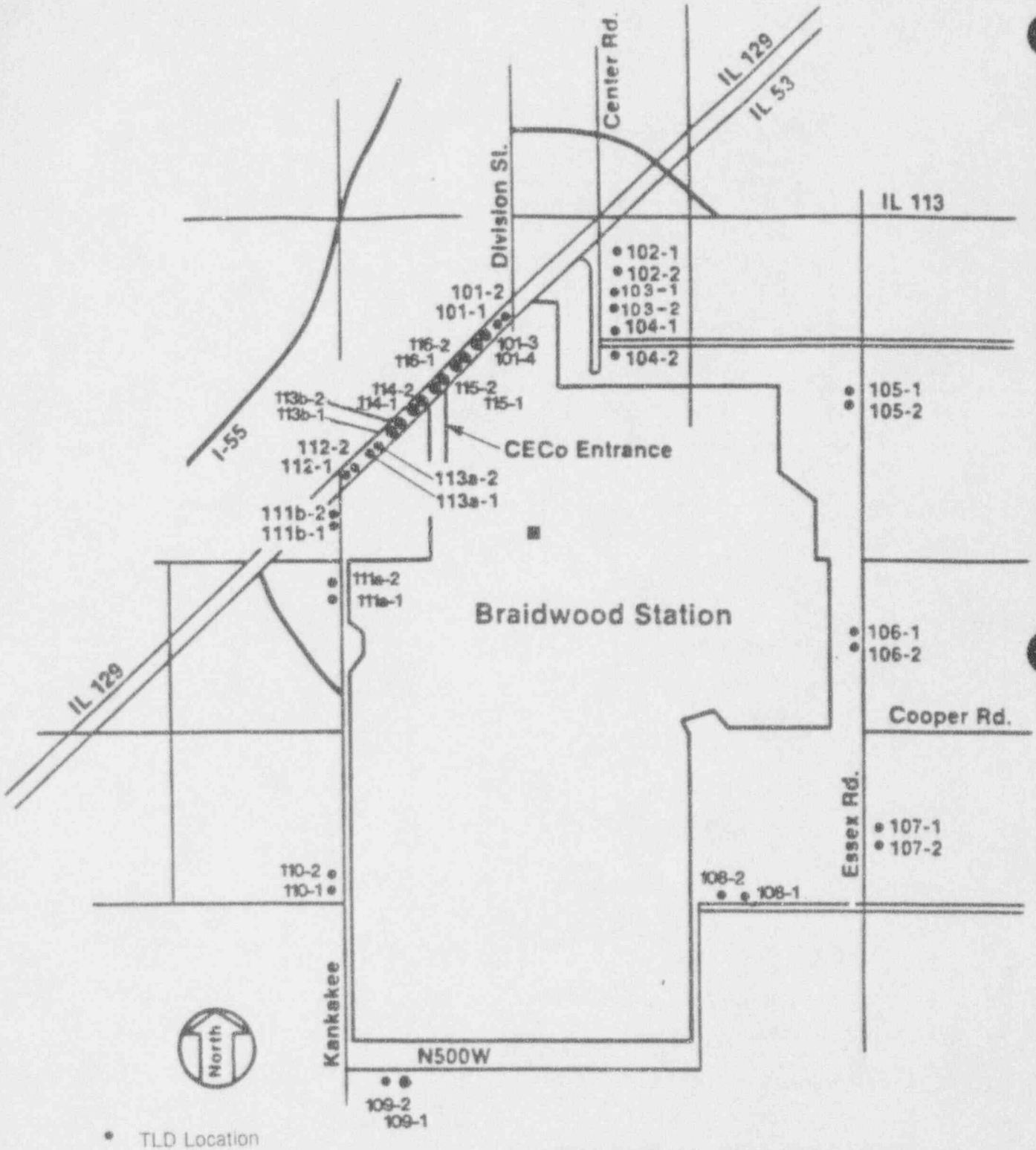
c LLD for drinking water samples. If no drinking water pathway exists, an LLD of 60 pCi/L may be used.



OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 11-1

FIXED AIR SAMPLING SITES AND
OUTER RING TLD LOCATIONS



• TLD Location

■ Braidwood Station

Scale

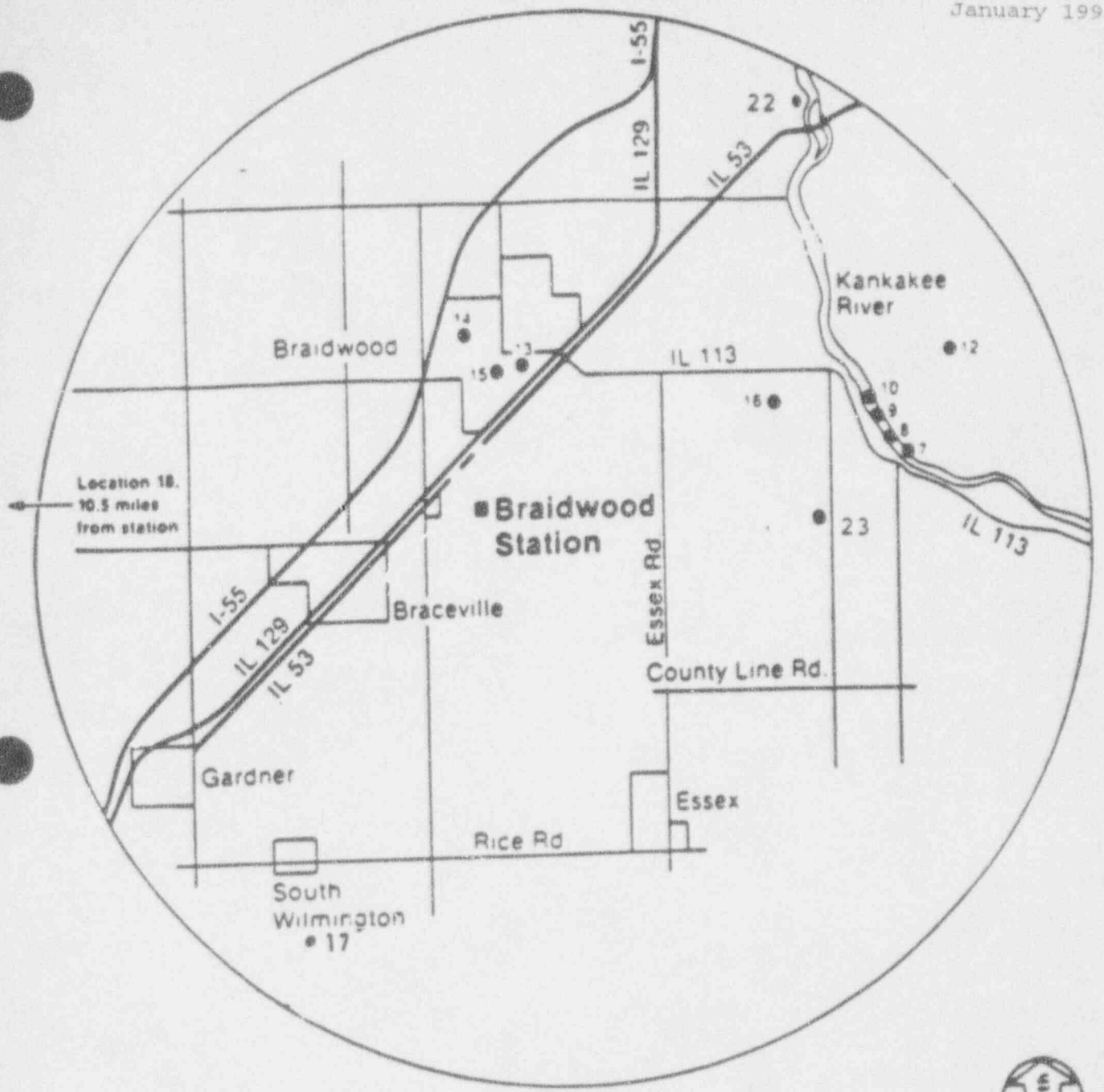
0 1.0 2.0 Miles

0 1 2 3 4 Kilometers

OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 11-2

INNER RING TLD LOCATIONS



Scale

0 1 2 3 4 5 Miles

0 1 2 4 6 8 10 Kilometers

• Sampling Location

■ Braidwood Station

OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE 11-3

INGESTION AND WATERBORNE EXPOSURE PATHWAY SAMPLE LOCATIONS

0972-4
07-00-395

CHAPTER 12.0

SPECIAL NOTE

The transfer of the Radiological Effluent Technical Specifications to the ODCM by Technical Specification, Amendment 35, dated April 13, 1992, was approved by the Nuclear Regulatory Commission.

BRAIDWOOD ANNEX INDEX

BRAIDWOOD ANNEX INDEX

CHAPTER 12

RADIOACTIVE EFFLUENT TECHNICAL STANDARDS (RETS) TABLE OF CONTENTS

CHAPTER 12

RADIOACTIVE EFFLUENT TECHNICAL STANDARDS (RETS) LIST OF TABLES

12.0 RADIOLOGICAL ENVIRONMENTAL TECHNICAL STANDARDS

12.1 DEFINITIONS

12.1.1 Action shall be that which prescribes remedial measures required under designated co' 'itions.

12.1.2 Analog Channel Operational Test shall be the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY of alarm, interlock and/or trip functions. The ANALOG CHANNEL OPERATIONAL TEST shall include adjustments, as necessary, of the alarm interlock and/or Trip Setpoints such that the Setpoints are within the required range and accuracy.

12.1.3 Channel Calibration shall be the adjustment, as necessary, of the channel such that it responds within the required range and accuracy to known values of input. The CHANNEL CALIBRATION shall encompass the entire channel including the sensors and alarm, interlock and/or trip functions and may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is calibrated.

12.1.4 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.

12.1.5 Digital Channel Operational Test shall consist of exercising the digital computer hardware using data base manipulation and injecting simulated process data to verify OPERABILITY of alarm and/or trip functions.

12.1.6 Dose Equivalent I-131 shall be that connection 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".

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

12.1.8 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), and when all necessary attendant instrumentation, controls, electrical power, 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).

12.1.9 Operational Mode (i.e. Mode) shall correspond to any one inclusive combination of core reactivity condition, power level, and average reactor coolant temperature specified in Table 1.2 of the Technical Specifications.

12.1.10 Process Control Program (PCP) shall contain the current formulas, sampling, analyses, tests, 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 10 CFR Parts 20, 61, 71 and State regulations, burial ground requirements, and other requirements governing the disposal of radioactive wastes.

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

12.1.12 Rated Thermal Power shall be a total core heat transfer rate to the reactor coolant of 3411 MWt.

12.1.13 Site Boundary shall be that line beyond which the land is neither owned, nor leased, nor otherwise controlled by the licensee.

12.1.14 Solidification shall be the conversion of wet wastes into a form that meets shipping and burial ground requirements.

12.1.15 Source Check shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

12.1.16 Thermal Power shall be the total core heat transfer rate to the reactor coolant.

12.1.17 Unrestricted Area means an area, access to which is neither limited nor controlled by the licensee.

12.1.18 Ventilation Exhaust Treatment System shall be any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Features Atmospheric Cleanup Systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

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

12.1.20 Waste Gas Holdup System shall be any system designed and installed to reduce radioactive gaseous effluents by collecting Reactor Coolant System off-gases from the Reactor Coolant System and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

12.1.21 Definitions Peculiar to Estimating Dose to Members of the Public Using the ODCM Computer Program.

a. ACTUAL - ACTUAL refers to using known release data to project the dose to members of the public for the previous time period. This data is stored in the database and used to demonstrate compliance with the reporting requirements of Chapter 12.

b. PROJECTED - PROJECTED refers to using known release data from the previous time period or estimated release data to forecast a future dose to members of the public. This data is not incorporated into the database.

TABLE 12.1-1

FREQUENCY NOTATIONS

Notation	Frequency
S	At least once per 12 hours
D	At least once per 24 hours
W	At least once per 7 days
M	At least once per 31 days
Q	At least once per 92 days
SA	At least once per 184 days
R	At least once per 18 months
S/U	Prior to each reactor startup
N.A.	Not applicable
P	Completed prior to each release

12.2 INSTRUMENTATION

12.2.1 Radioactive Liquid Effluent Monitoring Instrumentation

Operability Requirements

12.2.1.A The radioactive liquid effluent monitoring instrumentation channels shown in Table 12.2-1 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of 12.3.1.A are not exceeded. The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

Applicability: At all times

Action

1. With a radioactive liquid effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above specification, immediately suspend the release of radioactive liquid effluents monitored by the affected channel, or declare the channel inoperable.

2. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 12.2-1. Restore the inoperable instrumentation to OPERABLE status within the time specified in the ACTION, or explain in the next Radioactive Effluent Release Report pursuant to Section 12.6 why this inoperability was not corrected within the time specified.

Surveillance Requirements

12.2.1.B Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and DIGITAL and ANALOG CHANNEL OPERATIONAL TEST at the frequencies shown in Table 12.2-2.

Bases

12.2.1.C The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of RETS. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

TABLE 12.2-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release		
a. Liquid Radwaste Effluent Line (0RE-PR001)	1	31
b. Fire and Oil Sump (0RE-PR005)	1	34
c. Condensate Polisher Sump Discharge (0RE-PR041)	1	34
2. Radioactivity Monitors Providing Alarm But Not Providing Automatic Termination of Release		
a. Essential Service Water		
1) Unit 1		
a) RCFC 1A and 1C Outlet (1RE-PR002)	1	32
b) RCFC 1B and 1D Outlet (1RE-PR003)	1	32
2) Unit 2		
a) RCFC 2A and 2C Outlet (2RE-PR002)	1	32
b) RCFC 2B and 2D Outlet (2RE-PR003)	1	32
b. Station Blowdown Line (0RE-PR010)	1	32
3. Flow Rate Measurement Devices		
a. Liquid Radwaste Effluent Line (Loop-WX001)	1	33
b. Liquid Radwaste Effluent Low Flow Line (Loop-WX630)	1	33
c. Station Blowdown Line (Loop-CW032)	1	33

TABLE 12.2-1 (Continued)

ACTION STATEMENTS

ACTION 31 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 14 days provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Section 12.3 and

b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge line valving.

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 32 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided that, at least once per 12 hours, grab samples are collected and analyzed for radioactivity at a lower limit of detection as specified in Table 12.3-1.

ACTION 33 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow.

ACTION 34 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are analyzed for radioactivity at a lower limit of detection as specified in Table 12.3-1:

a. At least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01 microCurie/gram DOSE EQUIVALENT I-131, or

b. At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 microCurie/gram DOSE EQUIVALENT I-131.

TABLE 12.2-2

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST	ANALOG CHANNEL OPERATIONAL TEST
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release					
a. Liquid Radwaste Effluent Line (0RE-PR001)	D	P	R(3)#	Q(1)	N.A.
b. Fire and Oil Sump Discharge (0RE-PR005)	D	M	R(3)	Q(1)	N.A.
c. Condensate Polisher Sump Discharge (0RE-PR041)	D	M	R(3)	Q(1)*	N.A.
2. Radioactivity Monitors Providing Alarm But Not Providing Automatic Termination of Release					
a. Essential Service Water					
1) Unit 1					
a) RCFC 1A and 1C Outlet (1RE-PR002)	D	M	R(3)#	Q(2)	N.A.
b) RCFC 1B and 1D Outlet (1RE-PR003)	D	M	R(3)#	Q(2)	N.A.
2) Unit 2					
a) RCFC 2A and 2C Outlet (2RE-PR002)	D	M	R(3)#	Q(2)	N.A.
b) RCFC 2B and 2D Outlet (2RE-PR003)	D	M	R(3)#	Q(2)	N.A.
b. Station Blowdown Line (0RE-PR010)	D	M	R(3)#	Q(2)	N.A.
3. Flow Rate Measurement Devices					
a. Liquid Radwaste Effluent Line (Loop-WX001)	D(4)	N.A.	R#	N.A.	Q
b. Liquid Radwaste Effluent Low Flow Line (Loop-WX630)	D(4)	N.A.	R	N.A.	Q
c. Station Blowdown Line (Loop-CW032)	D(4)	N.A.	R	N.A.	Q

TABLE 12.2-2 (Continued)

TABLE NOTATIONS

#The specified 18 month interval may be extended to 32 months for cycle 1 only.

(1) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

a. Instrument indicates measured levels above the Alarm/Trip Setpoint,
or

b. Circuit failure (monitor loss of communications - alarm only, detector loss of counts, or monitor loss of power), or

c. Detector check source test failure, or

d. Detector channel out-of-service, or

* e. Monitor loss of sample flow. This is only applicable for ORE-PR001 and ORE-PR005. Monitor ORE-PR041 will not trip on loss of sample flow.

(2) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the Alarm Setpoint, or

b. Circuit failure (monitor loss of communications - alarm only, detector loss of counts, or monitor loss of power), or

c. Detector check source test failure, or

d. Detector channel out-of-service, or

e. Monitor loss of sample flow.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

(4) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

12.2.2 Radioactive Gaseous Effluent Monitoring Instrumentation

Operability Requirements

12.2.2.A The radioactive gaseous effluent monitoring instrumentation channels shown in Table 12.2-3 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Section 12.4 are not exceeded. The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

Applicability: As shown in Table 12.2-3

Action:

1. With a radioactive gaseous effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above section, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel inoperable.

2. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 12.2-3. Restore the inoperable instrumentation to OPERABLE status within the time specified in the ACTION, or explain in the next Semiannual Radioactive Effluent Release Report pursuant to Section 12.6 why this inoperability was not corrected within the time specified.

Surveillance Requirements

12.2.2.B Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and DIGITAL and CHANNEL OPERATIONAL TEST at the frequencies shown in Table 12.2-4.

Bases

12.2.2.C The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of RETS. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. The sensitivity of any noble gas activity monitor used to show compliance with the gaseous effluent release requirements of Section 12.4 shall be such that concentrations as low as 1×10^{-6} uCi/cc are measurable.

TABLE 12.2-3

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. Plant Vent Monitoring System - Unit 1			
a. Noble Gas Activity Monitor-Providing Alarm			
1) High Range (1RE-PR028D)	1	*	39
2) Low Range (1RE-PR028B)	1	*	39
b. Iodine Sampler (1RE-PR028C)	1	*	40
c. Particulate Sampler (1RE-PR028A)	1	*	40
d. Effluent System Flow Rate Measuring Device (LOOP-VA019)	1	*	36
e. Sampler Flow Rate Measuring Device (1FT-PR165)	1	*	36
2. Plant Vent Monitoring System - Unit 2			
a. Noble Gas Activity Monitor-Providing Alarm			
1) High Range (2RE-PR028D)	1	*	39
2) Low Range (2RE-PR028B)	1	*	39
b. Iodine Sampler (2RE-PR028C)	1	*	40
c. Particulate Sampler (2RE-PR028A)	1	*	40
d. Effluent System Flow Rate Measuring Device (LOOP-VA020)	1	*	36
e. Sampler Flow Rate Measuring Device (2FT-PR165)	1	*	36

TABLE 12.2-3 (Continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
3. Not Used.			
4. Gas Decay Tank System			
a. Noble Gas Activity Monitor-Providing Alarm and Automatic Termination of Release (0RE-PR002A and 2B)	2	*	35
5. Containment Purge System			
a. Noble Gas Activity Monitor-Providing Alarm (RE-PR001B)	1	*	37
b. Iodine Sampler (RE-PR001C)	1	*	40
c. Particulate Sampler (RE-PR001A)	1	*	40
6. Radioactivity Monitors Providing Alarm and Automatic Closure of Surge Tank Vent-Component Cooling Water Line (0RE-PR009 and RE-PR009)	2	*	41

TABLE 12.2-3 (Continued)

TABLE NOTATIONS

*At all times.

ACTION 35 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, the contents of the tank(s) may be released to the environment for up to 14 days provided that prior to initiating the release:

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

b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge valve lineup.

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 36 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours.

ACTION 37 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, immediately suspend PURGING of radioactive effluents via this pathway.

ACTION 38 - Not used.

ACTION 39 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.

ACTION 40 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via the affected pathway may continue for up to 30 days provided samples are continuously collected with auxiliary sampling equipment as required in Table 12.4-1.

ACTION 41 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided that, at least once per 12 hours, liquid grab samples are collected and analyzed for radioactivity at a lower limit of detection as specified in Table 12.3-1.

TABLE 12.2-4

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

FUNCTIONAL UNIT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
1. Plant Vent Monitoring System - Unit 1					
a. Noble Gas Activity Monitor-Providing Alarm					
1) High Range (1RE-PR028D)	D	M	R(3)##	Q(2)	*
2) Low Range (1RE-PR028B)	D	M	R(3)##	Q(2)	*
b. Iodine Sampler (1RE-PR028C)	D	M	R(3)##	Q(2)	*
c. Particulate Sampler (1RE-PR028A)	D	M	R(3)##	Q(2)	*
d. Effluent System Flow Rate Measuring Device (LOOP-VA019)	D	N.A.	R##	Q	*
e. Sampler Flow Rate Measuring Device (1FT-PR165)	D	N.A.	R##	Q	*
2. Plant Vent Monitoring System - Unit 2					
a. Noble Gas Activity Monitor-Providing Alarm					
1) High Range (2RE-PR028D)	D	M	R(3)##	Q(2)	*
2) Low Range (2RE-PR028B)	D	M	R(3)##	Q(2)	*
b. Iodine Sampler (2RE-PR028C)	D	M	R(3)##	Q(2)	*

TABLE 12.2-4 (Continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

FUNCTIONAL UNIT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	DIGITAL CHANNEL OPERATIONAL TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
2. Plant Vent Monitoring System - Unit 2 (Continued)					
c. Particulate Sampler (2RE-PR028C)	D	M	R(3)##	Q(2)	*
d. Effluent System Flow Rate Measuring Device (LOOP-VA020)	D	N.A.	R##	Q	*
e. Sampler Flow Rate Measuring Device (2FT-PR165)	D	N.A.	R##	Q	*
3. Not Used					
4. Gas Decay Tank System					
a. Noble Gas Activity Monitor Providing Alarm and Automatic Termination of Release (0RE-PR002A and 2B)	P	P	R(3)##	Q(1)*	*
5. Containment Purge System					
a. Noble Gas Activity Monitor-Providing Alarm (RE-PR001B)	D	P	R(3)##	Q(2)	*
b. Iodine Sampler (RE-PR001C)	P	P	R(3)##	N.A.	*
c. Particulate Sampler (RE-PR001A)	P	P	R(3)##	N.A.	*
6. Radioactivity Monitors Providing Alarm and Automatic Closure of Surge Tank Vent-Component Cooling Water Line (0RE-PR009 and RE-PR009)	D	M	R(3)##	Q(1)	*

TABLE 12.2-4 (Continued)

TABLE NOTATIONS

At all times.

##The specified 18 month interval may be extended to 32 months for cycle 1 only.

(1) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:

a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or

b. Circuit failure (monitor loss of communications - alarm only, detector loss of counts, or monitor loss of power), or

c. Detector check source test failure, or

d. Detector channel out-of-service, or

* e. Monitor loss of sample flow. Monitoring ORE-PR002A and 2B will not trip on loss of sample flow. This is only applicable for functional unit 6, ORE-PR009 and RE-009.

(2) The DIGITAL CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

a. Instrument indicates measured levels above the Alarm Setpoint, or

b. Circuit failure (monitor loss of communications - alarm only, detector loss of counts, or monitor loss of power), or

c. Detector check source test failure, or

d. Detector channel out-of-service, or

e. Monitor loss of sample flow.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

12.3 LIQUID EFFLUENTS

12.3.1 Concentration

Operability Requirements

12.3.1.A The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited to 10 times the concentration values in Appendix B, Table 2, Column 2 to 10 CFR 20.1001-20.2402, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microCurie/ml total activity.

Applicability: At all times

Action:

1. With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within the above limits.

Surveillance Requirements

12.3.1.1.B Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 12.3-1.

12.3.1.2.B The results of the radioactivity analysis shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of 12.3.1.A.

Bases

12.3.1.C This section is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than 10 times the concentration values in Appendix B, Table 2, Column 2 to 10 CFR 20.1001-20.2402. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within: (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC, and (2) the limits of 10 CFR Part 20.1301.

12.3 LIQUID EFFLUENTS (Continued)

Bases

This section applies to the release of radioactive materials in liquid effluents from all units at the site.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

TABLE 12.3-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[1] (μCi/ml)
1. Batch Release Tanks(2)	P Each Batch	P Each Batch	Principal Gamma Emitters(3)	$5x10^{-7}$
			I-131	$1x10^{-6}$
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	P Each Batch	M Composite (4)	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	P Each Batch	Q Composite (4)	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$
2. Continuous Releases (5)	Continuous[6]	W Composite[6]	Principal Gamma Emitters(3)	$5x10^{-7}$
			I-131	$1x10^{-6}$
a. Circulating Water Blowdown	M Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
b. Waste Water Treatment Discharge to Circulating Water Discharge	Continuous(6)	M Composite (6)	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
c. Condensate Polisher Sump Discharge	Continuous(6)	Q Composite (6)	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

TABLE 12.3-1 (Continued)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)[1] (μCi/ml)
3. Continuous Release(5) Essential Service Water Reactor Containment Fan Cooler (RCFC) Outlet Line	W(7) Grab Sample	W(7)	Principal Gamma Emitters(3)	5×10^{-7}
			I-131	1×10^{-6}
			Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
			H-3	1×10^{-5}
4. Continuous Surge Tank Vent-Component Cooling Water Line (9)	None	None	Principal Gamma Emitters(8)	5×10^{-7}
			Dissolved and Entrained Gases (Gamma Emitters)(8)	1×10^{-5}
			I-131	1×10^{-6}

TABLE 12.3-1 (Continued)

TABLE NOTATIONS

(1) The LLD is defined, for purposes of these sections, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% 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:

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

Where:

LLD = the lower limit of detection (microCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E = the counting efficiency (counts per disintegration),

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

2.22×10^6 = the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}), and

Δt = the elasped time between the midpoint of sample collection and the time of counting (sec).

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

It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

(2) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed by a method described in the ODCM to assure representative sampling.

TABLE 12.3-1 (Continued)

TABLE NOTATIONS

(3) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Section 12.6.2 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

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

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

(6) To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously whenever the effluent stream is flowing. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

(7) Not required unless the Essential Service Water RCFC Outlet Radiation Monitors RE-PR002 and RE-PR003 indicates measured levels greater than 1×10^{-6} µCi/ml above background at any time during the week.

(8) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for dissolved and entrained gases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for principal gamma emitters. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Section 12.6.2, in the format outlines in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(9) A continuous release is the discharge of dissolved and entrained gaseous waste from a nondiscrete liquid volume.

12.3.2 Dose

Operability Requirements

12.3.2.A The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each unit, to UNRESTRICTED AREAS (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited:

1. During any calendar quarter to less than or equal to 1.5 mrems to the whole body and to less than or equal to 5 mrems to any organ, and

2. During any calendar year to less than or equal to 3 mrems to the whole body and to less than or equal to 10 mrems to any organ.

Applicability: At all times.

Action:

1. 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, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

Surveillance Requirements

12.3.2.B Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

Bases

12.3.2.C This section is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Operability Requirements implement the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The dose calculation methodology and parameters 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 a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

12.3.2 Dose (Continued)

Bases

The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents For the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I" Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This section applies to the release of radioactive materials in liquid effluents from each reactor at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.3.3 Liquid Radwaste Treatment System

Operability Requirements

12.3.3.A The Liquid Radwaste Treatment System shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31-day period.

Applicability: At all times.

Action:

1. With radioactive liquid waste being discharged without treatment and in excess of the above limits and any portion of the Liquid Radwaste Treatment System not in operation, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that includes the following information:

   a. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,

   b. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

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

Surveillance Requirements

12.3.3.1.B Doses due to liquid releases from each unit to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM when the Liquid Radwaste Treatment System is not being fully utilized.

12.3.3.2.B The installed Liquid Radwaste Treatment System shall be considered OPERABLE by meeting Sections 12.3.1.A and 12.3.2.A.

Bases

12.3.3.C 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 section implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50.

12.3.3 Liquid Radwaste Treatment System (Continued)

Bases

The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

This section applies to the release of radioactive materials in liquid effluents from each unit at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.4 GASEOUS EFFLUENTS

12.4.1 Dose Rate

Operability Requirements

12.4.1.A The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited to the following:

1. For noble gases: less than or equal to a dose rate of 500 mrems/yr to the whole body and less than or equal to a dose rate of 3000 mrems/yr to the skin, and

2. For Iodine 131 and 133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to a dose rate of 1500 mrems/yr to any organ.

Applicability: At all times.

Action:

1. With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the above limit(s).

Surveillance Requirements

12.4.1.1.B The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM.

12.4.1.2.B The dose rate due to Iodine 131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 12.4-1.

Bases

12.4.1.C This section is provided to ensure that the dose at any time at and beyond the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10CFR20 to UNRESTRICTED AREAS. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC in an UNRESTRICTED AREA, either within or outside the SITE BOUNDARY, exceeding the limits specified in 10CFR20.1301.

12.4 GASEOUS EFFLUENTS

Bases

For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. Examples of calculations for such MEMBERS OF THE PUBLIC with the appropriate occupancy factors, shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrems/year to the whole body or to less than or equal to 3000 mrems/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 less than or equal to 1500 mrems/year.

This section applies to the release of radioactive materials in gaseous effluents from all units at the site.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry." Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

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 (e) DETECTION (LLD)(1) (μCi/cc)
1. Waste Gas Decay Tank	P Each Tank Grab Sample	P Each Tank	Principal Gamma Emitters(2)	$1x10^{-4}$
2. Containment Purge	P Each Purge(3) Grab Sample	P Each Purge(3)	Principal Gamma Emitters(2)	$1x10^{-4}$
			H-3	$1x10^{-7}$
3. Auxiliary Bldg. Vent Stack (Unit 1 and 2)	M(4)(5) Grab Sample	M	Principal Gamma Emitters(2)	$1x10^{-4}$
			H-3	$1x10^{-7}$
	Continuous(6)	W(7) Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous(6)	W(7) Particulate Sample	Principal Gamma Emitters(2)	$1x10^{-11}$
	Continuous(6)	M(7) Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous(6)	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$
	Continuous	Noble Gas Monitor	Noble Gases, Gross Beta or Gamma	$1x10^{-6}$

TABLE 12.4-1 (Continued)

TABLE NOTATIONS

(1) The LLD is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% 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:

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

Where:

LLD = the lower limit of detection (microCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E = the counting efficiency (counts per disintegration),

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

2.22×10^6 = the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}), and

Δt = the elasped time between the midpoint of sample collection and the time of counting (sec).

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

It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

(2) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141, and Ce-144 in iodine and particulate releases. This list does not mean that only these nuclides are to be considered.

TABLE 12.4-1 (Continued)

TABLE NOTATIONS

Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Section 12.6.2, in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(3) Sampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period.

(4) Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.

(5) Tritium grab samples shall be taken at least once per 7 days from the spent fuel pool area, whenever spent fuel is in the spent fuel pool.

(6) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Sections 12.4.1.A, 12.4.2.A and 12.4.3.A.

(7) Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or after removal from sampler. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if: (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the reactor coolant has not increased more than a factor of 3, and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

12.4.2 Dose - Noble Gases

Operability Requirements

12.4.2.A The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited to the following:

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

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

Applicability: At all times.

Action:

1 .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, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

Surveillance Requirements

12.4.2.B Cumulative dose contributions for the current calendar quarter and the current calendar year for noble gases shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

Bases

12.4.2.C This section is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Operability Requirements implement the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonable achievable." The Surveillance Requirements 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 a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

12.4.2 Dose - Noble Gases (Continued)

Bases

The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive materials in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents For the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I" Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors, Revision 1," July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY are based upon the historical average atmospheric conditions.

This section applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.4.3 Dose - Iodine I-131 and 133, Tritium, and Radioactive Material in Particulate Form

Operability Requirements

12.4.3.A The dose to a MEMBER OF THE PUBLIC from Iodine-131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each unit, to areas at and beyond the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) shall be limited to the following:

1. During any calendar quarter: Less than or equal to 7.5 mrems to any organ, and

2. During any calendar year: Less than or equal to 15 mrems to any organ.

Applicability: At all times.

Action:

1. With the calculated dose from the release of Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

Surveillance Requirements

12.4.3.B Cumulative dose contributions for the current calendar quarter and the current calendar year for Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

Bases

12.4.3.C This section is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Operability Requirements are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonable achievable." The ODCM calculational methods specified in the Surveillance Requirements 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 a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

12.4.3 Dose (Continued)

Bases

The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents For the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I" Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in the areas at and beyond the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY. The pathways that were examined in the development of these calculations were: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat producing animal's graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure to man.

This section applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.4.4 Gaseous Radwaste Treatment System

Operability Requirements

12.4.4.A The VENTILATION EXHAUST TREATMENT SYSTEM and the WASTE GAS HOLDUP SYSTEM shall be OPERABLE and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) would exceed:

1. 0.2 mrad to air from gamma radiation, or

2. 0.4 mrad to air from beta radiation, or

3. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

Applicability: At all times.

Action:

1. With radioactive gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that includes the following information:

   a. Identification of any inoperable equipment or subsystems, and the reason for the inoperability,

   b. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

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

Surveillance Requirements

12.4.4.1.B Doses due to gaseous releases from each unit to areas at and beyond the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM when Gaseous Radwaste Treatment Systems are not being fully utilized.

12.4.4.2.B The installed VENTILATION EXHAUST TREATMENT SYSTEM and WASTE GAS HOLDUP SYSTEM shall be considered OPERABLE by meeting Section 12.4.1 and 12.4.2 or 12.4.3.

Bases

12.4.4.C The OPERABILITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the system will be available for use whenever gaseous effluents require treatment prior to release to the environment.

12.4.4 Gaseous Radwaste Treatment System (Continued)

Bases

The requirement that the appropriate portions of this system be used when specified provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable". This section implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the Gaseous Radwaste Treatment System were specified as a suitable fraction of the dose design objectives set forth in Section II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This section applies to the release of radioactive materials in gaseous effluents from each unit at the site. When shared Radwaste Treatment Systems are used by more than one unit on a site, the wastes from all units are mixed for shared treatment; by such mixing, the effluent releases cannot accurately be ascribed to a specific unit. An estimate should be made of the contributions from each unit based on input conditions, e.g., flow rates and radioactivity concentrations, or, if not practicable, the treated effluent releases may be allocated equally to each of the radioactive waste producing units sharing the Radwaste Treatment System. For determining conformance to Operability Requirements, these allocations from shared Radwaste Treatment Systems are to be added to the releases specifically attributed to each unit to obtain the total releases per unit.

12.4.5 Total Dose

Operability Requirements

12.4.5.A The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

Applicability: At all times.

Action:

1. With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Sections 12.3.2, 12.4.2, or 12.4.3, calculations should be made including direct radiation contributions from the units and from outside storage tanks to determine whether the above limits of Section 12.4.5.A have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR 20.2203, shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentration of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40 CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

Surveillance Requirements

12.4.5.1.A Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Sections 12.3.2, 12.4.2, and 12.4.3, and in accordance with the methodology and parameters in the ODCM.

12.4.5.2.B Cumulative dose contributions from direct radiation from the units and from radwaste storage tanks shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in ACTION 1 of Section 12.4.5.A.

12.4.5 Total Dose (Continued)

Bases

12.4.5.C This section is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The section requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the reactor units and outside storage tanks are kept small. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.2203, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in Sections 12.3.1 and 12.4.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is p\rt of the nuclear fuel cycle.

12.5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

12.5.1 Monitoring Program

Operability Requirements

12.5.1.A The Radiological Environmental Monitoring Program shall be conducted as specified in Table 12.5-1.

Applicability: At all times.

Action:

1. 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 Environmental Operating Report required by Technical Specification 6.9.1.6, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

2. With the level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 12.5-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose* to a MEMBER OF THE PUBLIC is less than the calendar year limits of Section 12.3.2, 12.4.2, or 12.4.3. When more than one of the radionuclides in Table 12.5.2 are detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table 12.5-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to A MEMBER OF THE PUBLIC from all radionuclides is equal to or greater than the calendar year limits of Section 12.3.2, 12.4.2, or 12.4.3. 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 required by Section 12.6.1.

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*The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

12.5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

3. With the milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 12.5-1, identify specific locations for obtaining replacement samples and add them within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Submit controlled version of the ODCM within 180 days including a revised figure(s) and table reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of new location(s) for obtaining samples.

Surveillance Requirements

12.5.1.B The radiological environmental monitoring program samples shall be collected pursuant to Table 12.5-1 from the specific locations given in the table and figure(s) in the ODCM, and shall be analyzed pursuant to the requirements of Table 12.5-1 and the detection capabilities required by Table 12.5-3.

Bases

12.5.1.C The Radiological Environmental Monitoring Program required by this section provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and 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 the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 12.5-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

12.5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, LA., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

TABLE 12.5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation[2]	Forty routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY; An outer ring of stations, one in each meteorological sector in the 6- to 8- km range from the site; and The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly.	Gamma dose quarterly.

TABLE 12.5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Airborne			
Radioiodine and Particulates	Samples from five locations: Three samples from close to the three SITE BOUNDARY locations, in different sectors, of the highest calculated annual average ground level D/Q; One sample from the vicinity of a community having the highest calculated annual average ground-level D/Q; and One sample from a control location, as for example 10 to 30 km distant and in the least prevalent wind direction.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Radioiodine Canister: I-131 analysis weekly. Particulate Sampler: Gross beta radioactivity analysis following filter change;[3] and gamma isotopic analysis[4] of composite (by location) quarterly.
3. Waterborne			
a. Surface[5]	One sample upstream. One sample downstream.	Composite sample over 1-month period by weekly grab samples.	Gamma isotopic analysis[4] monthly. Composite for tritium analysis quarterly.
b. Ground	Samples from one or two sources only if likely to be affected [6].	Quarterly.	Gamma isotopic[4] and tritium analysis quarterly.

TABLE 12.5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
3. Waterborne (Continued)			
c. Drinking	One sample of each community drinking water supply within 10 miles downstream of the discharge. One sample from a control location.	Composite sample over 2-week period[6] when I-131 analysis is performed, monthly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year.(8) Composite for gross beta and gamma isotopic analyses (4) monthly. Composite for tritium analysis quarterly.
d. Sediment from shoreline	One sample from downstream area with existing or potential recreational value.	Semiannually.	Gamma isotopic analysis[4] semiannually.
4. Ingestion			
a. Milk	Samples from milking animals in three locations within 5 km distance having the highest dose potential. If there are none, then, one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr[8]. One sample from milking animals at a control location, 15 to 30 km distant and in the least prevalent wind direction.	Semimonthly when animals are on pasture, monthly at other times.	Gamma isotopic[4] and I-131 analysis semimonthly when animals are on pasture; monthly at other times.

TABLE 12.5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. Ingestion (continued)			
b. Fish and Invertebrates	Representative samples of commercially and recreationally important species in vicinity of plant discharge area.	Three times per year (spring, summer and fall).	Gamma isotopic analysis[4] on edible portions.
	Representative samples of commercially and recreationally important species in areas not influenced by plant discharge.		
c. Food Products	Representative samples of the principal classes of food products from any area within 10 miles of the plant that is irrigated by water in which liquid plant wastes have been discharged.	At the time of harvest[9].	Gamma isotopic analysis[4] on edible portion.
	Samples of three different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground-level D/Q if milk sampling is not performed.	Monthly when available.	Gamma isotopic[4] and I-131 analysis.
	One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly when available.	Gamma isotopic[4] and I-131 analysis.

TABLE 12.5-1 (Continued)

TABLE NOTATIONS

(1) Specific parameters of distance and direction sector from the centerline of one unit, and additional description where pertinent, shall be provided for each and every sample location in Table 12.5-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Section 12.6.1. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable specific alternative media and allocations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the Radiological Environmental Monitoring Program given in the ODCM. Submit controlled revisions of the ODCM within 180 days including a revised figure(s) and table reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples for that pathway and justifying the selection of the new location(s) for obtaining samples.

(2) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The 40 locations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

(3) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

TABLE 12.5-1 (Continued)

TABLE NOTATIONS

(4) Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

(5) The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond but near the mixing zone.

(6) A composite sample is one in which the quantity (aliquot) of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

(7) Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

(8) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

(9) If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

TABLE 12.5-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

ANALYSIS	REPORTING LEVELS				
	WATER (pCi/L)	AIRBORNE PARTICULATE OR GASES (pCi/m³)	FISH (pCi/kg, wet)	MILK (pCi/L)	FOOD PRODUCTS (pCi/kg, wet)
H-3	20,000*				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

*For drinking water samples. This is 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/L may be used.

TABLE 12.5-3

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[1]

LOWER LIMIT OF DETECTION (LLD)[2][3]

ANALYSIS	WATER (pCi/L)	AIRBORNE PARTICULATE OR GASES (pCi/m³)	FISH (pCi/kg, wet)	MILK (pCi/L)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2000*					
Mn-54	15		130			
Fe-59	30		260			
Co-58,60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1[4]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		

*If no drinking water pathway exists, a value of 3000 pCi/L may be used.

TABLE 12.5-3 (Continued)

TABLE NOTATIONS

(1) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Section 12.6.1.

(2) Required detection capabilities for thermoluminescent dosimeters used for environment Measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

(3) The LLD is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% 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:

$$LLD = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \times 10^5 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD = the "a priori" lower limit of detection (picoCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E = the counting efficiency (counts per disintegration),

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

2.22 = the number of disintegrations per minute per picoCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}), and

Δt = the elasped time between sample collection, or end of the sample collection period, and the time of counting (sec).

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

It should be recognized that the LLD is defined as a before the fact limit representing the capability of a measurement system and not as an after the fact limit for a particular measurement.

TABLE 12.5-3 (Continued)

TABLE NOTATIONS

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally, background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report pursuant to Section 12.6.1.

(4) LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

12.5.2 Land Use Census

Operability Requirements

12.5.2.A. A Land Use Census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, and the nearest residence. For dose calculation, a garden will be assumed at the nearest residence.

Applicability: At all times.

Action:

1. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in Section 12.4.3, identify the new location(s) in the next Annual Radiological Environmental Operating Report, pursuant to Section 12.6.1.

2. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with Section 12.5.1, add the new location(s) within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The sampling location(s), excluding the control location, having the lowest calculated dose or dose commitment(s), 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. Pursuant to Section 12.6.1, submit in the next Annual Radiological Environmental Operating Report documentation for a change in the ODCM including a revised figure(s) and table(s) for the ODCM reflecting the new location(s) with information supporting the change in sampling locations.

Surveillance Requirements

12.5.2.B The Land Use Census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities. The results of the Land Use Census shall be included in the Annual Radiological Environmental Operating Report pursuant to Section 12.6.1.

Bases

12.5.2.C This specification is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY are identified and that modifications to the Radiological Environmental Monitoring Program given in the ODCM are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey, or from consulting with local agricultural authorities shall be used.

12.5.2 Land Use Census (Continued)

Basis

This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. An annual garden census will not be required since the licensee will assume that there is a garden at the nearest residence in each sector for dose calculations.

12.5.3 Interlaboratory Comparison Program

Operability Requirements

12.5.3.A Analyses shall be performed on radioactive materials, supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission, that correspond to samples required by Table 12.5-1.

Applicability: At all times.

Action:

1. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to Section 12.6.1.

Surveillance Requirements

12.5.3.B The Interlaboratory Comparison Program shall be described in the ODCM. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to Section 12.6.1.

Bases

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

12.6 REPORTING REQUIREMENTS

12.6.1 Annual Radiological Environmental Operating Report*

Routine Annual Radiological Environmental Operating Report covering the operation of the Units during the previous calendar year shall be submitted prior to May 1 of each year. The initial report shall be submitted prior to May 1 of the year following initial criticality.

The Annual Radiological Environmental Operating Report shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, with operational controls as appropriate, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of the Land Use Census required by Section 12.5.2.

The Annual Radiological Environmental Operating Report shall include the results of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the tables and figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the Radiological Environmental Monitoring Program; at least two legible maps** covering all sampling locations keyed to a table giving distances and directions from the midpoint between the reactors; the results of licensee participation in the Interlaboratory Comparison Program and the corrective actions being taken if the specified program is not being performed as required by Section 12.5.3; reasons for not conducting the Radiological Environmental Monitoring Program as required by Section 12.5.1, and discussion of all deviations from the sampling schedule of Table 12.5-1; discussion of environmental sample measurements that exceed the reporting levels of Table 12.5-2 but are not the result of plant effluents, pursuant to Section 12.5-1; and discussion of all analyses in which the LLD required by Table 12.5-3 was not achievable.

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*A single submittal may be made for a multiple unit station.

**One map may cover locations near the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY; a second may include the more distant locations.

12.6 REPORTING REQUIREMENTS (Continued)

12.6.1 Annual Radiological Environmental Operating Report (Continued)

The Annual Radiological Environmental Operating Report shall also include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.* This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the Unit or Station during the previous calendar year. This same report shall also include an assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY/UNRESTRICTED AREA BOUNDARY (see Braidwood Station ODCM Annex, Appendix F, Figure F-1) during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in these reports. The meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents, as determined by sampling frequency and measurement, shall be used for determining the gaseous pathway doses. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the ODCM.

The Annual Radiological Environmental Operating Report to be submitted prior to May 1 of each year shall also include an assessment of radiation doses to the most likely exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation." Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1, October 1977.

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* In lieu of submission with the Annual Radiological Environmental Operating Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

12.6 REPORTING REQUIREMENTS (Continued)

12.6.2 Annual[1] Radioactive Effluent Release Report**

Routine Annual Radioactive Effluent Release Reports covering the operation of the unit during the previous calendar year operation shall be submitted prior to April 1[2] of the following year. The period of the first report shall begin with the date of initial criticality.

The Annual Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

For solid wastes, the format for Table 3 in Appendix B shall be supplemented with three additional categories: class of solid wastes (as defined by 10 CFR Part 61), type of container (e.g., LSA, Type A, Type B, Large Quantity), and SOLIDIFICATION agent or absorbent (e.g, cement, urea formaldehyde).

The Annual Radioactive Effluent Release Reports shall include a list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

The Annual Radioactive Effluent Release Reports shall include any changes made during the reporting period to the PCP, as well as any major changes to Liquid, Gaseous or Solid Radwaste Treatment Systems, pursuant to Section 12.6.3.

The Annual Radioactive Effluent Release Reports shall also include the following: an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in Section 12.2.1 or 12.2.2, respectively; and description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of Technical Specification 3.11.1.4 or 3.11.2.6, respectively.

** A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.

1 Semiannual Radioactive Effluent Release Reports are required until the frequency change to annual is approved by the NRC in the Braidwood Tech Specs.

2 Semiannual Radioactive Effluent Release reporting is required within 60 days after January 1 and July 1 of each year.

12.6 REPORTING REQUIREMENTS (Continued)

12.6.3 Offsite Dose Calculation Manual (ODCM)

12.6.3.1 The ODCM shall be approved by the Commission prior to implementation.

12.6.3.2 Licensee-initiated changes to the ODCM:

a. Shall be documented and records of reviews performed shall be Specification 6.10.2. This documentation shall contain:

1. Sufficient information to support the change together with the appropiate analyses or evaluations justifying the changes(s); and

2. A determination that the change will maintain the level of radioactive effluent control required by 10 CFR 20, 160, 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.

b. 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.

c. Shall be submitted to the Commission in the form of a complete legible copy of the entire ODCM as part of or concurrent with the Annual[1] 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 REPORTING REQUIREMENTS (Continued)

12.6.4 Major Changes to Liquid and Gaseous Radwaste Treatment Systems*

Licensee-initiated major changes to the Radwaste Treatment Systems (liquid and gaseous):

a. Shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Onsite Review and Investigative Function. The discussion of each change shall contain:

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

2) Sufficient detailed information to totally support the reason for the change without benefit of additional and supplemental information;

3) A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems.

4) 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 thereto;

5) An evaluation of the change, which shows the expected maximum exposures to a MEMBER OF THE PUBLIC in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the License application and amendments thereto;

6) 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 prior to when the changes are to be made;

7) An estimate of the exposure to plant operating personnel as a result of the change; and

8) Documentation of the fact that the change was reviewed and found acceptable by the Onsite Review and Investigative Function.

b. Shall become effective upon review and acceptance by the Onsite Review and Investigative Function.

* Licensees may choose to submit the information called for in this section as part of the annual FSAR update.

BRAIDWOOD ANNEX INDEX

APPENDIX F
STATION-SPECIFIC DATA FOR BRAIDWOOD UNITS 1 AND 2

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STATION-SPECIFIC DATA FOR BRAIDWOOD UNITS 1 AND 2

F.1 INTRODUCTION

This appendix contains data relevant to the Braidwood site. Included is a figure showing the unrestricted area boundary and values of parameters used in offsite dose assessment.

F.2 REFERENCES

1. Sargent & Lundy, Nuclear Analysis and Technology Division Braidwood Calculation No. ATD-0149, Revision 0 for Braidwood.

2. "Assessment of the Impact of Liquid Radioactive Effluents from Braidwood Station on Proposed Public Water Intakes at Wilmington, Illinois", J.C. Golden NSEP, January 1990.

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

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

Table F-1
Aquatic Environment Dose Parameters

General Information

There is no irrigation occurring on the Kankakee River downstream of the station.

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

Downstream dams are within 50 miles of the state. One is located on the Kankakee. The other is the Illinois River at Dresden Island, Marseilles, and Starved Rock. The Kankakee River flows into the Illinois River about 12 river miles downstream of the station.

This is based on information in Figure 2.1-13 of the Braidwood Environmental Report and in Section 2.4.1.1 and Figure 2.4-2 of the LaSalle Environmental Report.

Water and Fish Ingestion Parameters

Parameter[a]	Value
U^w, water usage, L/hr	0.042
U^f, fish consumption, kg/hr	2.4E-3
$1/M^w$, $1/M^f$	0.25, 1.0
F^w, cfs	1.85E4
P^f, cfs	5.63E3
t^f, hr[b]	24.0
t^w, hr[c]	3.0

Limits on Radioactivity in Unprotected Outdoor Tanks[d]

Outside Temporary Tank ≤ 10 Ci[e]

(per Technical Specification 3.11.1.4)

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

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

[c] t^w (hr) = 3 hr (distance nearest potable water intake, to Wilmington, is 4 river miles downstream; a flow rate of 1.4 mph is assumed)

[d] See Section A.2.4 of Appendix A.

[e] Tritium and dissolved or entrained noble gases are excluded from this limit.

Table F-2

Station Characteristics

STATION: Braidwood

LOCATION: Braceville, Illinois

CHARACTERISTICS OF ELEVATED RELEASE POINT: Not Applicable (NA)

1) Release Height = _____m 2) Diameter = _____m

3) Exit Speed = _____ms^{-1} 4) Heat Content_____Kcal s^{-1}

CHARACTERISTICS OF VENT STACK RELEASE POINT

1) Release Height = 60.66 m* 2) Diameter = 2.80 m

3) Exit Speed = 11.0 ms^{-1}*

CHARACTERISTICS OF GROUND LEVEL RELEASE

1) Release Height = 0 m

2) Building Factor (D) = 60.6 m*

METEOROLOGICAL DATA

A 320 ft Tower is Located 573 m NE of vent stack release point

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Tower Data Used in Calculations

Release Point	Wind Speed and Direction	Differential Temperature
Elevated	(NA)	(NA)
Vent	203 ft	199-30 ft
Ground	34 ft	199-30 ft

*Used in calculating the meteorological and dose factors in Tables F-5, F-6, and F-7. 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	610	610	800	None
NNE	914	914	1400	None
NE	792	792	1000	None
ENE	701	701	1300	None
E	1036	1036	1300	3540
ESE	2713	1841	3500	None
SE	3414	3414	4300	None
SSE	3444	3444	5300	None
S	4633	4633	6800	None
SSW	975	975	2400	None
SW	625	625	800	None
WSW	533	533	700	None
W	518	518	600	None
WNW	503	503	600	None
NW	495	495	600	7700
NNW	510	510	600	None

[a] See Updated Final Safety Analysis Report Table 2.1-1a and Environmental Report. Used in calculating the meteorological and 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] 1985 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.

Table F-4

Average Wind Speeds

Downwind Direction	Average Wind Speed (m/sec)[a]		
	Elevated[b]	Mixed Mode	Ground Level[b]
N	7.6	6.0	4.7
NNE	7.5	5.8	4.4
NE	6.1	5.3	3.9
ENE	6.?	5.2	3.7
E	6.6	5.4	4.0
ESE	6.8	5.6	4.3
SE	6.2	5.3	3.9
SSE	5.8	5.2	4.1
S	5.5	4.9	3.6
SSW	5.5	5.0	3.7
SW	5.3	4.8	3.3
WSW	4.7	4.2	2.4
W	5.4	4.4	2.2
WNW	6.0	4.6	2.4
NW	6.0	4.8	3.1
NNW	6.8	5.4	3.9

[a]Based on Braidwood site meteorological data, January 1978 through December 1987. Calculated in Reference 1 of Section P.2, using formulas in Section B.1.3 of Appendix B.

[b]The elevated and ground level values are provided for reference purposes only. Routine dose calculations are performed using the mixed mode values.

Table F-5
X/Q and D/Q Maxima at or Beyond the Unrestricted Area Boundary

Downwind Direction	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)	
N	610.	1.159E-06	610.	1.643E-08	610.	4.638E-06	3.355E-08	
NNE	914.	5.056E-07	914.	7.023E-09	914.	1.776E-06	1.382E-08	
NE	792.	2.977E-07	792.	4.274E-09	792.	1.730E-06	1.092E-08	
ENE	701.	4.273E-07	701.	4.903E-09	701.	2.170E-06	1.310E-08	
E	1036.	3.095E-07	1036.	3.780E-09	1036.	1.500E-06	8.551E-09	
ESE	2713.	1.063E-07	2713.	1.164E-09	2713.	3.977E-07	1.949E-09	
SE	3414.	7.561E-08	3414.	7.225E-10	3414.	2.746E-07	1.088E-09	
SSE	3444.	6.021E-08	3444.	6.345E-10	3444.	2.157E-07	1.015E-09	
S	4633.	4.060E-08	4633.	2.644E-10	4633.	1.743E-07	4.520E-10	
SSW	975.	1.918E-07	975.	2.843E-09	975.	1.329E-06	6.781E-09	
SW	625.	5.232E-07	625.	5.479E-09	625.	3.544E-06	1.520E-08	
WSW	533.	8.335E-07	533.	4.777E-09	533.	5.841E-06	1.973E-08	
W	518.	8.886E-07	518.	5.064E-09	518.	5.892E-06	1.830E-08	
WNW	503.	1.076E-06	503.	6.100E-09	503.	6.464E-06	1.913E-08	
NW	495.	1.080E-06	495.	8.650E-09	495.	5.492E-06	2.537E-08	
NNW	510.	1.096E-06	510.	1.185E-08	510.	5.408E-06	3.023E-08	

Braidwood Site Meteorological Data '78 - 12/87

Note: Based on Reference 1 of Section F.2 and the formulas in Sections B.3 and B.4 of Appendix A.

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

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

The ground level release data are provided for reference purposes only. Routine dose calculations are pertormed using mixed mode data.

Radius is the approximate distance from the midpoint between gaseous effluent release points to the 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	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)	
N	610.	1.159E-06	610.	1.643E-08	610.	4.638E-06	3.355E-08	
NNE	914.	5.056E-07	914.	7.023E-09	914.	1.776E-06	1.382E-08	
NE	792.	2.977E-07	792.	4.274E-09	792.	1.730E-06	1.092E-08	
ENE	701.	4.273E-07	701.	4.903E-09	701.	2.170E-06	1.310E-08	
E	1036.	3.095E-07	1036.	3.780E-09	1036.	1.500E-06	8.551E-09	
ESE	1841.	1.628E-07	1841.	2.122E-09	1841.	6.914E-07	3.803E-09	
SE	3414.	7.561E-08	3414.	7.225E-10	3414.	2.746E-07	1.088E-09	
SSE	3444.	6.021E-08	3444.	6.345E-10	3444.	2.157E-07	1.015E-09	
S	4633.	4.060E-08	4633.	2.644E-10	4633.	1.743E-07	4.520E-10	
SSW	975.	1.918E-07	975.	2.843E-09	975.	1.329E-06	6.781E-09	
SW	625.	5.232E-07	625.	5.479E-09	625.	3.544E-06	1.520E-08	
WSW	533.	8.335E-07	533.	4.777E-09	533.	5.841E-06	1.973E-08	
W	518.	8.886E-07	518.	5.064E-09	518.	5.892E-06	1.830E-08	
WNW	503.	1.076E-06	503.	6.100E-09	503.	6.464E-06	1.913E-08	
NW	495.	1.080E-06	495.	8.650E-09	495.	5.492E-06	2.537E-08	
NNW	510.	1.096E-06	510.	1.185E-08	510.	5.408E-06	3.023E-08	

Braidwood Site Meteorological Data 1/78 - 12/87

Note: Based on Reference 1 of Section F.2 and the formulas in Sections B.3 and B.4 of Appendix B.

The ground level release data are provided for reference purposes only. Routine dose calculations are performed using mixed mode data.

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

Table F-6

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

Downwind Direction	Nearest Milk Cow Radius (meters)	D/Q(1/m**2) Mixed Release	D/Q(1/m**2) Ground Release	Nearest Meat Animal Radius (meters)	D/Q(1/m**2) Mixed Release	D/Q(1/m**2) Ground Release
N	8000.	2.694E-10	4.083E-10	5200.	5.659E-10	8.828E-10
NNE	8000.	2.158E-10	3.221E-10	6900.	2.790E-10	4.202E-10
NE	8000.	1.333E-10	2.015E-10	7900.	1.363E-10	2.061E-10
ENE	8000.	1.305E-10	1.987E-10	4000.	4.090E-10	6.832E-10
E	3500.	6.300E-10	1.064E-09	6800.	2.133E-10	3.277E-10
ESE	8000.	1.962E-10	2.874E-10	3400.	8.158E-10	1.315E-09
SE	8000.	1.779E-10	2.395E-10	4800.	4.183E-10	5.969E-10
SSE	8000.	1.591E-10	2.270E-10	8000.	1.591E-10	2.270E-10
S	8000.	1.074E-10	1.704E-10	8000.	1.074E-10	1.704E-10
SSW	8000.	1.172E-10	1.757E-10	5200.	2.404E-10	3.800E-10
SW	8000.	1.417E-10	1.921E-10	5000.	2.640E-10	3.760E-10
WSW	8000.	1.143E-10	1.943E-10	2400.	7.320E-10	1.629E-09
W	8000.	9.700E-11	1.724E-10	4000.	3.005E-10	5.928E-10
WNW	8000.	9.286E-11	1.723E-10	6000.	1.515E-10	2.887E-10
NW	7700.	1.340E-10	2.388E-10	2700.	7.415E-10	1.524E-09
NNW	8000.	1.639E-10	2.781E-10	4800.	3.911E-10	6.931E-10

BRAIDWOOD SITE METEOROLOGICAL DATA 1/78 - 12/87

Note: Based on Reference 1 in Section F.2 and the formulas in Section B.4 of Appendix B.

Approximate distance from the station as determined by annual census.

The ground level release data are provided for reference purposes only.

Routine dose calculations are performed using mixed mode release data.

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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.455E-04	1.097E-04	610.	5.333E-04	4.021E-04
NNE	914.	914.	6.375E-05	4.807E-05	914.	2.125E-04	1.602E-04
NE	792.	792.	3.828E-05	2.886E-05	792.	2.007E-04	1.513E-04
ENE	701.	701.	5.294E-05	3.992E-05	701.	2.575E-04	1.941E-04
E	1036.	1036.	3.703E-05	2.792E-05	1036.	1.718E-04	1.295E-04
ESE	2713.	2713.	1.129E-05	8.514E-06	2713.	3.792E-05	2.859E-05
SE	3414.	3414.	7.089E-06	5.345E-06	3414.	2.141E-05	1.614E-05
SSE	3444.	3444.	6.047E-06	4.559E-06	3444.	1.798E-05	1.356E-05
S	4633.	4633.	3.224E-06	2.431E-06	4633.	9.268E-06	6.988E-06
SSW	975.	975.	2.363E-05	1.782E-05	975.	1.444E-04	1.088E-04
SW	625.	625.	6.030E-05	4.546E-05	625.	3.762E-04	2.836E-04
WSW	533.	533.	9.000E-05	6.786E-05	533.	6.336E-04	4.777E-04
W	518.	518.	9.909E-05	7.471E-05	518.	6.292E-04	4.744E-04
WNW	503.	503.	1.205E-04	9.082E-05	503.	6.653E-04	5.016E-04
NW	495.	495.	1.2E-04	9.366E-05	495.	6.066E-04	4.574E-04
NNW	510.	510.	1.322E-04	9.969E-05	510.	6.144E-04	4.633E-04

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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.

Routine dose calculations are performed using mixed mode (vent) release data.

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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	9.989E-04	9.590E-04	610.	2.731E-03	2.614E-03
NNE	914.	914.	4.979E-04	4.785E-04	914.	1.222E-03	1.171E-03
NE	792.	792.	3.618E-04	3.481E-04	792.	1.173E-03	1.124E-03
ENE	701.	701.	4.452E-04	4.280E-04	701.	1.363E-03	1.305E-03
E	1036.	1036.	3.452E-04	3.320E-04	1036.	1.023E-03	9.809E-04
ESE	2713.	2713.	1.220E-04	1.174E-04	2713.	3.051E-04	2.930E-04
SE	3414.	3414.	8.179E-05	7.874E-05	3414.	1.970E-04	1.893E-04
SSE	3444.	3444.	6.958E-05	6.700E-05	3444.	1.634E-04	1.570E-04
S	4633.	4633.	4.000E-05	3.851E-05	4633.	1.051E-04	1.010E-04
SSW	975.	975.	2.413E-04	2.323E-04	975.	9.063E-04	8.688E-04
SW	625.	625.	5.268E-04	5.065E-04	625.	2.019E-03	1.933E-03
WSW	533.	533.	7.031 -04	6.755E-04	533.	3.226E-03	3.087E-03
W	518.	518.	6.908E-04	6.632E-04	518.	3.081E-03	2.947E-03
WNW	503.	503.	7.511E-04	7.204E-04	503.	3.126E-03	2.988E-03
NW	495.	495.	8.396E-04	8.059E-04	495.	2.915E-03	2.788E-03
NNW	510.	510.	9.023E-04	8.662E-04	510.	3.091E-03	2.958E-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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.125E-05	1.088E-05	610.	2.986E-05	2.888E-05
NNE	914.	914.	5.661E-06	5.474E-06	914.	1.344E-05	1.300E-05
NE	792.	792.	4.192E-06	4.053E-06	792.	1.311E-05	1.268E-05
ENE	701.	701.	5.150E-06	4.980E-06	701.	1.486E-05	1.437E-05
E	1036.	1036.	4.044E-06	3.911E-06	1036.	1.145E-05	1.107E-05
ESE	2713.	2713.	1.468E-06	1.420E-06	2713.	3.702E-06	3.579E-06
SE	3414.	3414.	1.025E-06	9.911E-07	3414.	2.620E-06	2.534E-06
SSE	3444.	3444.	8.593E-07	8.310E-07	3444.	2.101E-06	2.032E-06
S	4633.	4633.	5.432E-07	5.253E-07	4633.	1.699E-06	1.643E-06
SSW	975.	975.	2.853E-06	2.759E-06	975.	1.042E-05	1.008E-05
SW	625.	625.	6.177E-06	5.973E-06	625.	2.259E-05	2.185E-05
WSW	533.	533.	8.227E-06	7.956E-06	533.	3.577E-05	3.459E-05
W	518.	518.	7.924E-06	7.663E-06	518.	3.388E-05	3.276E-05
WNW	503.	503.	8.499E-06	8.219E-06	503.	3.430E-05	3.317E-05
NW	495.	495.	9.567E-06	9.251E-06	495.	3.174E-05	3.069E-05
NNW	510.	510.	1.025E-05	9.909E-06	510.	3.393E-05	3.281E-05

Braidwood Site Meteorological Data 1/78 - 12/87

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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	3.313E-03	3.217E-03	610.	8.088E-03	7.853E-03
NNE	914.	914.	1.650E-03	1.602E-03	914.	3.649E-03	3.543E-03
NE	792.	792.	1.249E-03	1.213E-03	792.	3.373E-03	3.275E-03
ENE	701.	701.	1.516E-03	1.472E-03	701.	4.077E-03	3.958E-03
E	1036.	1036.	1.150E-03	1.117E-03	1036.	2.954E-03	2.868E-03
ESE	2713.	2713.	3.948E-04	3.834E-04	2713.	8.084E-04	7.849E-04
SE	3414.	3414.	2.559E-04	2.486E-04	3414.	4.691E-04	4.555E-04
SSE	3444.	3444.	2.231E-04	2.167E-04	3444.	4.098E-04	3.979E-04
S	4633.	4633.	1.162E-04	1.129E-04	4633.	2.055E-04	1.996E-04
SSW	975.	975.	8.253E-04	8.015E-04	975.	2.477E-03	2.405E-03
SW	625.	625.	1.782E-03	1.731E-03	625.	5.714E-03	5.548E-03
WSW	533.	533.	2.340E-03	2.273E-03	533.	9.198E-03	8.931E-03
W	518.	518.	2.276E-03	2.210E-03	518.	8.931E-03	8.671E-03
WNW	503.	503.	2.431E-03	2.360E-03	503.	9.052E-03	8.789E-03
NW	495.	495.	2.792E-03	2.711E-03	495.	8.646E-03	8.395E-03
NNW	510.	510.	2.982E-03	2.896E-03	510.	9.023E-03	8.761E-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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	7.997E-03	7.772E-03	610.	1.968E-02	1.911E-02
NNE	914.	914.	4.019E-03	3.906E-03	914.	8.899E-03	8.644E-03
NE	792.	792.	3.059E-03	2.974E-03	792.	8.441E-03	8.199E-03
ENE	701.	701.	3.725E-03	3.621E-03	701.	9.870E-03	9.586E-03
E	1036.	1036.	2.878E-03	2.798E-03	1036.	7.394E-03	7.182E-03
ESE	2713.	2713.	1.022E-03	9.941E-04	2713.	2.215E-03	2.152E-03
SE	3414.	3414.	6.859E-04	6.670E-04	3414.	1.396E-03	1.357E-03
SSE	3444.	3444.	5.929E-04	5.766E-04	3444.	1.185E-03	1.151E-03
S	4633.	4633.	3.301E-04	3.210E-04	4633.	6.987E-04	6.792E-04
SSW	975.	975.	2.066E-03	2.009E-03	975.	6.466E-03	6.281E-03
SW	625.	625.	4.447E-03	4.323E-03	625.	1.443E-02	1.402E-02
WSW	533.	533.	5.857E-03	5.693E-03	533.	2.300E-02	2.234E-02
W	518.	518.	5.607E-03	5.449E-03	518.	2.205E-02	2.141E-02
WNW	503.	503.	5.947E-03	5.779E-03	503.	2.232E-02	2.167E-02
NW	495.	495.	6.814E-03	6.622E-03	495.	2.097E-02	2.036E-02
NNW	510.	510.	7.265E-03	7.060E-03	510.	2.215E-02	2.151E-02

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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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	4.323E-03	4.199E-03	610.	7.655E-03	7.435E-03
NNE	914.	914.	1.692E-03	1.643E-03	914.	2.645E-03	2.569E-03
NE	792.	792.	1.305E-03	1.268E-03	792.	2.219E-03	2.155E-03
ENE	701.	701.	1.577E-03	1.532E-03	701.	3.016E-03	2.929E-03
E	1036.	1036.	9.092E-04	8.833E-04	1036.	1.387E-03	1.347E-03
ESE	2713.	2713.	1.140E-04	1.108E-04	2713.	9.720E-05	9.442E-05
SE	3414.	3414.	4.392E-05	4.266E-05	3414.	2.983E-05	2.897E-05
SSE	3444.	3444.	3.822E-05	3.712E-05	3444.	3.079E-05	2.990E-05
S	4633.	4633.	9.027E-06	8.769E-06	4633.	6.198E-06	6.021E-06
SSW	975.	975.	6.764E-04	6.571E-04	975.	1.066E-03	1.036E-03
SW	625.	625.	1.785E-03	1.734E-03	625.	3.262E-03	3.168E-03
WSW	533.	533.	2.159E-03	2.097E-03	533.	5.063E-03	4.917E-03
W	518.	518.	2.170E-03	2.108E-03	518.	4.949E-03	4.807E-03
WNW	503.	503.	2.410E-03	2.341E-03	503.	5.589E-03	5.428E-03
NW	495.	495.	3.227E-03	3.134E-03	495.	7.228E-03	7.020E-03
NNW	510.	510.	3.714E-03	3.608E-03	510.	7.735E-03	7.512E-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-90

Downwind Direction	Unrestricted Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	8.576E-04	8.317E-04	610.	9.142E-04	8.863E-04
NNE	914.	914.	1.453E-04	1.409E-04	914.	1.212E-04	1.175E-04
NE	792.	792.	1.302E-04	1.263E-04	792.	1.132E-04	1.098E-04
ENE	701.	701.	1.874E-04	1.817E-04	701.	1.634E-04	1.584E-04
E	1036.	1036.	5.480E-05	5.316E-05	1036.	3.996E-05	3.875E-05
ESE	2713.	2713.	2.691E-07	2.610E-07	2713.	1.795E-07	1.741E-07
SE	3414.	3414.	1.662E-08	1.612E-08	3414.	6.748E-09	6.546E-09
SSE	3444.	3444.	2.647E-08	2.568E-08	3444.	2.033E-08	1.972E-08
S	4633.	4633.	5.354E-10	5.193E-10	4633.	3.704E-10	3.592E-10
SSW	975.	975.	4.411E-05	4.278E-05	975.	3.803E-05	3.688E-05
SW	625.	625.	2.343E-04	2.273E-04	625.	2.074E-04	2.011E-04
WSW	533.	533.	2.628E-04	2.550E-04	533.	2.229E-04	2.161E-04
W	518.	518.	2.822E-04	2.738E-04	518.	1.673E-04	1.622E-04
WNW	503.	503.	3.444E-04	3.341E-04	503.	2.412E-04	2.339E-04
NW	495.	495.	5.611E-04	5.442E-04	495.	5.535E-04	5.366E-04
NNW	510.	510.	8.014E-04	7.772E-04	510.	9.221E-04	8.940E-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-131m

Downwind Direction	Unrestricted Area Bound (meters)	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	610.	610.	1.355E-04	1.065E-04	610.	4.922E-04	3.831E-04
NNE	914.	914.	6.125E-05	4.839E-05	914.	1.988E-04	1.553E-04
NE	792.	792.	3.806E-05	3.031E-05	792.	1.946E-04	1.520E-04
ENE	701.	701.	5.153E-05	4.083E-05	701.	2.358E-04	1.838E-04
E	1036.	1036.	3.805E-05	3.024E-05	1036.	1.677E-04	1.310E-04
ESE	2713.	2713.	1.232E-05	9.849E-06	2713.	4.412E-05	3.474E-05
SE	3414.	3414.	8.612E-06	6.883E-06	3414.	3.046E-05	2.401E-05
SSE	3444.	3444.	6.862E-06	5.499E-06	3444.	2.387E-05	1.883E-05
S	4633.	4633.	4.603E-06	3.676E-06	4633.	1.914E-05	1.510E-05
SSW	975.	975.	2.441E-05	1.949E-05	975.	1.504E-04	1.176E-04
SW	625.	625.	6.166E-05	4.886E-05	625.	3.680E-04	2.865E-04
WSW	533.	533.	9.058E-05	7.145E-05	533.	6.049E-04	4.705E-04
W	518.	518.	9.576E-05	7.527E-05	518.	5.874E-04	4.565E-04
WNW	503.	503.	1.132E-04	8.870E-05	503.	6.171E-04	4.790E-04
NW	495.	495.	1.167E-04	9.171E-05	495.	5.515E-04	4.285E-04
NNW	510.	510.	1.244E-04	9.777E-05	510.	5.698E-04	4.432E-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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	2.551E-04	2.223E-04	610.	8.256E-04	7.023E-04
NNE	914.	914.	1.216E-04	1.063E-04	914.	3.481E-04	2.984E-04
NE	792.	792.	8.185E-05	7.244E-05	792.	3.399E-04	2.912E-04
ENE	701.	701.	1.055E-04	9.274E-05	701.	4.017E-04	3.426E-04
E	1036.	1036.	8.032E-05	7.091E-05	1036.	2.943E-04	2.524E-04
ESE	2713.	2713.	2.749E-05	2.446E-05	2713.	8.394E-05	7.303E-05
SE	3414.	3414.	1.908E-05	1.697E-05	3414.	5.806E-05	5.060E-05
SSE	3444.	3444.	1.562E-05	1.394E-05	3444.	4.609E-05	4.022E-05
S	4633.	4633.	1.005E-05	8.929E-06	4633.	3.632E-05	3.171E-05
SSW	975.	975.	5.390E-05	4.788E-05	975.	2.651E-04	2.276E-04
SW	625.	625.	1.260E-04	1.108E-04	625.	6.188E-04	5.267E-04
WSW	533.	533.	1.767E-04	1.542E-04	533.	1.004E-03	8.520E-04
W	518.	518.	1.799E-04	1.560E-04	518.	9.658E-04	8.185E-04
WNW	503.	503.	2.046E-04	1.763E-04	503.	1.001E-03	8.459E-04
NW	495.	495.	2.185E-04	1.894E-04	495.	9.067E-04	7.683E-04
NNW	510.	510.	2.337E-04	2.027E-04	510.	9.487E-04	8.059E-04

Braidwood Site Meteorological Data 1/78 - 12/87

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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	2.824E-04	2.536E-04	610.	9.100E-04	8.050E-04
NNE	914.	914.	1.355E-04	1.224E-04	914.	3.891E-04	3.466E-04
NE	792.	792.	9.079E-05	8.273E-05	792.	3.804E-04	3.389E-04
ENE	701.	701.	1.161E-04	1.052E-04	701.	4.450E-04	3.946E-04
E	1036.	1036.	8.914E-05	8.108E-05	1036.	3.295E-04	2.937E-04
ESE	2713.	2713.	3.072E-05	2.812E-05	2713.	9.583E-05	8.640E-05
SE	3414.	3414.	2.135E-05	1.953E-05	3414.	6.660E-05	6.011E-05
SSE	3444.	3444.	1.740E-05	1.596E-05	3444.	5.275E-05	4.767E-05
S	4633.	4633.	1.130E-05	1.033E-05	4633.	4.215E-05	3.809E-05
SSW	975.	975.	5.975E-05	5.460E-05	975.	2.978E-04	2.657E-04
SW	625.	625.	1.386E-04	1.255E-04	625.	6.830E-04	6.045E-04
WSW	533.	533.	1.924E-04	1.733E-04	533.	1.103E-03	9.738E-04
W	518.	518.	1.965E-04	1.762E-04	518.	1.056E-03	9.311E-04
WNW	503.	503.	2.231E-04	1.990E-04	503.	1.088E-03	9.570E-04
NW	495.	495.	2.383E-04	2.135E-04	495.	9.911E-04	8.736E-04
NNW	510.	510.	2.563E-04	2.299E-04	510.	1.044E-03	9.221E-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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.924E-03	1.856E-03	610.	4.403E-03	4.240E-03
NNE	914.	914.	9.071E-04	8.750E-04	914.	1.913E-03	1.843E-03
NE	792.	792.	6.745E-04	6.509E-04	792.	1.628E-03	1.568E-03
ENE	701.	701.	8.149E-04	7.862E-04	701.	2.191E-03	2.110E-03
E	1036.	1036.	5.710E-04	5.510E-04	1036.	1.368E-03	1.319E-03
ESE	2713.	2713.	1.557E-04	1.503E-04	2713.	2.479E-04	2.391E-04
SE	3414.	3414.	8.843E-05	8.536E-05	3414.	1.163E-04	1.122E-04
SSE	3444.	3444.	7.741E-05	7.472E-05	3444.	1.062E-04	1.025E-04
S	4633.	4633.	3.277E-05	3.163E-05	4633.	4.020E-05	3.879E-05
SSW	975.	975.	4.100E-04	3.957E-04	975.	1.011E-03	9.747E-04
SW	625.	625.	9.034E-04	8.718E-04	625.	2.580E-03	2.485E-03
WSW	533.	533.	1.154E-03	1.114E-03	533.	4.266E-03	4.108E-03
W	518.	518.	1.187E-03	1.145E-03	518.	4.362E-03	4.200E-03
WNW	503.	503.	1.304E-03	1.258E-03	503.	4.495E-03	4.327E-03
NW	495.	495.	1.546E-03	1.490E-03	495.	4.695E-03	4.521E-03
NNW	510.	510.	1.673E-03	1.613E-03	510.	4.688E-03	4.514E-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-135

Downwind Direction	Unrestricted Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.353E-03	1.307E-03	610.	3.674E-03	3.548E-03
NNE	914.	914.	6.781E-04	6.554E-04	914.	1.652E-03	1.596E-03
NE	792.	792.	4.952E-04	4.788E-04	792.	1.599E-03	1.545E-03
ENE	701.	701.	6.084E-04	5.880E-04	701.	1.833E-03	1.770E-03
E	1036.	1036.	4.753E-04	4.595E-04	1036.	1.395E-03	1.348E-03
ESE	2713.	2713.	1.700E-04	1.644E-04	2713.	4.326E-04	4.181E-04
SE	3414.	3414.	1.160E-04	1.121E-04	3414.	2.914E-04	2.816E-04
SSE	3444.	3444.	9.782E-05	9.459E-05	3444.	2.377E-04	2.297E-04
S	4633.	4633.	5.868E-05	5.674E-05	4633.	1.698E-04	1.641E-04
SSW	975.	975.	3.328E-04	3.217E-04	975.	1.253E-03	1.211E-03
SW	625.	625.	7.237E-04	6.995E-04	625.	2.748E-03	2.653E-03
WSW	533.	533.	9.642E-04	9.318E-04	533.	4.369E-03	4.218E-03
W	518.	518.	9.408E-04	9.091E-04	518.	4.151E-03	4.008E-03
WNW	503.	503.	1.018E-03	9.833E-04	503.	4.203E-03	4.058E-03
NW	495.	495.	1.139E-03	1.101E-03	495.	3.908E-03	3.773E-03
NNW	510.	510.	1.225E-03	1.183E-03	510.	4.166E-03	4.022E-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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	6.360E-04	6.154E-04	610.	1.202E-03	1.164E-03
NNE	914.	914.	2.578E-04	2.494E-04	914.	4.345E-04	4.205E-04
NE	792.	792.	1.950E-04	1.887E-04	792.	3.640E-04	3.522E-04
ENE	701.	701.	2.355E-04	2.279E-04	701.	4.977E-04	4.816E-04
E	1036.	1036.	1.407E-04	1.361E-04	1036.	2.400E-04	2.322E-04
ESE	2713.	2713.	2.042E-05	1.976E-05	2713.	1.931E-05	1.868E-05
SE	3414.	3414.	8.468E-06	8.195E-06	3414.	6.393E-06	6.186E-06
SSE	3444.	3444.	7.384E-06	7.146E-06	3444.	6.474E-06	6.265E-06
S	4633.	4633.	1.951E-06	1.888E-06	4633.	1.457E-06	1.410E-06
SSW	975.	975.	1.038E-04	1.004E-04	975.	1.812E-04	1.753E-04
SW	625.	625.	2.625E-04	2.541E-04	625.	5.373E-04	5.199E-04
WSW	533.	533.	3.189E-04	3.087E-04	533.	8.494E-04	8.219E-04
W	518.	518.	3.247E-04	3.143E-04	518.	8.444E-04	8.170E-04
WNW	503.	503.	3.635E-04	3.517E-04	503.	9.371E-04	9.067E-04
NW	495.	495.	4.769E-04	4.615E-04	495.	1.167E-03	1.129E-03
NNW	510.	510.	5.441E-04	5.265E-04	510.	1.222E-03	1.182E-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-138

Downwind Direction	Unrestricted Area Bound (meters)	Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	4.201E-03	4.079E-03	610.	9.169E-03	8.898E-03
NNE	914.	914.	1.982E-03	1.925E-03	914.	3.986E-03	3.869E-03
NE	792.	792.	1.504E-03	1.460E-03	792.	3.379E-03	3.280E-03
ENE	701.	701.	1.805E-03	1.753E-03	701.	4.549E-03	4.415E-03
E	1036.	1036.	1.262E-03	1.225E-03	1036.	2.830E-03	2.747E-03
ESE	2713.	2713.	3.395E-04	3.297E-04	2713.	5.079E-04	4.931E-04
SE	3414.	3414.	1.926E-04	1.871E-04	3414.	2.381E-04	2.312E-04
SSE	3444.	3444.	1.685E-04	1.636E-04	3444.	2.185E-04	2.121E-04
S	4633.	4633.	7.045E-05	6.842E-05	4633.	8.174E-05	7.937E-05
SSW	975.	975.	9.144E-04	8.880E-04	975.	2.091E-03	2.030E-03
SW	625.	625.	2.021E-03	1.963E-03	625.	5.325E-03	5.168E-03
WSW	533.	533.	2.567E-03	2.493E-03	533.	8.769E-03	8.510E-03
W	518.	518.	2.609E-03	2.534E-03	518.	8.973E-03	8.708E-03
WNW	503.	503.	2.834E-03	2.751E-03	503.	9.247E-03	8.973E-03
NW	495.	495.	3.387E-03	3.288E-03	495.	9.733E-03	9.445E-03
NNW	510.	510.	3.657E-03	3.551E-03	510.	9.712E-03	9.425E-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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	5.141E-03	4.977E-03	610.	1.283E-02	1.242E-02
NNE	914.	914.	2.568E-03	2.485E-03	914.	5.780E-03	5.595E-03
NE	792.	792.	1.935E-03	1.873E-03	792.	5.421E-03	5.248E-03
ENE	701.	701.	2.357E-03	2.282E-03	701.	6.445E-03	6.239E-03
E	1036.	1036.	1.803E-03	1.746E-03	1036.	4.745E-03	4.593E-03
ESE	2713.	2713.	6.281E-04	6.080E-04	2713.	1.352E-03	1.309E-03
SE	3414.	3414.	4.128E-04	3.996E-04	3414.	8.140E-04	7.880E-04
SSE	3444.	3444.	3.580E-04	3.466E-04	3444.	7.007E-04	6.783E-04
S	4633.	4633.	1.924E-04	1.862E-04	4633.	3.770E-04	3.650E-04
SSW	975.	975.	1.289E-03	1.247E-03	975.	4.067E-03	3.937E-03
SW	625.	625.	2.785E-03	2.695E-03	625.	9.244E-03	8.948E-03
WSW	533.	533.	3.676E-03	3.558E-03	533.	1.482E-02	1.435E-02
W	518.	518.	3.562E-03	3.448E-03	518.	1.430E-02	1.384E-02
WNW	503.	503.	3.806E-03	3.685E-03	503.	1.449E-02	1.403E-02
NW	495.	495.	4.350E-03	4.211E-03	495.	1.371E-02	1.327E-02
NNW	510.	510.	4.647E-03	4.498E-03	510.	1.439E-02	1.393E-02

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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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.455E-04	1.097E-04	610.	5.333E-04	4.021E-04
NNE	914.	914.	6.375E-05	4.807E-05	914.	2.125E-04	1.602E-04
NE	792.	792.	3.828E-05	2.886E-05	792.	2.007E-04	1.513E-04
ENE	701.	701.	5.294E-05	3.992E-05	701.	2.575E-04	1.941E-04
E	1036.	1036.	3.703E-05	2.792E-05	1036.	1.718E-04	1.295E-04
ESE	1841.	1841.	1.848E-05	1.394E-05	1841.	7.237E-05	5.457E-05
SE	3414.	3414.	7.089E-06	5.345E-06	3414.	2.141E-05	1.614E-05
SSE	3444.	3444.	6.047E-06	4.559E-06	3444.	1.798E-05	1.356E-05
S	4633.	4633.	3.224E-06	2.431E-06	4633.	9.268E-06	6.988E-06
SSW	975.	975.	2.363E-05	1.782E-05	975.	1.444E-04	1.088E-04
SW	625.	625.	6.030E-05	4.546E-05	625.	3.762E-04	2.836E-04
WSW	533.	533.	9.000E-05	6.786E-05	533.	6.336E-04	4.777E-04
W	518.	518.	9.909E-05	7.471E-05	518.	6.292E-04	4.744E-04
WNW	503.	503.	1.205E-04	9.082E-05	503.	6.653E-04	5.016E-04
NW	495.	495.	1.242E-04	9.366E-05	495.	6.066E-04	4.574E-04
NNW	510.	510.	1.322E-04	9.969E-05	510.	6.144E-04	4.633E-04

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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.

Routine dose calculations are performed using mixed mode release data.

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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	9.989E-04	9.590E-04	610.	2.731E-03	2.614E-03
NNE	914.	914.	4.979E-04	4.785E-04	914.	1.222E-03	1.171E-03
NE	792.	792.	3.618E-04	3.481E-04	792.	1.173E-03	1.124E-03
ENE	701.	701.	4.452E-04	4.280E-04	701.	1.363E-03	1.305E-03
E	1036.	1036.	3.452E-04	3.320E-04	1036.	1.023E-03	9.809E-04
ESE	1841.	1841.	1.921E-04	1.849E-04	1841.	5.190E-04	4.981E-04
SE	3414.	3414.	8.179E-05	7.874E-05	3414.	1.970E-04	1.893E-04
SSE	3444.	3444.	6.958E-05	6.700E-05	3444.	1.634E-04	1.570E-04
S	4633.	4633.	4.000E-05	3.851E-05	4633.	1.051E-04	1.010E-04
SSW	975.	975.	2.413E-04	2.323E-04	975.	9.063E-04	8.688E-04
SW	625.	625.	5.268E-04	5.065E-04	625.	2.019E-03	1.933E-03
WSW	533.	533.	7.031E-04	6.755E-04	533.	3.226E-03	3.087E-03
W	518.	518.	6.908E-04	6.632E-04	518.	3.081E-03	2.947E-03
WNW	503.	503.	7.511E-04	7.204E-04	503.	3.126E-03	2.988E-03
NW	495.	495.	8.396E-04	8.059E-04	495.	2.915E-03	2.788E-03
NNW	510.	510.	9.023E-04	8.662E-04	510.	3.091E-03	2.958E-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 Kr-85

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.125E-05	1.088E-05	610.	2.986E-05	2.888E-05
NNE	914.	914.	5.661E-06	5.474E-06	914.	1.344E-05	1.300E-05
NE	792.	792.	4.192E-06	4.053E-06	792.	1.311E-05	1.268E-05
ENE	701.	701.	5.150E-06	4.980E-06	701.	1.486E-05	1.437E-05
E	1036.	1036.	4.044E-06	3.911E-06	1036.	1.145E-05	1.107E-05
ESE	1841.	1841.	2.270E-06	2.195E-06	1841.	6.054E-06	5.854E-06
SE	3414.	3414.	1.025E-06	9.911E-07	3414.	2.620E-06	2.534E-06
SSE	3444.	3444.	8.593E-07	8.310E-07	3444.	2.101E-06	2.032E-06
S	4633.	4633.	5.432E-07	5.253E-07	4633.	1.699E-06	1.643E-06
SSW	975.	975.	2.853E-06	2.759E-06	975.	1.042E-05	1.008E-05
SW	625.	625.	6.177E-06	5.973E-06	625.	2.259E-05	2.185E-05
WSW	533.	533.	8.227E-06	7.956E-06	533.	3.577E-05	3.459E-05
W	518.	518.	7.924E-06	7.663E-06	518.	3.388E-05	3.276E-05
WNW	503.	503.	8.499E-06	8.219E-06	503.	3.430E-05	3.317E-05
NW	495.	495.	9.567E-06	9.251E-06	495.	3.174E-05	3.069E-05
NNW	510.	510.	1.025E-05	9.909E-06	510.	3.393E-05	3.281E-05

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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)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	3.313E-03	3.217E-03	610.	8.088E-03	7.853E-03
NNE	914.	914.	1.650E-03	1.602E-03	914.	3.649E-03	3.543E-03
NE	792.	792.	1.249E-03	1.213E-03	792.	3.373E-03	3.275E-03
ENE	701.	701.	1.516E-03	1.472E-03	701.	4.077E-03	3.958E-03
E	1036.	1036.	1.150E-03	1.117E-03	1036.	2.954E-03	2.868E-03
ESE	1841.	1841.	6.359E-04	6.175E-04	1841.	1.433E-03	1.391E-03
SE	3414.	3414.	2.559E-04	2.486E-04	3414.	4.691E-04	4.555E-04
SSE	3444.	3444.	2.231E-04	2.167E-04	3444.	4.098E-04	3.979E-04
S	4633.	4633.	1.162E-04	1.129E-04	4633.	2.055E-04	1.996E-04
SSW	975.	975.	8.253E-04	8.015E-04	975.	2.477E-03	2.405E-03
SW	625.	625.	1.782E-03	1.731E-03	625.	5.714E-03	5.548E-03
WSW	533.	533.	2.340E-03	2.273E-03	533.	9.198E-03	8.931E-03
W	518.	518.	2.276E-03	2.210E-03	518.	8.931E-03	8.671E-03
WNW	503.	503.	2.431E-03	2.360E-03	503.	9.052E-03	8.789E-03
NW	495.	495.	2.792E-03	2.711E-03	495.	8.646E-03	8.395E-03
NNW	510.	510.	2.982E-03	2.896E-03	510.	9.023E-03	8.761E-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 Kr-88

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	7.997E-03	7.772E-03	610.	1.968E-02	1.911E-02
NNE	914.	914.	4.019E-03	3.906E-03	914.	8.899E-03	8.644E-03
NE	792.	792.	3.059E-03	2.974E-03	792.	8.441E-03	8.199E-03
ENE	701.	701.	3.725E-03	3.621E-03	701.	9.870E-03	9.586E-03
E	1036.	1036.	2.878E-03	2.798E-03	1036.	7.394E-03	7.182E-03
ESE	1841.	1841.	1.607E-03	1.563E-03	1841.	3.762E-03	3.655E-03
SE	3414.	3414.	6.859E-04	6.670E-04	3414.	1.396E-03	1.357E-03
SSE	3444.	3444.	5.929E-04	5.766E-04	3444.	1.185E-03	1.151E-03
S	4633.	4633.	3.301E-04	3.210E-04	4633.	6.987E-04	6.792E-04
SSW	975.	975.	2.066E-03	2.009E-03	975.	6.466E-03	6.281E-03
SW	625.	625.	4.447E-03	4.323E-03	625.	1.443E-02	1.402E-02
WSW	533.	533.	5.857E-03	5.693E-03	533.	2.300E-02	2.234E-02
W	518.	518.	5.607E-03	5.449E-03	518.	2.205E-02	2.141E-02
WNW	503.	503.	5.947E-03	5.779E-03	503.	2.232E-02	2.167E-02
NW	495.	495.	6.814E-03	6.622E-03	495.	2.097E-02	2.036E-02
NNW	510.	510.	7.265E-03	7.060E-03	510.	2.215E-02	2.151E-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)	Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	4.323E-03	4.199E-03	610.	7.655E-03	7.435E-03
NNE	914.	914.	1.692E-03	1.643E-03	914.	2.645E-03	2.569E-03
NE	792.	792.	1.305E-03	1.268E-03	792.	2.219E-03	2.155E-03
ENE	701.	701.	1.577E-03	1.532E-03	701.	3.016E-03	2.929E-03
E	1036.	1036.	9.092E-04	8.833E-04	1036.	1.387E-03	1.347E-03
ESE	1841.	1841.	3.136E-04	3.046E-04	1841.	3.337E-04	3.242E-04
SE	3414.	3414.	4.392E-05	4.266E-05	3414.	2.983E-05	2.897E-05
SSE	3444.	3444.	3.822E-05	3.712E-05	3444.	3.079E-05	2.990E-05
S	4633.	4633.	9.027E-06	8.769E-06	4633.	6.198E-06	6.021E-06
SSW	975.	975.	6.764E-04	6.571E-04	975.	1.066E-03	1.036E-03
SW	625.	625.	1.785E-03	1.734E-03	625.	3.262E-03	3.168E-03
WSW	533.	533.	2.159E-03	2.097E-03	533.	5.063E-03	4.917E-03
W	518.	518.	2.170E-03	2.108E-03	518.	4.949E-03	4.807E-03
WNW	503.	503.	2.410E-03	2.341E-03	503.	5.589E-03	5.428E-03
NW	495.	495.	3.227E-03	3.134E-03	495.	7.228E-03	7.020E-03
NNW	510.	510.	3.714E-03	3.608E-03	510.	7.735E-03	7.512E-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 Kr-90

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release		Ground Level Release		
		Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	8.576E-04	8.317E-04	610.	9.142E-04	8.863E-04
NNE	914.	914.	1.453E-04	1.409E-04	914.	1.212E-04	1.175E-04
NE	792.	792.	1.302E-04	1.263E-04	792.	1.132E-04	1.098E-04
ENE	701.	701.	1.874E-04	1.817E-04	701.	1.634E-04	1.584E-04
E	1036.	1036.	5.480E-05	5.316E-05	1036.	3.996E-05	3.875E-05
ESE	1841.	1841.	3.759E-06	3.647E-06	1841.	2.477E-06	2.403E-06
SE	3414.	3414.	1.662E-08	1.612E-08	3414.	6.748E-09	6.546E-09
SSE	3444.	3444.	2.647E-08	2.568E-08	3444.	2.033E-08	1.972E-08
S	4633.	4633.	5.354E-10	5.193E-10	4633.	3.704E-10	3.592E-10
SSW	975.	975.	4.411E-05	4.278E-05	975.	3.803E-05	3.688E-05
SW	625.	625.	2.343E-04	2.273E-04	625.	2.074E-04	2.011E-04
WSW	533.	533.	2.628E-04	2.550E-04	533.	2.229E-04	2.161E-04
W	518.	518.	2.822E-04	2.738E-04	518.	1.673E-04	1.622E-04
WNW	503.	503.	3.444E-04	3.341E-04	503.	2.412E-04	2.339E-04
NW	495.	495.	5.611E-04	5.442E-04	495.	5.535E-04	5.366E-04
NNW	510.	510.	8.014E-04	7.772E-04	510.	9.221E-04	8.940E-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 Xe-131m

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.355E-04	1.065E-04	610.	4.922E-04	3.831E-04
NNE	914.	914.	6.125E-05	4.839E-05	914.	1.988E-04	1.553E-04
NE	792.	792.	3.806E-05	3.031E-05	792.	1.946E-04	1.520E-04
ENE	701.	701.	5.153E-05	4.083E-05	701.	2.358E-04	1.838E-04
E	1036.	1036.	3.805E-05	3.024E-05	1036.	1.677E-04	1.310E-04
ESE	1841.	1841.	1.944E-05	1.553E-05	1841.	7.757E-05	6.091E-05
SE	3414.	3414.	8.612E-06	6.883E-06	3414.	3.046E-05	2.401E-05
SSE	3444.	3444.	6.862E-06	5.499E-06	3444.	2.387E-05	1.883E-05
S	4633.	4633.	4.603E-06	3.676E-06	4633.	1.914E-05	1.510E-05
SSW	975.	975.	2.441E-05	1.949E-05	975.	1.504E-04	1.176E-04
SW	625.	625.	6.166E-05	4.886E-05	625.	3.680E-04	2.865E-04
WSW	533.	533.	9.058E-05	7.145E-05	533.	6.049E-04	4.705E-04
W	518.	518.	9.576E-05	7.527E-05	518.	5.874E-04	4.565E-04
WNW	503.	503.	1.132E-04	8.870E-05	503.	6.171E-04	4.790E-04
NW	495.	495.	1.167E-04	9.171E-05	495.	5.515E-04	4.285E-04
NNW	510.	510.	1.244E-04	9.777E-05	510.	5.698E-04	4.432E-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 Xe-133m

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	2.561E-04	2.223E-04	610.	8.256E-04	7.023E-04
NNE	914.	914.	1.216E-04	1.063E-04	914.	3.481E-04	2.984E-04
NE	792.	792.	8.185E-05	7.244E-05	792.	3.399E-04	2.912E-04
ENE	701.	701.	1.055E-04	9.274E-05	701.	4.017E-04	3.426E-04
E	1036.	1036.	8.032E-05	7.091E-05	1036.	2.943E-04	2.524E-04
ESE	1841.	1841.	4.305E-05	3.825E-05	1841.	1.435E-04	1.243E-04
SE	3414.	3414.	1.908E-05	1.697E-05	3414.	5.806E-05	5.060E-05
SSE	3444.	3444.	1.562E-05	1.394E-05	3444.	4.609E-05	4.022E-05
S	4633.	4633.	1.005E-05	8.929E-06	4633.	3.632E-05	3.171E-05
SSW	975.	975.	5.390E-05	4.788E-05	975.	2.651E-04	2.276E-04
SW	625.	625.	1.260E-04	1.108E-04	625.	6.188E-04	5.267E-04
WSW	533.	533.	1.767E-04	1.542E-04	533.	1.004E-03	8.520E-04
W	518.	518.	1.799E-04	1.560E-04	518.	9.658E-04	8.185E-04
WNW	503.	503.	2.046E-04	1.763E-04	503.	1.001E-03	8.459E-04
NW	495.	495.	2.185E-04	1.894E-04	495.	9.067E-04	7.683E-04
NNW	510.	510.	2.337E-04	2.027E-04	510.	9.487E-04	8.059E-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 Xe-133

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	2.824E-04	2.536E-04	610.	9.100E-04	8.050E-04
NNE	914.	914.	1.355E-04	1.224E-04	914.	3.891E-04	3.466E-04
NE	792.	792.	9.079E-05	8.273E-05	792.	3.804E-04	3.389E-04
ENE	701.	701.	1.161E-04	1.052E-04	701.	4.450E-04	3.946E-04
E	1036.	1036.	8.914E-05	8.108E-05	1036.	3.295E-04	2.937E-04
ESE	1841.	1841.	4.812E-05	4.401E-05	1841.	1.630E-04	1.464E-04
SE	3414.	3414.	2.135E-05	1.953E-05	3414.	6.660E-05	6.011E-05
SSE	3444.	3444.	1.740E-05	1.596E-05	3444.	5.275E-05	4.767E-05
S	4633.	4633.	1.130E-05	1.033E-05	4633.	4.215E-05	3.809E-05
SSW	975.	975.	5.975E-05	5.460E-05	975.	2.978E-04	2.657E-04
SW	625.	625.	1.386E-04	1.255E-04	625.	6.830E-04	6.045E-04
WSW	533.	533.	1.924E-04	1.733E-04	533.	1.103E-03	9.738E-04
W	518.	518.	1.965E-04	1.762E-04	518.	1.056E-03	9.311E-04
WNW	503.	503.	2.231E-04	1.990E-04	503.	1.088E-03	9.570E-04
NW	495.	495.	2.383E-04	2.135E-04	495.	9.911E-04	8.736E-04
NNW	510.	510.	2.563E-04	2.299E-04	510.	1.044E-03	9.221E-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 Xe-135m

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.924E-03	1.856E-03	610.	4.403E-03	4.240E-03
NNE	914.	914.	9.071E-04	8.750E-04	914.	1.913E-03	1.843E-03
NE	792.	792.	6.745E-04	6.509E-04	792.	1.628E-03	1.568E-03
ENE	701.	701.	8.149E-04	7.862E-04	701.	2.191E-03	2.110E-03
E	1036.	1036.	5.710E-04	5.510E-04	1036.	1.368E-03	1.319E-03
ESE	1841.	1841.	2.866E-04	2.766E-04	1841.	5.369E-04	5.177E-04
SE	3414.	3414.	8.843E-05	8.536E-05	3414.	1.163E-04	1.122E-04
SSE	3444.	3444.	7.741E-05	7.472E-05	3444.	1.062E-04	1.025E-04
S	4633.	4633.	3.277E-05	3.163E-05	4633.	4.020E-05	3.879E-05
SSW	975.	975.	4.100E-04	3.957E-04	975.	1.011E-03	9.747E-04
SW	625.	625.	9.034E-04	8.718E-04	625.	2.580E-03	2.485E-03
WSW	533.	533.	1.154E-03	1.114E-03	533.	4.266E-03	4.108E-03
W	518.	518.	1.187E-03	1.145E-03	518.	4.362E-03	4.200E-03
WNW	503.	503.	1.304E-03	1.258E-03	503.	4.495E-03	4.327E-03
NW	495.	495.	1.546E-03	1.490E-03	495.	4.695E-03	4.521E-03
NNW	510.	510.	1.673E-03	1.613E-03	510.	4.688E-03	4.514E-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-135

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	1.353E-03	1.307E-03	610.	3.674E-03	3.548E-03
NNE	914.	914.	6.781E-04	6.554E-04	914.	1.652E-03	1.596E-03
NE	792.	792.	4.952E-04	4.788E-04	792.	1.599E-03	1.545E-03
ENE	701.	701.	6.084E-04	5.880E-04	701.	1.833E-03	1.770E-03
E	1036.	1036.	4.753E-04	4.595E-04	1036.	1.395E-03	1.348E-03
ESE	1841.	1841.	2.657E-04	2.569E-04	1841.	7.227E-04	6.983E-04
SE	3414.	3414.	1.160E-04	1.121E-04	3414.	2.914E-04	2.816E-04
SSE	3444.	3444.	9.782E-05	9.459E-05	3444.	2.377E-04	2.297E-04
S	4633.	4633.	5.868E-05	5.674E-05	4633.	1.698E-04	1.641E-04
SSW	975.	975.	3.328E-04	3.217E-04	975.	1.253E-03	1.211E-03
SW	625.	625.	7.237E-04	6.995E-04	625.	2.748E-03	2.653E-03
WSW	533.	533.	9.642E-04	9.318E-04	533.	4.369E-03	4.218E-03
W	518.	518.	9.408E-04	9.091E-04	518.	4.151E-03	4.008E-03
WNW	503.	503.	1.018E-03	9.833E-04	503.	4.203E-03	4.058E-03
NW	495.	495.	1.139E-03	1.101E-03	495.	3.908E-03	3.773E-03
NNW	510.	510.	1.225E-03	1.183E-03	510.	4.166E-03	4.022E-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-137

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	6.360E-04	6.154E-04	610.	1.202E-03	1.164E-03
NNE	914.	914.	2.578E-04	2.494E-04	914.	4.345E-04	4.205E-04
NE	792.	792.	1.950E-04	1.887E-04	792.	3.640E-04	3.522E-04
ENE	701.	701.	2.355E-04	2.279E-04	701.	4.977E-04	4.816E-04
E	1036.	1036.	1.407E-04	1.361E-04	1036.	2.400E-04	2.322E-04
ESE	1841.	1841.	5.208E-05	5.040E-05	1841.	6.192E-05	5.992E-05
SE	3414.	3414.	8.468E-06	8.195E-06	3414.	6.393E-06	6.186E-06
SSE	3444.	3444.	7.384E-06	7.146E-06	3444.	6.474E-06	6.265E-06
S	4633.	4633.	1.951E-06	1.888E-06	4633.	1.457E-06	1.410E-06
SSW	975.	975.	1.038E-04	1.004E-04	975.	1.812E-04	1.753E-04
SW	625.	625.	2.625E-04	2.541E-04	625.	5.373E-04	5.199E-04
WSW	533.	533.	3.189E-04	3.087E-04	533.	8.494E-04	8.219E-04
W	518.	518.	3.247E-04	3.143E-04	518.	8.444E-04	8.170E-04
WNW	503.	503.	3.635E-04	3.517E-04	503.	9.371E-04	9.067E-04
NW	495.	495.	4.769E-04	4.615E-04	495.	1.167E-03	1.129E-03
NNW	510.	510.	5.441E-04	5.265E-04	510.	1.222E-03	1.182E-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-138

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Ground Level Release Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	4.201E-03	4.079E-03	610.	9.169E-03	8.898E-03
NNE	914.	914.	1.982E-03	1.925E-03	914.	3.986E-03	3.869E-03
NE	792.	792.	1.504E-03	1.460E-03	792.	3.379E-03	3.280E-03
ENE	701.	701.	1.805E-03	1.753E-03	701.	4.549E-03	4.415E-03
E	1036.	1036.	1.262E-03	1.225E-03	1036.	2.830E-03	2.747E-03
ESE	1841.	1841.	6.291E-04	6.110E-04	1841.	1.106E-03	1.074E-03
SE	3414.	3414.	1.926E-04	1.871E-04	3414.	2.381E-04	2.312E-04
SSE	3444.	3444.	1.685E-04	1.636E-04	3444.	2.185E-04	2.121E-04
S	4633.	4633.	7.045E-05	6.842E-05	4633.	8.174E-05	7.937E-05
SSW	975.	975.	9.144E-04	8.880E-04	975.	2.091E-03	2.030E-03
SW	625.	625.	2.021E-03	1.963E-03	625.	5.325E-03	5.168E-03
WSW	533.	533.	2.567E-03	2.493E-03	533.	8.769E-03	8.510E-03
W	518.	518.	2.609E-03	2.534E-03	518.	8.973E-03	8.708E-03
WNW	503.	503.	2.834E-03	2.751E-03	503.	9.247E-03	8.973E-03
NW	495.	495.	3.387E-03	3.288E-03	495.	9.733E-03	9.445E-03
NNW	510.	510.	3.657E-03	3.551E-03	510.	9.712E-03	9.425E-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 Ar-41

Downwind Direction	Controlled Area Bound (meters)	Mixed Mode(Vent) Release			Ground Level Release		
		Radius (meters)	V (mrad/yr)/(uCi/sec)	VBAR	Radius (meters)	G (mrad/yr)/(uCi/sec)	GBAR
N	610.	610.	5.141E-03	4.977E-03	610.	1.283E-02	1.242E-02
NNE	914.	914.	2.568E-03	2.485E-03	914.	5.780E-03	5.595E-03
NE	792.	792.	1.935E-03	1.873E-03	792.	5.421E-03	5.248E-03
ENE	701.	701.	2.357E-03	2.282E-03	701.	6.445E-03	6.239E-03
E	1036.	1036.	1.803E-03	1.746E-03	1036.	4.745E-03	4.593E-03
ESE	1841.	1841.	1.001E-03	9.688E-04	1841.	2.351E-03	2.275E-03
SE	3414.	3414.	4.128E-04	3.996E-04	3414.	8.140E-04	7.880E-04
SSE	3444.	3444.	3.580E-04	3.466E-04	3444.	7.007E-04	6.783E-04
S	4633.	4633.	1.924E-04	1.862E-04	4633.	3.770E-04	3.650E-04
SSW	975.	975.	1.289E-03	1.247E-03	975.	4.067E-03	3.937E-03
SW	625.	625.	2.785E-03	2.695E-03	625.	9.244E-03	8.948E-03
WSW	533.	533.	3.676E-03	3.558E-03	533.	1.482E-02	1.435E-02
W	518.	518.	3.562E-03	3.448E-03	518.	1.430E-02	1.384E-02
WNW	503.	503.	3.806E-03	3.685E-03	503.	1.449E-02	1.403E-02
NW	495.	495.	4.350E-03	4.211E-03	495.	1.371E-02	1.327E-02
NNW	510.	510.	4.647E-03	4.498E-03	510.	1.439E-02	1.393E-02

Braidwood Site Meteorological Data 1/78 - 12/87

Supplemental Table A

Mixed Mode Joint Frequency Distribution Table Summaries

203 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	290	321	441	315	303	256	292	285	474	369	202	197	181	274	483	421	5.076
B	197	241	284	206	205	167	196	220	352	288	180	182	206	225	327	335	3.633
C	321	302	431	283	201	203	277	312	437	404	222	342	373	389	457	409	5.474
D	1.523	1.580	2.149	1.974	1.372	1.014	1.324	1.528	2.031	1.900	1.589	1.846	2.108	2.246	2.191	2.014	28.713
E	679	512	784	976	586	670	1.138	1.439	2.079	1.501	1.085	921	983	1.133	922	780	18.885
F	344	278	260	286	387	496	530	636	859	525	285	397	589	898	555	417	7.148
G	166	085	088	079	158	174	270	213	186	199	268	210	283	285	184	159	2.966
Total	3.520	3.439	4.416	4.143	3.611	3.180	4.035	4.416	5.118	5.187	4.322	4.104	4.714	5.231	5.100	4.545	70.076

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	018	027	025	001	000	017	017	001	001	002	018	037	026	001	026	.222
1.05	044	032	042	045	026	025	039	031	032	023	033	025	037	035	040	028	.532
2.05	224	266	281	280	239	213	243	225	237	220	208	208	282	264	248	243	3.819
3.05	405	426	540	810	458	334	487	438	596	383	383	384	447	427	507	487	7.313
4.05	538	622	755	973	570	453	614	883	696	643	586	653	678	702	748	782	10.629
5.05	624	519	675	826	681	482	668	838	789	677	711	881	728	782	888	808	11.670
6.05	670	807	781	676	674	567	857	728	944	826	823	766	786	875	809	876	12.278
8.05	732	789	955	534	726	519	1.073	1.227	2.076	1.858	1.288	1.131	1.378	1.558	1.381	1.041	18.580
10.05	137	154	174	094	127	156	235	423	727	821	285	216	331	404	359	245	4.887
13.05	007	008	005	002	008	010	014	026	047	037	012	012	017	028	020	012	.285
18.00	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
99.00	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
Total	3.520	3.439	4.416	4.143	3.611	3.180	4.035	4.416	5.118	5.187	4.322	4.104	4.714	5.231	5.100	4.545	70.076

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

In order to determine the final mixed mode values, 70.076% of the elevated value (presented in the 250 FT Mixed Mode table) and 29.924% of the ground level value (presented in the 30 FT Mixed Mode table) are used to calculate the final values.

Supplemental Table A - Continued

Mixed Mode Joint Frequency Distribution Table Summaries

203 Foot Elevation Data

Summary Table of Percent by Speed and Class

Class / Speed	A	B	C	D	E	F	G
.45	.008	.005	.006	.075	.052	.048	.030
1.05	.014	.025	.027	.200	.108	.071	.086
2.05	.175	.187	.378	1.756	.858	.372	.263
3.05	.500	.583	.836	3.100	1.206	.883	.383
4.05	.803	.597	1.005	4.441	2.225	1.083	.575
5.05	.850	.574	.921	4.456	2.885	1.230	.484
6.05	.885	.588	.806	4.760	3.357	1.417	.486
8.05	1.483	.654	1.180	7.631	5.000	1.976	.581
10.05	.325	.180	.320	2.185	1.332	.269	.078
13.05	.015	.011	.015	.129	.081	.009	.002
18.00	.000	.000	.000	.000	.000	.000	.000
88.00	.000	.000	.000	.000	.000	.000	.000

Supplemental Table A - Continued

Mixed Mode Joint Frequency Distribution Table Summaries

34 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	.068	.071	.077	.054	.100	.075	.110	.135	.278	.215	.062	.050	.127	.270	.257	.176	2.129
B	.054	.044	.059	.031	.035	.049	.061	.083	.172	.123	.058	.045	.121	.178	.150	.096	1.357
C	.087	.056	.098	.058	.044	.049	.051	.124	.212	.133	.121	.082	.212	.278	.218	.184	2.005
D	.453	.551	.613	.453	.420	.423	.641	.828	1.487	1.230	.687	.717	1.084	1.486	1.044	.889	13.125
E	.304	.387	.248	.180	.230	.388	.580	1.093	1.981	1.311	.435	.348	.298	.343	.227	.317	8.859
F	.044	.063	.050	.059	.086	.160	.161	.137	.339	.306	.077	.133	.144	.120	.074	.050	2.014
G	.022	.006	.013	.025	.035	.059	.061	.037	.102	.079	.024	.058	.039	.038	.026	.017	.641
Total	1.012	1.177	1.159	.860	.950	1.181	1.705	2.535	4.580	3.387	1.475	1.430	2.027	2.729	1.997	1.709	28.924

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	.014	.002	.014	.018	.010	.008	.004	.008	.001	.001	.000	.000	.005	.000	.006	.000	.086
1.05	.014	.016	.027	.048	.085	.081	.030	.025	.013	.010	.010	.016	.019	.018	.018	.017	.408
2.05	.051	.052	.093	.161	.245	.259	.185	.095	.072	.055	.051	.087	.119	.138	.103	.077	1.849
3.05	.121	.145	.172	.202	.188	.261	.309	.248	.288	.222	.166	.280	.234	.213	.174	.151	3.325
4.05	.188	.155	.187	.168	.173	.215	.319	.364	.490	.508	.245	.222	.241	.243	.237	.220	4.139
5.05	.130	.134	.155	.123	.152	.191	.286	.385	.600	.521	.238	.148	.233	.287	.270	.214	4.075
6.05	.141	.152	.186	.085	.096	.128	.310	.435	.718	.639	.216	.167	.244	.388	.340	.247	4.499
8.05	.280	.325	.268	.038	.017	.066	.238	.887	1.488	1.032	.420	.321	.544	.922	.648	.498	7.746
10.05	.111	.168	.050	.001	.000	.001	.532	.214	.578	.302	.102	.117	.289	.371	.183	.195	2.799
13.05	.023	.029	.006	.000	.000	.000	.005	.078	.216	.102	.024	.082	.107	.131	.015	.076	.881
18.00	.000	.000	.000	.000	.000	.000	.000	.014	.027	.002	.004	.012	.011	.017	.000	.010	.098
88.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Total	1.012	1.177	1.159	.860	.950	1.181	1.705	2.535	4.580	3.387	1.475	1.430	2.027	2.729	1.997	1.709	28.924

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

Supplemental Table A - Continued

Mixed Mode Joint Frequency Distribution Table Summaries

34 Foot Elevation Data

Summary Table of Percent by Speed and Class

Class / Speed	A	B	C	D	E	F	G
45	.000	.000	.000	.006	.015	.031	.044
1.05	.001	.001	.003	.049	.126	.151	.076
2.05	.017	.020	.029	.335	.890	.531	.226
3.05	.127	.103	.157	1.118	1.175	.491	.155
4.05	.277	.182	.281	1.886	1.211	.363	.096
5.05	.332	.209	.274	1.670	1.178	.176	.035
6.05	.381	.215	.358	2.238	1.223	.076	.005
8.05	.735	.445	.632	3.883	1.844	.088	.001
10.05	.214	.126	.211	1.358	.837	.053	.000
13.05	.038	.040	.044	.424	.320	.024	.000
18.00	.001	.002	.005	.045	.040	.005	.000
99.00	.000	.000	.000	.000	.000	.000	.000

Supplemental Table B

Ground Level Joint Frequency Distribution Table Summaries

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	.379	.615	.670	.384	.420	.281	.417	.418	.728	.637	.246	.229	.358	.572	.548	.609	7.230
B	.260	.256	.336	.241	.229	.206	.285	.332	.539	.411	.256	.206	.340	.407	.441	.431	5.203
C	.365	.373	.501	.358	.248	.228	.388	.471	.885	.521	.462	.380	.598	.688	.624	.619	7.504
D	2.098	2.216	2.532	2.483	1.786	1.392	2.034	2.882	3.811	3.198	2.674	2.392	3.085	3.678	3.083	2.925	41.820
E	.968	1.029	.914	1.221	1.210	1.387	1.849	2.756	4.116	2.772	1.298	1.256	1.197	1.411	1.052	1.088	25.502
F	.339	.347	.302	.382	.552	.788	.729	.605	.946	.850	.386	.630	.795	.765	.441	.313	9.153
G	.147	.074	.128	.153	.228	.356	.330	.229	.804	.300	.133	.286	.248	.233	.191	.157	3.588
Total	4.595	4.740	5.183	5.242	4.850	4.847	8.012	7.502	11.013	8.887	5.435	5.359	8.600	7.753	8.460	8.122	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	.184	.111	.128	.160	.078	.087	.042	.125	.063	.013	.078	.004	.037	.051	.401	.054	1.328
1.05	.215	.263	.364	.579	.985	.517	.311	.287	.218	.181	.174	.186	.257	.284	.275	.289	5.038
2.05	.530	.845	.956	1.858	1.833	1.898	1.367	.952	.771	.631	.581	.842	1.078	1.189	.952	.780	16.571
3.05	.949	1.045	1.179	1.782	1.085	1.218	1.784	1.581	1.820	1.436	1.128	1.533	1.442	1.359	1.174	1.070	21.158
4.05	.915	.802	1.015	.838	.577	.624	1.228	1.593	2.123	2.039	1.256	1.084	1.197	1.160	1.185	1.215	18.947
5.05	.850	.841	.887	.416	.280	.282	.841	1.128	1.881	1.520	.837	.609	.884	1.104	.995	.959	13.582
6.05	.495	.462	.432	.159	.113	.143	.395	.758	1.435	1.236	.598	.445	.644	.935	.770	.751	8.771
8.05	.408	.472	.348	.048	.015	.087	.247	.785	1.782	1.228	.573	.430	.708	1.160	.808	.738	9.815
10.05	.113	.170	.050	.001	.000	.001	.032	.214	.678	.302	.102	.118	.289	.372	.183	.201	2.805
13.05	.023	.029	.008	.000	.000	.000	.005	.078	.214	.102	.024	.082	.107	.131	.015	.076	.889
18.00	.000	.000	.000	.000	.000	.000	.000	.014	.027	.002	.004	.012	.011	.017	.000	.010	.098
95.00	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Total	4.595	4.740	5.183	5.242	4.850	4.847	8.012	7.502	11.013	8.887	5.435	5.359	8.600	7.763	8.460	8.122	100.000

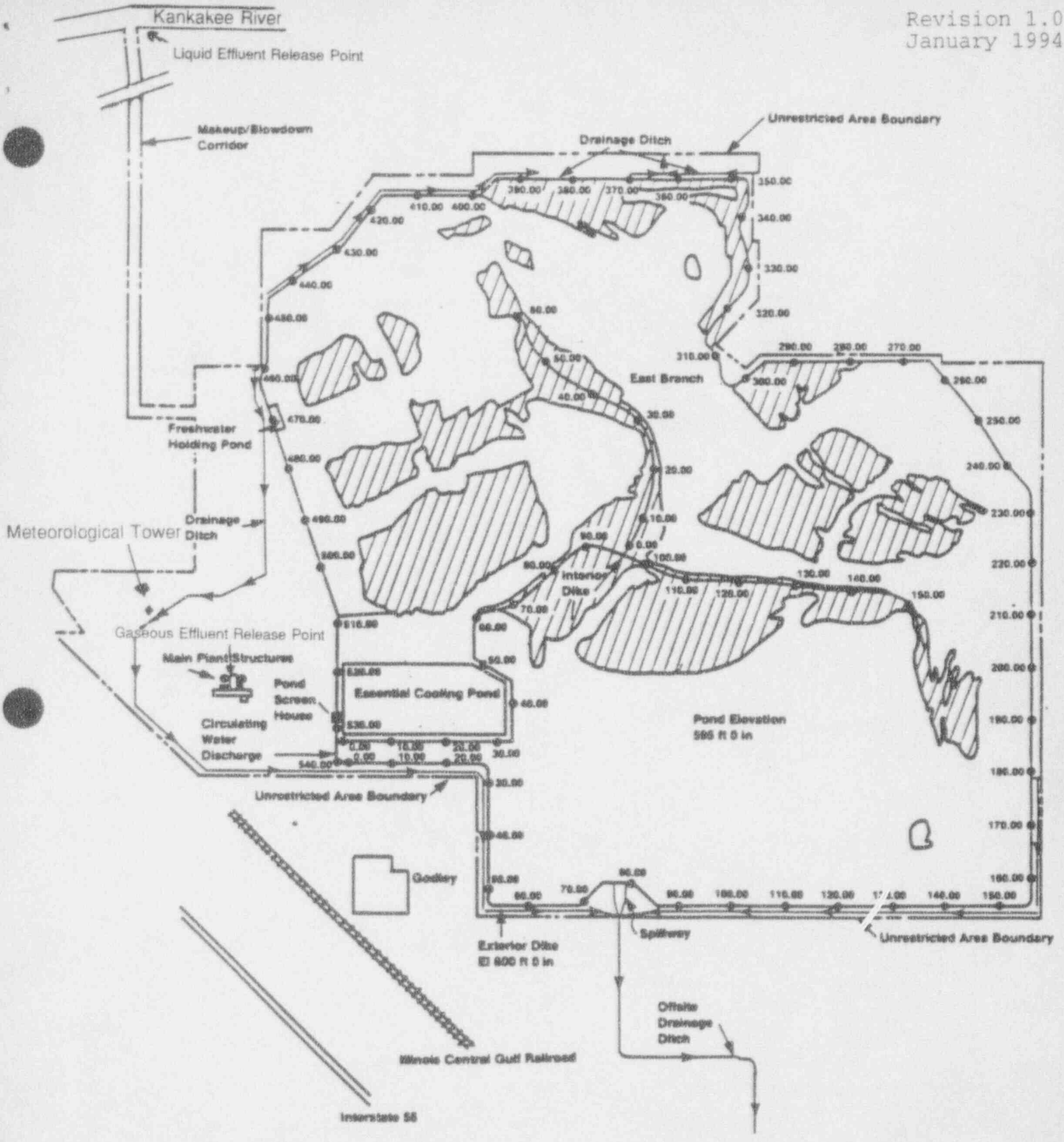
NOTE: Wind directions in tables are presented in "wind from" and not "wind to" direction.

Supplemental Table B -Continued

Ground Level Joint Frequency Distribution Table Summaries

Summary Table of Percent by Speed and Class

Class / Speed	A	B	C	D	E	F	G
.45	.027	.018	.021	.187	.339	.288	.338
1.05	.102	.093	.145	1.038	1.463	1.379	.818
2.05	.426	.498	.798	4.865	5.158	3.380	1.446
3.05	1.147	1.009	1.493	8.288	5.225	2.342	.672
4.05	1.618	1.158	1.699	8.574	4.586	1.059	.244
5.05	1.445	.969	1.213	5.908	2.689	.304	.055
6.05	1.155	.681	1.007	5.053	1.783	.118	.014
8.05	1.054	.528	.870	5.084	2.086	.107	.002
10.05	.215	.126	.212	1.360	.839	.053	.000
13.05	.028	.040	.044	.423	.320	.024	.000
18.00	.001	.002	.004	.048	.040	.000	.000
88.00	.000	.000	.000	.000	.000	.000	.000



Unrestricted Area Boundary

Scale 1000 0 1000 2000 Feet

300 0 600 Meters

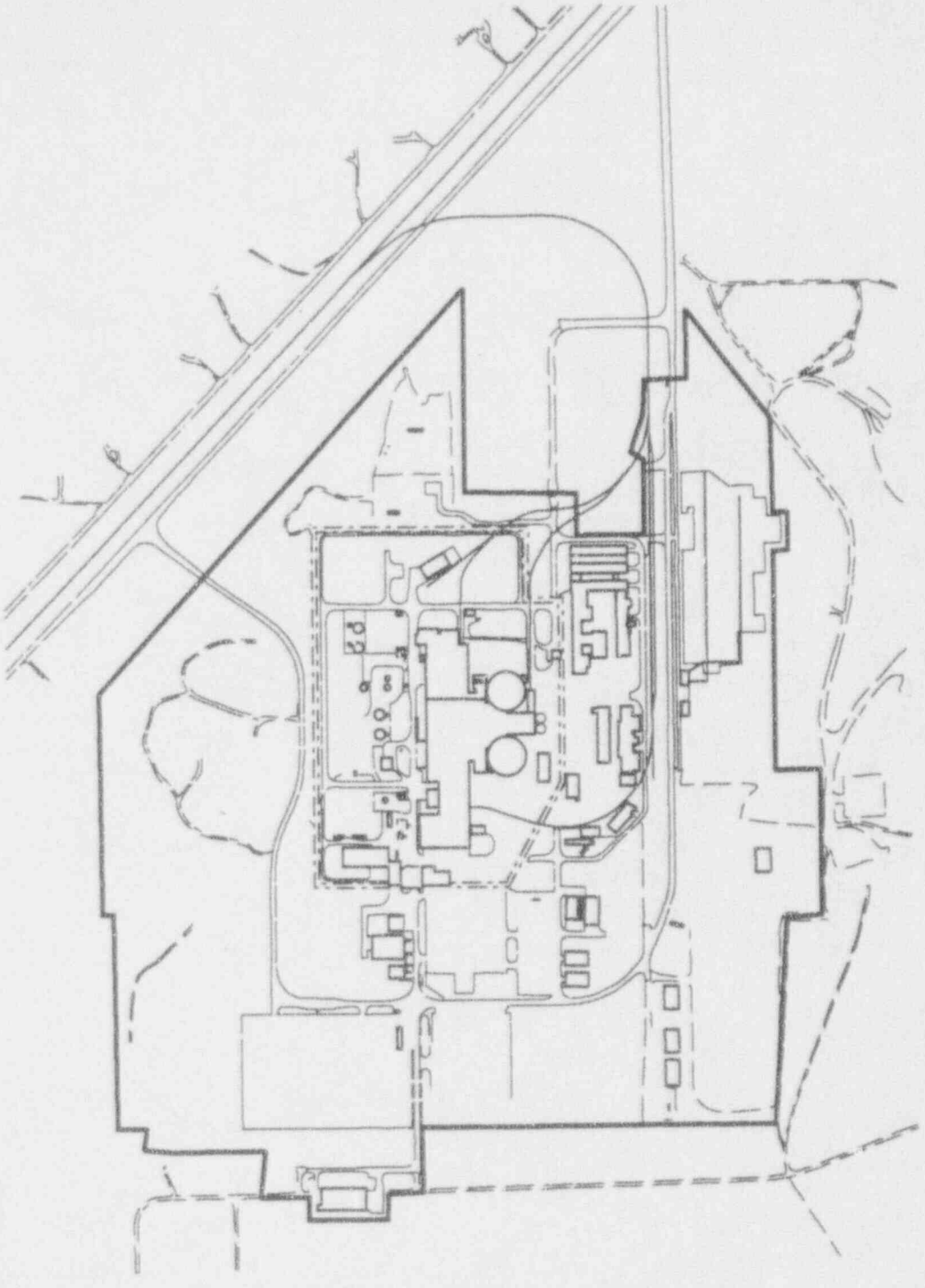
North

OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

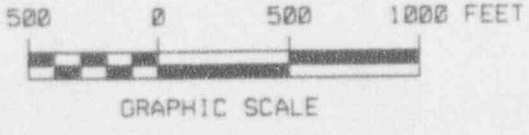
FIGURE F-1

UNRESTRICTED AREA BOUNDARY

6972-1
07-85—395



Restricted Area Boundary



OFFSITE DOSE CALCULATION MANUAL
BRAIDWOOD STATION

FIGURE F-2

RESTRICTED AREA BOUNDARY